

Teaching Science During the COVID Pandemic: K-12 Teachers Tell Their Stories

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Introduction

In early 2020, the COVID virus became a worldwide concern. By March of that year, schools across the country were shutting down in an effort to “flatten the curve” (Williams, 2020). Initially, many schools simply paused, often by extending spring breaks, with the assumption that the shutdown would last a few days or weeks. However, as it became apparent that students and teachers would not be returning to their classrooms that school year, schools transitioned to an online distance-learning model (Berger, Kuang, Jerry, & Freund, 2022).

For most teachers, this transition happened swiftly with little to no warning. Many were told to immediately transition to online learning with little support, instruction, or preparation time. Many had never used an online teaching platform. Many had never used videoconferencing technology. Yet, teachers quickly pivoted, putting in long hours in efforts to cobble together some semblance of science instruction for the remainder of the school year. They devoted enormous amounts of time planning, digitizing, uploading assignments, delivering instruction, and assessing student work, all in an attempt to stay one step ahead. And despite this investment, they struggled to inspire engagement or enthusiasm from students who were trying to figure out how to navigate this new reality themselves.

Unfortunately, online learning represented a best-case scenario at that time. Where school districts were not able to provide their students with computers, tablets, or internet access, historic inequities in access to technology magnified inequities in access to learning (National Center for Education Statistics, 2022). Although some students were able to secure these resources on their own, others essentially stopped going to school. Teaching stopped. Learning stopped. This scenario is particularly troubling if one considers the schools most impacted in these ways, namely small schools in rural areas and schools serving large percentages of high-poverty students. For example, 41 percent of teachers in rural areas reported students did not have internet access, compared to 61 percent of teachers in suburban areas (Berger, Kuang, Jerry, & Freund, 2022; Stelitano, et al, 2020).

As the pandemic persisted into the 2020–21 school year, parents, teachers, students, and schools were faced with the decisions about how to proceed. Many schools opted to begin the school year entirely online while others opted to return fully in person. Still others took a hybrid approach in which small groups of students participated in in-person instruction on select days of the week while others participated virtually (Oster, et al, 2021). Learning models shifted throughout the 2020–21 school year, with virtual learning waning and in-person learning gradually increasing. By the end of the school year, in-person and hybrid modes were much more common than virtual-only learning. However, in-person and hybrid models, while generally best for student learning, brought a host of health and safety measures and protocols that teachers were asked to implement and enforce in addition to their already overwhelming workloads. These included face masks,

face shields, plexiglass dividers, temperature checks, frequent handwashing, and desk disinfecting to name a few.

Regardless of the learning model, teachers were still responsible for teaching science content and, in some cases, preparing students for state-mandated and/or Advanced Placement (AP) exams.¹ For some science teachers, the topic of viruses was a natural fit with their required curriculum. Others had to integrate COVID-focused instruction in more creative ways, often in connection with lessons on adaptations or the nature of science. Still others covered COVID as a standalone topic, choosing to discuss this historic event even if it meant sacrificing time spent on required course content.

As might be expected, students had a lot of questions about COVID, and science teachers were the ones they naturally turned to for answers. Science teachers fielded student questions related to the virus itself (e.g., what it is, where it came from), how it is transmitted, and the efficacy of health and safety measures, including social distancing, masking, and hand washing. As the pandemic wore on, students approached teachers with questions about vaccines, confused about the polarized viewpoints they were hearing from adults in their families, communities, and the country at large. However, students also approached teachers with questions that went beyond science content, frequently looking for an outlet to voice their fears, concerns, and frustrations. Teachers had to toggle between attending to students' social emotional needs and their learning, and at times these overlapped.

However, students were not the only ones who experienced emotional distress. More than a quarter of schools reported increases in teachers seeking mental health services.² Many teachers struggled to find a balance between their work life and home life, torn between the need to take care of themselves and their families and the expectation (imposed by themselves and others) that they put students first. Teachers mourned the loss of loved ones -- but showed up for school the next day. Teachers battled anxiety and depression -- but showed up for school the next day. Teachers managed underlying health conditions, including autoimmune diseases and chronic health conditions -- but showed up for school the next day. Because, no matter what was going on in their lives, teachers were determined not to let their students down.

Although the 2021–22 school year brought about some measure of normalcy, impacts of the previous two years were widely felt. These impacts included student learning loss, emotional distress, and behavioral problems stemming from underdeveloped social skills. In fact, two-thirds of schools reported that the pandemic played a major role in students being behind grade level to start the school year, and more than three-fourths reported

¹ Some states suspended end-of-year tests when the pandemic-related disruptions were at their peak.

² This is almost certainly an underestimate, as half of school reported not knowing whether teachers sought such services. (Institute of Education Sciences, National Center for Education Statistics, 2023)

that the pandemic negatively impacted their students' behavioral development (Institute of Education Sciences, National Center for Education Statistics, 2023). It was not as simple as bringing kids back into classrooms and moving forward with business as usual. Teachers found themselves picking up pieces and trying to put schools and students back together, often while still navigating COVID-related restrictions.

The following vignettes highlight 40 science teachers' experiences teaching during the COVID pandemic. These vignettes encapsulate the range of events, activities, practices, and feelings that were part of teachers' daily lives during this time. While the stories certainly share some similarities, they are as unique as the teachers who shared them with us. Our hope is that in contrast to the widely circulating facts and figures about the impacts of the pandemic, the vignettes will serve to humanize this moment in time by sharing teachers' stories in their own words. But above all, we hope the vignettes will lead to a deeper understanding of and appreciation for the monumental effort science teachers shouldered in providing accurate and timely scientific information in challenging, frightening, and often contentious times.

Vignette Teachers at a Glance

Name[†]	Grade Band	Teaching Assignment	State	Community Type
Ms. Clemmons	Elementary	General Science	DC	Urban
Ms. Lockhart	Elementary	General Science	NJ	Suburban
Ms. Lee	Elementary	General Science	FL	Urban
Ms. Oakley	Elementary	General Science	NC	Suburban
Ms. Xavier	Elementary	General Science	NJ	Suburban
Ms. Burton	Elementary	General Science	TN	Urban
Mr. Green	Elementary	General Science	MN	Urban
Ms. Simon	Elementary	General Science	OH	Urban
Mr. Hartfield	Elementary	General Science	AZ	Suburban
Ms. Ramirez	Elementary	General Science	NY	Urban
Mr. Grayson	Middle	General Science	OH	Urban
Ms. Wright	Middle	General Science	IL	Suburban
Ms. Simpson	Middle	General Science	AL	Rural
Ms. Williams	Middle	General Science	WV	Suburban
Ms. Trudy	Middle	General Science	PA	Online
Ms. Brewington	Middle	General Science	CA	Suburban
Ms. Lopez	Middle	General Science	CA	Urban
Ms. Levy	Middle	General Science	MI	Suburban
Ms. Kim	Middle	General Science	KS	Rural
Mr. Flanagan	Middle	General Science	OR	Rural
Mr. Reeves	High	Life Science	MN	Suburban
Mr. Hill	High	Non-Life Science	NY	Rural
Mr. Stephenson	High	Life Science	UT	Suburban
Mr. Gifford	High	Non-Life Science	CA	Urban
Ms. Gordon	High	Life Science	KY	Online
Ms. Meier	High	Non-Life Science	IL	Rural
Mr. Taylor	High	Life Science	OH	Rural
Ms. Hall	High	Non-Life Science	MI	Rural
Mr. Smith	High	Life Science	MI	Urban
Ms. Goodall	High	Non-Life Science	IL	Suburban
Ms. Davis	High	Non-Life Science	NY	Suburban
Mr. Johns	High	Life Science	LA	Rural
Mr. Henley	High	Life Science	WI	Rural
Ms. Casey	High	Non-Life Science	AZ	Suburban
Ms. Bullard	High	Life Science	NC	Suburban
Dr. Stone	High	Non-Life Science	NJ	Suburban
Mr. Pate	High	Life Science	ID	Rural
Ms. Britt	High	Life Science	GA	Suburban
Ms. Aziz	High	Non-Life Science	IL	Rural
Ms. Keller	High	Life Science	IL	Urban

[†] All teacher names used in this report are pseudonyms.

Teacher Vignettes

I Can't Take 22,000 Steps in a Day

Ms. Clemmons is a science specialist in an urban Catholic school in Washington, D.C. Prior to the pandemic, she provided hands-on science instruction to students in grades K-5, engaging with each classroom 2-3 times per week. She described a typical day of instruction during this time as very physically demanding.

My normal school year would be 19 different classes, 19 different classrooms all on different floors, with a four- or five-minute transition time to go from place to place. So I could be in a kindergarten classroom and have to go to my office to pick up a change of books and materials and then run up to the third floor to teach a fifth grade class and then go to the opposite side of the building to a third grade classroom. And those would be back to back to back.

I would normally log maybe 22,000 steps a day, and I didn't have to do that at all because I was so embedded on the same floor as my office. . . For me, physically, it was actually kind of nice.

In the spring of 2020, Ms. Clemmons' instruction immediately became online and asynchronous with the arrival of the COVID pandemic. This shift significantly reduced the amount of time available for science instruction, typically limiting her to one lesson per week with any given class. The shift also forced her to rely on videorecorded lessons that utilized materials students might have already had available in their homes.

Normally, the structure of those classes would be some foundation discussion about some sort of topic, and then we would do something, either an experiment or some sort of hands-on activity or an exploration. And there, I could not necessarily make the assumption that the materials that I would normally use were readily available to them. So a number of things had to be modified with household items that they could easily get their hands on.

When students and teachers returned for the 2020-21 school year, Ms. Clemmons' school implemented a hybrid structure with half of the school coming for in-person instruction and the other half working at home on any given day. Although Ms. Clemmons was once again teaching in person, she was limited to third grade classrooms to prevent the spread of COVID across grade levels as much as possible. Because of her limited teaching schedule, she was also assigned a host of non-instructional duties, including cleaning/sanitizing and lunch and recess supervision. Although the situation wasn't desirable, the change made her realize that her physically and instructionally demanding workload in previous years would need to change moving forward.

Physically, that COVID year was easier because I did not have to do that travel from class to class. I would normally log maybe 22,000 steps a day, and I didn't have to do that at all because I was so embedded on the same floor as my office. I didn't walk around as much. For me, physically, it was actually kind of nice. I feel bad saying that, but it was.

Ms. Clemmons took advantage of her extended time with 3rd graders during the 2020–21 school year, adding in activities and demonstrations focused on germs, specifically viruses and bacteria.

Talking about the spread, I would take a little handful of baby powder, and I had a little turkey baster type of thing to get a puff of air. And I showed that if you have that puff of air, like when you sneeze, how those germs can spread so far with powder. And then I did something with hand sanitizer. I just mixed hand sanitizer with a really fine glitter and then shook everybody's hands. And even after you shake 20 children's hands, they still get glitter on them.

However, even though she was able to cover an extended science curriculum with her third-grade classes, Ms. Clemmons found that students were generally behind academically due to the previous year of online, asynchronous instruction. Therefore, she found herself reteaching and reinforcing key science ideas that students should have already learned.

This year was a lot of going back and figuring out what important topics were never covered and incorporating or reinforcing topics with maybe some of their new work.

In the 2021–22 school year, Ms. Clemmons returned to what felt like a mostly normal school experience, as all students were back to school in person. Although she resumed her normal rotation of K–5 classes, teaching during the pandemic brought about some positive changes in how her teaching was structured. For example, Ms. Clemmons continued to incorporate lessons around the spread of germs into her instruction because she recognized the importance of these topics for students' day-to-day lives, both now and into the future.

I think there's more of an understanding as to the need for washing your hands. When you start to talk about it and bringing in touching glitter or seeing how baby powder expands, I think the visual is a little bit more powerful. And even something as simple as doing the germs with a bread sample and seeing how that grows with the right conditions and then really being able to refer to it in the future is important and useful.

Further, after experiencing what a school day would be like if she focused on one grade at a time, Ms. Clemmons approached her principal and requested to see all of the classes from one grade level consecutively. This change made Ms. Clemmons' school day and travel around the building more efficient and manageable compared to what she experienced pre-pandemic.

At the end of 2021, I went into the principal and I said, "I can't and don't want to do that kind of traveling. All my grades need to be back- to-back."

Special Education in a Pandemic

Ms. Lockhart is a special education teacher in a suburban elementary school in New Jersey. Prior to the pandemic, she typically taught in a self-contained environment except for science, where she and a general education teacher co-taught both groups of students.

As a result of the COVID pandemic, her school rapidly shifted to virtual instruction in the winter of 2020. However, she and her students found it very difficult to make this transition, as her students were not equipped to navigate independent learning.

We were basically told to upload work into Google Classroom for our students. We were not even meeting with them via Google Meet. And as a special ed teacher, expecting my students to do work independently and handle it, that just wasn't happening.

Many of Ms. Lockhart's students quickly stopped engaging with the materials she was posting online. Further, without any personal interaction, Ms. Lockhart had no way to check for student engagement or understanding. As a result, her instruction essentially came to a halt.

Real instruction kind of stopped. We were posting things for the kids to do. Some of them did it, some of them didn't. . . There was really no real understanding of, "Are they learning anything from this?"

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The 2020-21 school year brought significant improvements. Although many students were back to school in person, the school offered a virtual option as well. Due to personal health concerns, Ms. Lockhart opted to continue teaching virtually. However, in contrast to the previous school year, she was able to meet live with students over Google Meets. She also offered virtual office hours and was frequently able to meet with students one on one. As a result, she was able to hold her students to higher expectations and track their learning progress. Ms. Lockhart noted that, overall, her students thrived during that school year.

I am probably an exception, but my students did phenomenal virtually last year. Like I said, I was on students. If you weren't in class, if you didn't turn something in, I was calling your parents. And we talked about it as a class later in the year, and we talked about the pros and cons to virtual learning and across the board, the kids all agreed that having those office hours that they could meet with me one on one, was a game changer because whatever it was, whether it was science, whether it was math, whatever they were struggling with, I could actually devote time to work with them one on one, on specifically what they needed.

Even though her students were thriving in this virtual learning environment, Ms. Lockhart was concerned that they were lacking the hands-on science experiences they would typically get in an in-person environment. Therefore, she decided to donate her time and money to provide students with regular supply drop-offs so they had the materials they needed to engage more deeply with the content.

I did try to do a monthly porch drop where I would actually drop supplies off to students' homes so that we could actually do something hands-on. I did the best I could to incorporate even a little bit of hands-on for them. . . . Just so much work and also money and time was involved. I live 30 minutes away from where I teach, so in order to do those porch drops, which I was not told I needed to do, but to be honest, in order for the instruction to be good, they needed to be done. So, that was me driving 30 minutes and then driving an hour and a half across town multiple times. It wasn't like I'm all in the same neighborhood. I was all over the place.

Ms. Lockhart also dedicated herself to providing students with differentiated instruction, an approach made possible by her streamlined and efficient online schedule.

It was the greatest way to differentiate instruction that I've ever seen, because we just don't have the time when you're in school full day and you're supposed to be teaching this curriculum at this time and for this length of time, and it does not give you a lot of leeway when you have kids who are maybe falling behind, so this was great.

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For the 2021–22 school year, all students returned for in-person instruction. Ms. Lockhart was able to resume her pre-pandemic approach of self-contained instruction coupled with team instruction for science. However, she reflected on the fact that her students were initially very resistant to pushing into the general education classroom because these larger group settings were different from what they had been accustomed to.

When we started pushing into the gen ed class, it was strange because normally my special ed kids liked to be around the gen ed kids. But this group, they were a little annoyed that we had to push in. Maybe that is a result of COVID because the class sizes were smaller last year, so they were used to having more teacher support. And when we go into the gen ed class, it's loud. There's 30 plus bodies, and it's not as easy for me to help them individually. . . . We're spreading them out and trying to get them to work with model peers, so I don't think they loved it.

Ms. Lockhart also lamented that the return to in-person instruction resulted in diminished student motivation, increased misbehavior, and overall stressful school days for her and her students. She found this contrast with the year before to be frustrating and

disheartening and expressed disappointment in herself and her teaching during this transition back to “normal” science instruction.

It wasn't what it could have been for students and . . . you always, of course, feel a little guilty if you know that you didn't do your best instruction. Especially coming down off of such a high from last year where the assistant superintendent is reaching out because she's hearing all these positive things about me. You go from knowing that you're doing a really, really good job to knowing that you're just kind of doing a mediocre job. So, there's that guilt a little bit, but trying to be gentle with myself and with my colleagues that we were just kind of adjusting back to being in person after not being in person, and that was difficult. It was a struggle for all of us.

Last Kindergarten Teacher Standing

To better understand the extent to which COVID impacted education, one might start by looking at the kindergarten classrooms in one urban elementary school in Florida. After struggling through years of rapidly changing COVID-related policies, procedures, and practices, Ms. Lee was the only kindergarten teacher left. She explained that eight other kindergarten teachers moved on during this difficult time, with most leaving the profession because they felt as though they could no longer balance their home and work responsibilities.

I'm the only kindergarten teacher that stayed from the start of pandemic to the end. We lost all of them. We lost maybe eight different teachers or more if you count this year. Some of them had small children at home, and they had to take care of their own kids at home, so they quit because they couldn't handle it anymore.

This mass exodus was put into motion in March of 2020 when Ms. Lee and her colleagues learned about the COVID pandemic. As rumblings of the effects of the pandemic started to spread across the county, their school district decided it was time to temporarily transition to online instruction. However, as COVID transmission spiked, the district made the decision to remain online for the rest of the school year.

Honestly, we thought we were going to have a week off. We thought it might be a day or two. We had no clue that those kids were going to go home and never come back or only be online.

As students went home in March of 2020, Ms. Lee's school district was able to equip all students with laptops so they could participate in online instruction during this time.

I have to say my county was amazing the way they came up with computers for every single student.

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Additionally, the district took exceptional measures to ensure students were online and present for instruction. Ms. Lee recalled that the district even enlisted the help of social workers to go out and check on students that weren't online in those first few weeks.

It was just unbelievable how hard they pulled together. . . . They literally had social workers going out and checking on why [students] weren't online. So they really, really did a heck of a job.

The majority of Ms. Lee's kindergarten class were English Language Learners (ELL). To bridge the language gap, her students regularly used Immersive Reader software³ on their computers to help with translations. Ms. Lee noted that the Immersive Reader software was extremely helpful during online instruction.

I speak a little bit of Spanish, but we have Immersive Reader on our computers, and it was already there because of being an ELL school. We just had to figure out how to use it more, and it was amazing how well set up [my school] was. . . . We were really set up and ready for [online learning], and I don't think anybody could have ever imagined, but we just were.

The school district provided teachers with a lot of autonomy when it came to deciding what content to cover with students during online instruction. Although it was not mandatory, Ms. Lee chose to teach science.

I do have a very strong background in science. I have an associate's degree in biology, and I was a medical illustrator, so science is my thing. I integrated a lot of it into my choices because at that point, we were pretty much on our own to do our curriculum.

Because of her passion for and background in science, Ms. Lee also decided to use curriculum materials provided by her county to discuss COVID-related topics. She noted that she aimed to not only involve her students in learning about COVID, but also their parents.

There was a curriculum my county posted that was online, and so I utilized it for discussing washing your hands and how to cough. . . . And I also had that in my curriculum for the parents to do with the kids, so they could go and educate themselves.

I do have a very strong background in science. I have an associate's degree in biology, and I was a medical illustrator, so science is my thing. I integrated a lot of it into my choices because at that point, we were pretty much on our own to do our curriculum.

Instruction remained online for the first part of the following school year (2020-21), with a shift back to in-person instruction in December 2020. As students returned to the classroom, the district requested that teachers emphasize mathematics and language arts in an effort to combat learning loss.

They really just wanted us to teach the kids the letters, their sounds, and the basic math skills, their numbers, how to count. So we were so geared towards getting the basics into them.

³ Immersive Reader is an online tool designed to help students improve their reading and comprehension. It also translates text into different languages.

Ms. Lee explained that the district focus on mathematics and language arts, along with increased COVID safety measures, limited the time she could devote to science instruction and impacted her ability to implement hands-on activities.

Science just dwindled out. It was in my curriculum, but I know no one put as much stress on it. But I did because, like I said, I love science. When you do a lot of hands-on projects in science, that's what really affects kids and sticks in their brain. But I couldn't have them less than six feet apart, so I couldn't have them participate in experiments and things. I could do them in front of them, but it's not quite the same as doing the hands-on where they really are part of it.

However, despite these challenges, Ms. Lee made time to discuss COVID-related topics with her students because she had seen the direct, positive results of doing so the year prior. She proudly explained that her efforts to educate her students about COVID and model best practices seemed to limit the spread of the virus in her classroom and between her students and their families.

I took it seriously. I did see teachers where their kids were all over each other and they were doing centers before they were supposed to. But I made them stay in their desks and do what they were supposed to do. And those people ended up getting sick, and my kids did not spread COVID because I really took it seriously. Even standing in line, I had marks on the floor of exactly where each person stood, so they were the right amount apart, and we walked in a line. They really didn't get that close to each other or touch each other. They were really good about it.

The 2021-22 school year brought some feelings of normalcy as COVID transmission lessened and students continued to attend school in person. Ms. Lee kept the same group of students from the previous year, transitioning with them from kindergarten to first grade. She continued to address COVID with these students and noticed that they seemed to understand and buy into the importance of measures for preventing the spread of the virus.

I would say that [they had an] understanding of cleanliness and the importance of hand washing and keeping things clean and giving each other personal space and keeping your hands and your feet to yourself.

It Was True Survival

Ms. Oakley, a second-grade teacher at a suburban school in North Carolina, vividly recalls the sequence of events when her school abruptly moved to online instruction during the spring of 2020.

We had heard that there was some virus. I even remember there was a girl that taught beside me, we were talking about it one day, and she said, "I don't know what the big deal is. Lysol kills it. And we all have Lysol. So what's the big deal?" Then probably two weeks later, we were told to send computers home with our kids that weekend, which we don't normally do, or didn't at the time, and then that weekend, they ended up shutting the school systems down.

She and her colleagues were not prepared for online instruction and had no prior experience teaching in that way. However, they had no choice but to quickly pull together some educational experiences for their students.

They gave us two or three days, the teachers, to figure out how to do virtual instruction. They didn't give us any instruction. . . . Basically, we had to figure out how to teach online and share that information with our second-grade children to then get them online to do something educational at that point. So it was a quick change and very awkward. . . . They just threw us at it and said, "Here, do it." There was no instruction from the school system as to what they wanted. I had never done videos of myself. I had never worked on Microsoft Teams. I had never done any of that stuff. So it was survival at that time. It was true survival.

Despite Ms. Oakley's best effort, online instruction was extremely challenging. She recalled the long hours spent planning, recording and uploading lessons and delivering instruction. Although she and her colleagues tried to implement a collaborative approach, she noted that the time she devoted to teaching was overwhelming.

I'll tell you, I struggled. I really honestly did. I think I probably struggled more than any of the kids that I taught.

I would start working at 7:30 in the morning, and I wouldn't end until 6:00 or 6:30 that night trying to get the Canvas page up, trying to get everything into Seesaw or Google Classroom. . . . So we had 15 teachers, and we worked together. One person would put all the reading plans together and say, "Okay, here are your Seesaw lessons." All I had to do was click to save it and then assign it to my kids. But all that for reading, math, science, writing. Somebody sent me a Canvas page, they gave us the baseline of it, but then I still had to personalize it for my class. I was just personalizing and clicking save and assign, I wasn't starting from scratch all totally by myself, but it took a number of hours. . . . Nights. Weekends. It was unreal. It was crazy.

After completing the 2019-20 school year online, the district decided to start the next school year (2020-21) in person. However, Ms. Oakley explained that the many safety and sanitation protocols in place continued to make instruction challenging.

We took the piece of writing away from the kids because we weren't allowed to transfer paper or books back and forth. We had to make it sit for two or three days before we could touch it. Well, if I made a copy and gave it to them, then they had to let it sit for two or three days before they could even touch it. And then in return, they complete it. And then I have to let it sit for two or three days before I can even look at it. That did not even make sense.

Although the situation was not ideal, it did provide Ms. Oakley with avenues for discussing COVID with her students.

We talked about the importance of what social distancing was, the importance of staying away. We did have some plexiglass shields in the school. "Why were there some of those plexiglass shields? Why did some people choose to wear a mask, but then the little face shield thing too? What were some of the reasons why people did different things?" And that kind of thing. What we boiled down to was everybody's different and it's okay to be different. And that's one thing that our school is very big on is, it's okay to be different. Everybody's different. It's okay to be different. So we just embedded that into our regular part of our day.

However, the return to in-person instruction also caused Ms. Oakley to fear for her personal safety due to a preexisting autoimmune disease that put her at increased risk.

I'll tell you, I struggled. I really honestly did. I think I probably struggled more than any of the kids that I taught . . . because of that autoimmune disease that I said I have. And we still weren't quite sure. And even to this day, nobody's been able to give me a true answer about what would happen [if I got COVID].

Yet, rather than trying to hide her condition from her students, she used her personal experience as a way of introducing her students to another facet of COVID.

I talked about my autoimmune disease and how I might do things differently, but that's because this is what I need to do. And you might do things differently because that's what you need to do. They were really good about it.

I can say this for any of us, we truly, honestly, with everything in our bodies and souls, we did everything that we could to the very best of our abilities.

As the pandemic persisted, the tension between Ms. Oakley's desire to be an effective teacher and her need to protect herself came to a head. During the middle of the 2020-21 school year, her class was scheduled to go on a field trip, a prospect that brought her a great deal of anxiety.

In February, at some point, my principal deemed that we needed to go on a field trip. I had a panic attack. I mean, it was a full-blown panic attack, because I would

have to get onto a bus with all of those students. I mean, I was still staying six feet away from kids. I was wearing my mask every day. I couldn't do it. I started looking for some virtual jobs. I did have a virtual position in another county offered to me. And then I went and talked to my principal and was like, "Look, I have a virtual position. I'd rather stay here, but I can't do the field trip. I'm still struggling with some of this." So he said, "If you're willing not to take the virtual position, stay here. I will work with you." He ended up doing a job share thing. He had another teacher go in my place, and I covered that teacher's class that day. So that helped me mentally.

During the 2021-22 school year, her school was able to resume more "normal" practices and procedures. However, the challenges of the pandemic made Ms. Oakley question her ability to remain in the teaching profession. In the end, financial considerations ended up being a major driving factor in her decision to persist.

I talked to my human resource people, and I am three years away from retirement. If I go now, I'm giving up an awful lot of money. . . . I could retire right now because you have to be a certain age and you have to have taught a certain number of years and all that. I qualify for all that stuff. But it would be a very marked 40 percent or 50 percent of what I would normally bring home for the rest of my life. It makes a difference.

Ms. Oakley indicated that she wished others knew just how much teachers poured into their students, at the expense of themselves and their families, during these very difficult times.

I can say this for any of us, we truly, honestly, with everything in our bodies and souls, we did everything that we could to the very best of our abilities. It was not perfect. Nobody taught us how to do it. We taught ourselves. We were floating 9 times out of 10, not even having a clue of where we were headed. But our mindset was, "Let's give the kids the best instruction that we truly can." We were there for those students in our classrooms. I wish that people would realize that in doing that, we put our own families on hold.

We Continued With Science

In early 2020, the large suburban school in New Jersey in which Ms. Xavier served as a K-5 science specialist closed its doors due to COVID. School leaders, like many others across the country, initially underestimated the severity of the situation. Therefore, Ms. Xavier and her colleagues were tasked with finding ways to teach online for two weeks with the belief that they would then return to the classroom.

I basically rewrote the entire curriculum to try to have students be able to do it at home with materials that they could have at home. . . . I was a week ahead, that's all I could do was go a week ahead. And I would sit for hours and recreate plans that parents could follow.

We were told two weeks we're going to stay home, just to keep everybody safe for two weeks. And so we were charged with creating opportunities for kids to do science at home with just basically reading and writing. . . . We sent everybody off with some really cool informational texts to read and some thinking questions, maybe looked at some data. And that was going to be their science for two weeks.

However, this online instructional arrangement persisted beyond two weeks as the state governor kept slowly extending the timeline for a return to school. With no end in sight, Ms. Xavier and her colleagues decided to shift their efforts to providing a more engaging, hands-on virtual science experience for their students.

We made a decision early on after [the extended school closure] that we wanted to try to mirror the best we could the hands-on approach that we'd take in school. But we knew we weren't going to be able to get any materials to anybody, so that meant how do we help teachers? And we were not synchronous at the time. We were not allowed to teach via live video. There were some issues with things happening in homes and then being broadcast. And plus we were originally on Zoom, but it didn't have the right filters that we needed for privacy and whatever. So we ended up trying to do hands-on, but not live teaching. So sending home assignments and/or teachers could make videos that kids could then watch but not live. So that's what we did for four more weeks.

As COVID continued to spread, the school decided that instruction would remain online for the duration of the school year. Therefore, Ms. Xavier changed direction once again, putting in long hours to fully rewrite the FOSS⁴ science curriculum materials that her school had adopted.

My hat changed completely from a teaching role at that point to, "How do I help K-5 teachers have students still do science at home?" So that was really my focus for

⁴ Full Option Science System (FOSS) is a hands-on, student-focused science curriculum for elementary and middle grades students. (<https://fossnextgeneration.com>)

that spring. I sat myself down at my kitchen table, and I rewrote FOSS, and I basically rewrote the entire curriculum to try to have students be able to do it at home with materials that they could have at home. . . . I was a week ahead, that's all I could do was go a week ahead. And I would sit for hours and recreate plans that parents could follow.

Ms. Xavier explained that her priority was to amend the existing curriculum in ways that were amenable to online teaching without disrupting students' conceptual development. As a result of her efforts, teachers in her school had the support they needed to continue teaching science under challenging conditions.

I am very proud to say that we continued with science, because I know a lot of districts did not in elementary schools. And I worked my tail off to take the teacher's manual and follow the sequence of learning. Because I know how carefully FOSS scaffolds conceptual development, so we didn't want to skip any of that. . . . And we were really successful having kids still experience science. Did they learn deeply the way they do in class? No, and we certainly didn't assess the same way. It was really just hoping that the kids had some experience so that when they met those concepts again in the following years it would not be brand new to them. Our goal was really, "We know how conceptual development works. Let's at least have the kids touch these ideas and think about them, even if we can't have them deeply engage with them the way we normally do."

The following school year (2020-21) started online before students were eventually given a choice to return in person or remain online. This hybrid arrangement meant that Ms. Xavier and her colleagues were responsible for providing science instruction to both groups of students simultaneously, a task they found to be very difficult.

We are in a real Title I community. I would say maybe 60 percent of our students are Title I, free lunch available. We have a lot of multi-generational families, so a lot of parents kept their kids home because our governor had given them the right, legally, to stay virtual for the year. And our district decided, for whatever reason, there would not be a virtual teacher. The teachers and classes remained the same. And so teachers were teaching live to kids who wanted to come in, and then kids whose families wanted them home, they were online. . . . So it was very difficult for teachers to teach to two populations at the same time.

Further, even though a subset of students returned to classrooms in person, this did not mean that teaching and learning went back to normal. Ms. Xavier noted that the many safety policies and procedures intended to keep everyone safe significantly hampered teachers' abilities to facilitate collaborative, hands-on science lessons.

Science, for us anyway, is such a collaborative experience. But we had to completely change how we taught it. And so, "Yay, we got the curriculum back," but now we have to teach it a whole different way because they can't share materials. They can't really even sit near each other.

Despite the less-than-ideal circumstances, teachers persisted in teaching science during the hybrid year and were extremely relieved when the 2021-22 school year brought a return to some measure of normalcy. All students were back in person and, while there were still school-wide COVID prevention measures in place, teachers were once again able to use best teaching practices.

I think people need to actually understand how committed teachers were to trying to support students in the scariest time our world really has faced for any student alive today.

I think I would say we've gotten pretty close to normal. Our physical makeup is not normal in that there's still a desire to have the barriers. We have been given permission from central administration to have students work collaboratively in science, so depending on the teachers' comfort level, kids are working back in groups. That's been huge. We did make a great investment in air purifiers and lots of wipes. And also, the teachers have really gotten used to having kids help wipe materials down. So I feel comfortable saying the way we teach science is very close to being back to normal, the pragmatic parts of it.

Reflecting on her efforts and the efforts of her colleagues during the pandemic, Ms. Xavier wishes the general public knew just how important teachers were during this time, providing students with knowledge, stability, and reassurance when the world seemed to be falling apart.

I think people need to actually understand how committed teachers were to trying to support students in the scariest time our world really has faced for any student alive today. I mean, the only thing I can liken it to as a teacher was September 11th. I was teaching on September 11th. . . and we saw the fighter jets literally going up and down the corridor. We could see the smoke from when the Twin Towers tumbled. That was the hardest time to teach, but it was for a finite period. It was two weeks we were off, and then we were back trying to assure kids that they were safe and all of those things. I get chills still thinking about that But this has been three years of trying to keep students feeling that they're safe while they're learning. . . . And I really would love for people to know how much we worked to keep things as normal as possible. Because the one thing we do know as educators, and most parents know, is structure and stability go a long way for student learning and student mental health. And so even though we had to change a lot of things we did, we also tried to make sure kids had the same routine. We were the constant. Teachers were the constant for students.

Meeting Students' Social, Emotional, Physical, and Intellectual Needs

At the beginning of 2020, Ms. Burton was serving as a 4th and 5th grade STEM specialist at an urban Tennessee elementary school. In this position, she was travelling to 4th and 5th grade classrooms during the school day for 45-minute STEM instruction sessions. However, after spring break, her school decided students and teachers would complete the rest of the school year online due to the COVID pandemic. Ms. Burton had already introduced the yearly science fair project that she typically does with students. Although students were learning remotely, she had them continue work on the project they had picked.

To begin with, I just had them work on their science fair projects. I really thought we would probably be back in school in May, so just work on their science fair projects.

Some of her students had decided to research COVID for their science fair project, which led to a lot of online class discussions about the virus. In fact, her students' interest encouraged Ms. Burton to do a more structured lesson around COVID.

There were lots of questions about COVID, and so I felt like it was important for me to almost give a lesson and just say something about the latest CDC news, and this was what this means, and breaking it down into child-friendly things. But I was also trying to be transparent too, and just telling them not to be afraid and that this is the ultimate science experiment really. We're working in this global Petri dish, so to speak, so it turned into a learning opportunity in my opinion.

Ms. Burton noted that the pandemic served as an opportunity to make science relevant for her students and for them to see scientific processes happening in real time. She found that talking about the virus with her students encouraged them to ask questions and make comments about things they were seeing unfold. The experience also increased student interest in science and helped them envision themselves in future scientific careers.

There were lots of questions about COVID, and so I felt like it was important for me to almost give a lesson and just say something about the latest CDC news, and this was what this means, and breaking it down into child-friendly things.

I felt like, first of all, this is science in real life. This is real time. Science is always evolving and changing and how science affects our lives and in so many ways. I know that there was one little girl that said, "When I grow up, I want to be that lady with a scarf." It was that medical person that was always commenting on CNN from the White House. And so the kids would tell me which kind of scarfs this woman had on every day. It was so funny, but the career thing, that was really a neat little unexpected outcome. But just having the kids talk openly about what they knew, and parents appreciated the transparency and just having the kids having another outlet to talk to.

While Ms. Burton felt it was important to address COVID in her instruction, she also felt it was important to prioritize the students and their families. As students spent more and more time away from the school building, Ms. Burton became increasingly concerned with their well-being and ability to deal with the weight of the pandemic. As a result, she dedicated a lot of her time to addressing her students' mental and physical health.

We talked to our guidance counselors, "Hey, y'all need to pitch in and talk if kids are having anxiety or if there are extra things going on." And we were able to start food bags, and we put extra hygiene products in our blessing boxes, which usually have non-perishable food. Because there was a need. Kids were telling us, "Well, we don't have Clorox wipes at home" or "We've run out of masks. What do we do?" And if you think about Maslow's hierarchy, basic needs also needed to be met during the pandemic with these children.

As teachers were still figuring out how to meet student needs during this period of online instruction, the district announced that the academic year would end early. The fast transition to online teaching coupled with the shortened school year left Ms. Burton dissatisfied with the quality of instruction she was able to provide.

And then we figured out that the district was going to end school early. They were just going to cut it. So we did probably about three weeks' worth of just rounding out the school year and [covering] some of the standards that I hadn't gotten to that year. I just basically put it on Canvas⁵ and did some synchronous and asynchronous teaching. And I'll just be honest, it wasn't my best work.

In addition to the early end to the 2019-20 school year, Ms. Burton's district made the decision to delay the start of the 2020-21 school year. She explained that this decision was made to provide time for teachers and administrators to set up their classroom and the mandated safety protocols, as well as time to prepare to transition smoothly from virtual instruction to in-person instruction.

We delayed the start, and we started in person. And once again, it was almost like pivoting and shifting gears again. We still use technology in the classroom, but we allow the students to take the technology home with them. . . . It didn't take long for us to get back in the routine of the live experiments and doing things not so much on Canvas.

Pivoting back to in-person instruction came relatively easily to students, and Ms. Burton thought they adjusted well, having spent such little time learning remotely.

Kids adjusted a lot faster than the teachers did, I believe, and especially myself. It seemed like to me that students were just hungry for that face-to-face interaction.

⁵ Canvas is a learning management system (LMS) that supports online learning and teaching. Schools and teachers across the nation rely on Canvas and other LMSs as a platform for posting information, assignments, videos, and grades.

I feel that the top students were doing fine. But my kids, my most fragile, lower quintile of students, were on video games and sitting in front of the TV while virtual. I felt like they really regressed and not just in science.

Further, even with the limited online instruction the previous school year, teachers gained valuable experience that allowed them to meet the needs of students who were absent due to COVID. Ms. Burton reflected on the fact that course content could be easily accessed online, an opportunity she and other teachers would not have been able to provide prior to the pandemic.

The beauty of it is we do have lessons in Canvas and so we can do some synchronous and asynchronous. And then we also have swivel cameras, which basically follow the teacher as they teach. Let's just say last year we had a child that had chickenpox, and so we were able to take that swivel camera in the classroom. and that first-grade teacher was able just to continue teaching with the swivel camera, with the live feed to the parents when they were doing ELA and mathematics and science and social studies. So it was a great tool to have, and I don't think we would've thought outside the box before the pandemic about providing these opportunities for families that have sick children.

Despite an easy transition back to the classroom, Ms. Burton started to notice that students were not entirely fine. COVID was still a very real part of their daily lives, and as the year wore on, student behaviors started to deteriorate.

As the school year progressed, we really had to spend a lot of time on behaviors and getting kids acclimated to sitting in seats again and getting them acclimated to expectations for homework.

Students also began regressing academically, and Ms. Burton noticed that those students who had struggled with school prior to the pandemic were the most affected.

I feel that the top students were doing fine. But my kids, my most fragile, lower quintile of students, were on video games and sitting in front of the TV while virtual. I felt like they really regressed and not just in science.

For Ms. Burton, the pandemic highlighted the need for more social emotional support in schools and classrooms.

I feel like the pandemic shined a light on social emotional relationships, personalized learning, and some of these things that we talk about but probably weren't doing in the realm that we are doing it now. And I feel like that, in essence, it's made us stronger.

Despite the challenges of the previous two academic years, Ms. Burton went into the 2021-22 school year hopeful and prepared. Before the year began, she worked to put more resources on Canvas that students could access in any situation where they had to miss school.

We went ahead, just as a precautionary measure, we went ahead and put up a week's worth of Canvas lessons. We loaded up just in the event, we don't anticipate shutting down or anything of that nature, but it is nice to have . . . almost like sub plans in a way, but also with that, trying to do as much in person as possible at this time.

She also decided to expand her COVID instruction and made arrangements for the school nurse to supplement some lessons around germs and virus transmission.

Our school nurse got involved this year. We actually did some classes together and did some germ experiments, putting [GloGerm lotion] on your hands and how you touch all this stuff and then the [UV] light shines, and we've even talked about it this year about how, even though I asked just the other day, if anybody knew what the latest CDC recommendations were, and so a couple of kids knew it. And they're becoming more, I feel like educated on the world around them, especially the scientific world.

Ms. Burton experienced not only hardships but also growth while teaching science during the pandemic. She reflected on how proud she is of everything she accomplished and the ways in which she helped her students. While some adults doubted science at the time, her students were able to grow their love for the subject and become more trusting of science professionals.

I feel like I'm just so proud looking back on it. Gosh, where we were at and then where we went. It was not a wonderful time. People were scared, but just knowing that the students trusted us to make important decisions. They were resilient, and this was actually a fantastic opportunity to highlight science. And I feel like I have several students that just grew in their love of science because so much of what we talked about [that was] news related was science related and then talking about misconceptions in science and how we use science to inform. There were really some positive things to come out of this.

I Was Born of Distance Learning

At the beginning of 2020, Mr. Green was student teaching in a 5th grade classroom at an urban elementary school in Minnesota. His semester of student teaching had generally been progressing as planned until he and his mentor teacher found out that their school would be shifting to online instruction due to the COVID pandemic. In preparing for this sudden transition, Mr. Green and his mentor teacher collaborated with the rest of the 5th grade teaching team to put together asynchronous lessons on Schoology⁶ and Seesaw.⁷

With my mentor teacher and our grade level team, . . . we just started creating digital content basically and trying to put it in folders and organize it for students.

As the team felt more confident and comfortable with online teaching and learning platforms, they began meeting with their students synchronously. However, even though their school had a 1-to-1 initiative where each student was provided with an iPad, Mr. Green and his mentor teacher had a difficult time contacting their students.

Honestly, it was just super disheartening the amount of engagement we were getting from students. . . . It was hard to feel like we were making an impact really at all.

Students had emails, but we weren't using them regularly before that. So figuring out how to get in touch with them [was difficult]. Lots of calling families to get students online and working through tech problems. Our district is 1-to-1 iPads, so that was pretty helpful that students had a device. It was just getting them used to a schedule that they had to be in charge of. Getting them online and doing the assignments and checking in for the day.

Mr. Green recalled that the limited contact with students made it difficult to get any sense of how engaged they were during remote learning. Although he was not the full-time teacher, Mr. Green still felt very discouraged not knowing if he and his mentor teacher were having any kind of impact on student learning.

Honestly, it was just super disheartening the amount of engagement we were getting from students. . . . It was them going from really having a lot of support in the classroom to potentially being in a home setting where they didn't have a lot of support throughout the day to keep them on task. It was hard to feel like we were making an impact really at all. Keeping them on track would be one thing, but in a lot of ways felt like we

⁶ Schoology is a website for teachers to use with their students. Student can visit their teacher's Schoology page for online lessons, videos, peer discussions, and announcements.

⁷ Seesaw is an interactive learning platform that teachers can use to create tasks and assignments for students to complete while distance learning. Tasks and assignments can be uploaded as instructional lessons, files for students to download, or video instruction previously recorded by the teacher.

weren't even meeting and we weren't even able to check in with them enough to make sure they have a safe place at home and they're able to do really any schoolwork.

Although the experience was far from typical, Mr. Green completed his student teaching and enthusiastically started his first teaching job in fall 2020 as a PK-5 science specialist at a new school in the same area. However, the continuation of online learning, coupled with significant teacher turnover in the school, led to a very uncertain and chaotic start to his teaching career.

It being my first teaching year, there were lots of different things going on. I didn't have to set up a classroom, but I did have to set up my curriculum and lessons for the year. And also, because of how hiring shook out with the pandemic, lots of people retiring, and then also people not feeling comfortable starting the year, I really didn't know I had my job until two weeks before I started, which I think really influenced the first couple weeks in terms of just trying to get anchored. And so a big part of it was learning how many classes I see per day and in what format I see them.

As students settled into another semester of online instruction, Mr. Green's interaction with them was very limited. As the science specialist, his first weeks of school consisted of developing and sharing pre-recorded lessons as a means of getting acquainted with the students and introducing the science instruction he would be delivering.

For the first two weeks, . . . we did not meet synchronously through Google Meet with the students, only asynchronously. And that was because they needed families to be able to figure out how to get online, learn the agenda for the day, and when they would see us. And then also just to focus on spending time with their classroom teacher. And so I had no in-person contact with students for the first couple weeks. I was mostly producing half-hour lessons of get to know me, get to know you, this is what science is, what do you already know about science, what do you do as a scientist.

He was eventually able to meet with students synchronously during the school day and slowly started to move through his planned curriculum. While the pace was slower than what might be expected in a typical school year, Mr. Green was thankful for the slower pace. As a first-year teacher, it allowed him more time to plan and revise each unit before leading students through them.

Because of how many classes I would see, I really used those lessons for the first six to eight weeks of school because I would only see classes for two weeks at a time. That slowed everything down. I think back on it now as a blessing in some ways. As a new teacher, because of the slow pace starting, I was able to spend a lot of time going through the unit plans for the science standards and building my lesson planning spreadsheet and figuring out units from beginning to end. Whereas I feel like if I was in person, so much more of my time would've been

spent face-to-face with students that maybe some aspects of that wouldn't have been as well planned out.

However, as he started doing lessons with students, Mr. Green was disappointed by the lack of hands-on activities that online teaching afforded. Although he could ask students to do some at home activities, the school requested that any lessons that required students to have materials on hand needed to be accessible to all students to ensure the same learning experience.

It would usually be an introduction and then they go and do something, whether it'd be online or whether for some things like "Go outside and observe something" or even build something if they had materials. I think the problem was mostly equity. And that was the language you're getting from my district as well is "Do not push anything that you think could be unsafe and also anything that potentially could result in some students not having the materials."

To combat potentially inequitable online instruction, the school gave teachers the option to do two material drop-offs at predetermined times during the year. However, because the beginning of the year was so chaotic for Mr. Green, he missed the first material drop off.

I think we only had two opportunities to get materials to students. Sadly, the first opportunity was the first week of school, and being a new teacher, I had no idea of anything going on. And so I wasn't able to get them base materials other than what the school got them—paper, crayons, maybe basic science material type stuff—until November. And then I did some take-home stuff that could be more specific to science, like Mystery Science worksheets and pipe cleaners and more hands-on materials.

I think there are definitely really hard days and weeks, but overall, I've felt really empowered to be a teacher.

Teachers and students returned in person for the 2021-22 school year, which was Mr. Green's first opportunity to teach students face-to-face. Although welcomed, the shift back to in-person instruction brought a whole new set of challenges for Mr. Green, as his previous teaching experiences had been mainly online.

I think because I started in distance learning and then transitioned to in-person, I think it was just really difficult to get back to hands-on science. I felt the residual impacts because I was born of distance learning. It just got hard to get back to basic teaching practices like Think-Pair-Share and special groups and just normal teaching stuff because you couldn't do any of it online. And then not building the skillsets for how to manage hands-on, that was a huge learning curve this year. . . . I had to learn science safety actually and try to anticipate what could happen with the materials once they're in the hands of students.

Mr. Green particularly struggled with lesson planning as he transitioned to in-person instruction. He noted that his school required lesson plans well ahead of time, along with regular observations by his assigned mentor to ensure he was on track. Although helpful, these activities were daunting at times.

This year, I had a coach the whole year. That felt hard. I had expectations on having lessons done, which eventually wasn't a big deal at all. But at the beginning of the year, it felt very daunting having everything done way ahead of time and having someone critique it and then have to take what they said and put it in the lessons for the week.

Classroom management was also a new challenge because his only experience managing classroom behaviors came during the first part of student teaching.

I think the biggest thing was having my own space and relearning, honestly, classroom management. I think when I was student teaching, it felt really daunting the days that I would be alone in the classroom, but I didn't know any different. So learning that dynamic of them coming to you into a new space and you're in charge of how the space operates.

Additionally, Mr. Green struggled to figure out how to move away from tried-and-true digital lessons and activities to things that were more engaging and hands-on.

And then how do I authentically change my digital learning lessons? I still want to keep improving, but how do I stop using so many videos and digital assessments and move on from that, and get back to grouping and small group discussions and in-person teaching rather than just lots of independent work?

Looking back, Mr. Green recognizes that the start to his teaching career was much different than he expected and much different than almost every other first-year teachers' experience previous to the pandemic. Although it was a difficult start, he slowly gained confidence in his own teaching and learned lessons that many new teachers never had the chance to, like the need to balance hands-on work and technology in the classroom and ways to build relationships with students. He expressed confidence that this experience will make him a more effective teacher in the future.

I think there are definitely really hard days and weeks, but overall, I've felt really empowered to be a teacher. I think we've learned so much with distance learning. And we knew so much before about in-person teaching that now we just need to build a better normal. . . . I think that as a new teacher, I need to build the relationships with students still. And that got better by the end of the year. I think just being open to uncertainty has been difficult, but also I think just really good for everybody. And I think going forward will really help make me and other teachers more effective.

Making Adjustments

During the 2019–20 school year, Ms. Simon was working as a 5th and 6th grades science teacher at an urban school in Ohio. In March of 2020, her school, like many others across the country, decided to send teachers and students home to finish the school year virtually in response to COVID. However, online instruction was initially delayed because it took time to distribute computers to students at their homes. Online instruction was then further delayed because it became obvious that most students and their parents were not familiar with these devices and needed a great deal of technology support.

I had to wait for them to get their computers. So once we got that, we noticed, in most cases, this was their first time having a computer. So we had to take literally half of the first quarter, which is about five weeks, . . . to teach them how to use the computers and to even help their parents use them.

Once students felt comfortable with their devices, Ms. Simon was able to resume science instruction. However, she found it extremely difficult to find ways to make science engaging and interesting in an environment that was not hands-on. She noticed that her students were also frustrated with this new style of learning.

As far as science teaching, it was hard because I teach hands-on most of the time when I'm in the science lab. So it was really hard trying to make science interesting when they are looking at the computer all day for every single subject. . . . So it was just me trying to figure out how to make science interesting while they're at home pouting and tired of just sitting and looking at the computer.

Because she and her students were struggling with online instruction, Ms. Simon took the initiative to implement well-being surveys and have regular check-ins with students so they had an outlet to talk about things that were going on in their lives.

We did a brief survey with students. "How are you feeling today? Do you need to talk to the teacher about a personal matter? Yes or no? If you typed yes, send an email to one of us." So we did that, just to set the tone.

So it was just me trying to figure out how to make science interesting while they're at home pouting and tired of just sitting and looking at the computer.

Online instruction continued into the first half of the 2020–21 school year but shifted to a hybrid learning environment during the second semester of the year where small groups of students alternated between in-person and online learning on select days. Hybrid instruction brought its own set of challenges, as it required Ms. Simon and her students to adjust to new safety protocols and classroom procedures. These protocols made it difficult at times for Ms. Simon to even provide students with basic needs, such as water.

Sometimes the air wasn't working, and we're all sweaty with that mask and breathing and frustrated and angry with each other from that. So it was those little

things. Or making sure they gave us water because, obviously, they can't use the water fountain. But it's hot, . . . so we would have to constantly remind custodial staff, we have legal documents that we need a certain amount of water in our classrooms . . . because we have five children with illnesses where they have to have constant water coming in and cool water at that. The simplest things like water were a challenge.

She noted that the safety protocols also hindered her ability to immerse students in hands-on science activities.

Our district mandated we had to do six feet [of distance] and we could only, at the most, fit 12 kids in each room. It was better being able to physically see each other, but we still couldn't do group work. So they had to do all of their lab work by themselves. And that's not too motivating. You can talk with each other, but you can't be close. So I was trying to teach them one-on-one, but for a science experiment where science should be group work.

However, Ms. Simon felt that it was important to talk to students about COVID and why the safety mandates were important. She regularly had informal discussions with students about these topics, and also brought in an expert to lead a lesson about infectious diseases.

I had a partnership with a neighboring university, . . . and they have a STEM program for underrepresented communities and urban school districts for children of color. And one of the mentors my students had was working on her PhD in infectious disease. She did a bacteria growth lesson with them. She explained to them what a pandemic was, what it does, and what her job is studying infectious disease. She really broke it apart for them to understand.

Ms. Simon explained that her students were able to use this information to think through the pandemic more logically. She also found that discussing COVID helped calm student anxiety because they had access to unbiased facts from a trusted source.

Teachers are looking at their options, and now it's going to humble a lot of people who think that teachers do not do anything. It's going to be a mass shortage of teachers. Which is sad, but it's a reality of what's going on now.

Even though it's a scary situation, we were able to relate it to what they learned from [the expert]. Because she talked about how many times we'll see a pandemic throughout our lifetime and how they mutate and all this type of stuff. And I mean, to see them use their knowledge to really understand how it really works and why it's spreading, you know, it was a good thing.

All students and teachers eventually returned to in-person instruction for the 2021-22 school year. Ms. Simon made sure that each science lesson included a hands-on element and opportunities for collaboration to make up for lost opportunities over the previous school years.

I made my entire science instruction hands-on. . . . And students were better than they were last year. And I think it was because they were happy to be physically together and talk to each other.

However, the stress and struggles that accompanied teaching during the pandemic eventually took their toll and Ms. Simon made the difficult decision to leave the field at the conclusion of the 2021-22 school year to pursue new opportunities. She reflected on this choice that she and so many others are now having to make.

I think the world is going to see an exodus of teachers leaving. I think COVID being here, it opened up to the doors to a lot of things. Teachers are looking at their options, and now it's going to humble a lot of people who think that teachers do not do anything. It's going to be a mass shortage of teachers. Which is sad, but it's a reality of what's going on now.

Pulled in Two Directions

Mr. Hartfield is a 2nd grade teacher at a suburban elementary school in Arizona. When COVID emerged in spring of 2020, district leaders decided to close the schools and move instruction online. With no prior virtual teaching experience or training, and limited engagement from students, Mr. Hartfield found online instruction lacking.

Five students just disappeared for the rest of the year, essentially. Then participation was up and down. I felt it was kind of a wash almost. Nothing really happened academically. We tried to connect emotionally with the kids, but I would say academically it was just kind of a waste of time.

Further, school administrators directed elementary teachers to focus solely on reading and mathematics. As a result, Mr. Hartfield's students received no science instruction, not even about COVID.

For that section of time, there was no science or social studies or phonics, any of that. It was all reading comprehension and math work. . . . I know the district sent out COVID information by email, but as far as in my classroom, it's almost like we ignored it, and we just did the math and the reading work.

Nothing really happened academically. We tried to connect emotionally with the kids, but I would say academically it was just kind of a waste of time.

The 2020-21 school year started with a semester online, but this time Mr. Hartfield felt better prepared for virtual teaching. He provided daily live meetings (recorded for those who missed them) and was able to touch on all academic subjects, including science. However, Mr. Hartfield was dissatisfied with the quality of the science instruction and learning for his students.

We did not have kits, we did not have materials for students at home. So it was basically science reading is what it wined up being. Science comprehension passages, not actually the practice of science.

Mr. Hartfield lamented that this way of teaching was in direct contrast to his philosophy, as he is a strong proponent of hands-on science education in lower elementary grades.

Science learning is best when it's doing the process of science, when they're actually planning it themselves and building themselves and creating the models themselves. It's just super difficult at such a young age for them to conceptualize these ideas. They really have to have it physically in front of them. . . . For the younger kids, second, first, kindergarten, I just feel like they have to have something in front of them in person.

The opportunity to interact with students in person came during the second semester of the 2020-2021 academic year as his school adopted a hybrid model. Classes were split into halves and students alternated between virtual and in-person learning. However,

while Mr. Hartfield preferred in-person instruction, it also came with higher risks. He recognized that COVID posed a serious threat to his health and that of everyone around him, including his family, his students, and their families.

I was kind of pulled in two directions because I wanted to be in class. I did want to be in class because I think learning at such a young age is better in person, but also at the same time with all the fears, especially earlier in the pandemic, you don't want to be in class. You want everyone home safe. So I really felt kind of pulled in two directions. Of course, I want everybody safe. That was super important for me. But I was also kind of seeing as it went on this year, we are not learning, they're not growing. . . . I wanted us to be there, but I also wanted to be home protecting my family.

Mr. Hartfield also explained that he felt very protective of his students at that time, a weight that he had never had to carry before.

There was a very personal direct connection of I am the one who has to protect them here from this virus. So I think I had a lot more buy-in. I've never really cared about flu season. Kids get sick, and they come and go, but with COVID being what it was, I think I felt like I had a role to actually protect them, which is kind of intimidating.

Therefore, Mr. Hartfield worked hard to reduce the health risks. He got vaccinated, sanitized his classroom daily and enforced mask-wearing and social distancing with his students. He also explained COVID to his students at a level they could understand and corrected their misconceptions.

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In second grade, a lot of them just did not understand a lot of it still, despite how much they had probably talked to their family about it. "So why are we wearing masks? Why are we spaced out?" I think that was still confusing for a lot of them. I wouldn't say there were fears, but more exaggerations. So they didn't seem anxious or anything, but they were like, "You can die in class," or things like that. I had to be like, "No, we're going to stay safe."

Unfortunately, despite his efforts to mitigate the risks, the return to in-person classes did not bring the return of hands-on learning. The district feared the spread of germs if students shared materials, so students had to watch from their socially distanced seats as Mr. Hartfield demonstrated the hands-on activities his students would normally get to do themselves. Ultimately, he found that the hybrid model was no more effective than online learning.

It was still, more or less, a wasted year. . . . It was just a strange year socially, a quieter year in the sense that they weren't as happy-go-lucky and kind of

rambunctious as they usually are in second. . . . Just in general, they are so much farther behind.

Finally, 2021–22 offered a glimpse of normalcy. The hybrid model ended, and all students returned to in-person classes. Restrictions eased, though Mr. Hartfield still discussed COVID with his class and encouraged them to wear masks and social distance. But perhaps the most significant change for Mr. Hartfield was the return to truly hands-on learning. He finally felt like his science teaching was effective again – and fun.

It felt a lot better having access to the hands-on stuff. So last year was a very fun year because it was really the first for me as well, with those same kits. . . . It was fun for me to see them actually get to interact with it. I could tell with them, too, it was just so much more interesting for them. They learned so much more because they got to actually do it.

With health risks easing and hands-on teaching restored, Mr. Hartfield ended the school year feeling optimistic about his future as a science teacher.

I love teaching, so whatever they throw at me, I'm pretty sure I'm going to be good with it.

Science Specialist at the Epicenter

Ms. Ramirez teaches lower elementary science at a school in urban New York. In a typical year, classes would come to her dedicated science lab twice a week for hands-on activities and experiments, but that changed abruptly in early 2020 when New York

It was just horrible not to be in the same room with them so we could talk, laugh together, ask questions—all the things that you become a teacher to do because you enjoy the actual physical presence of being with the kids.

became one of the earliest epicenters of the COVID outbreak in the United States. Her school quickly closed its doors and switched to virtual-only instruction. As a science specialist, Ms. Ramirez was not expected to hold live, synchronous sessions with the students. Instead, she planned to record videos of herself doing experiments and encourage students to send back videos of themselves doing the experiment at home. She tried to find experiments that would use household materials, but the pandemic was causing major shortages, even of things that used to be commonplace.

So many of my labs would have something I never would've thought about before. . . . One of the first labs I do is leaf chromatography with the little kids, and you need rubbing alcohol. . . . But, for love nor money, you could not get rubbing alcohol.

Ms. Ramirez did eventually come up with several lessons students could successfully do from home, which she continued to use in 2020–21 when the school adopted a hybrid model of instruction where some students came to school in person and others continued to learn virtually. Ms. Ramirez mailed kits of supplies to her virtual students every two weeks to ensure they could participate in class activities. She also made an effort to interact with online students at the same time she was teaching students in person. But despite her best efforts, she was not satisfied with online teaching.

It was just horrible not to be in the same room with them so we could talk, laugh together, ask questions—all the things that you become a teacher to do because you enjoy the actual physical presence of being with the kids. Going over this stuff and seeing their excitement and pleasure as they figure stuff out—all that was lost. . . . When you're teaching lower school science, everything should be hands-on, and you've got to be present so you can anticipate questions and then answer the ones you don't anticipate. There's no substitute. You're lying if you say you can do that over Zoom or online. You cannot.

Teaching in person came with its own set of challenges. Her school needed space for students to maintain social distance, so Ms. Ramirez's lab classroom was converted to an overflow classroom. Instead of having students come to her, Ms. Ramirez was given a cart to transport her lab materials to the various classrooms. She reflected on how logistically tricky it was to pack up everything she would need from her lab each morning, and how

physically tricky it was moving through the multi-story building with a cart precariously packed with supplies.

It really was difficult to sit there and think, “Okay, so my class is building plankton. I’m going to need 15 cups of water. How am I going to get all this?” You get really creative and plan 20 steps ahead, and still you’ve forgotten something—like, “The pipe cleaners are on the seventh floor!” I got hyper-organized. I had three shelves in my cart, and on one I’d have massive supplies of general stuff that I could always use in a pinch. And I got unbelievably great about pushing around carts that had 15 things of water. . . . I’m taking the elevator everywhere, so I got very clever about just being very, very calm as I pushed on and off the elevator.

Still, Ms. Ramirez enjoyed interacting with her students in person so much that it was worth the inconvenience, and far preferable to virtual.

The bright point was that I could go into the students’ classrooms. Even though we were all masked and the children had to sit at their desks behind dividers, . . . I would just make double the number of kits, and they’d all do it at their desks. And surprisingly, a ton of it was super fun. It was so great to be in a room with them that you overlooked some of the petty annoyances.

In spring of 2021, Ms. Ramirez’s optimism surged when teachers in New York became some of the first in the country eligible for the newly released COVID vaccine—not because of what it meant for her but because of what it meant for her students.

I remember we were all tearing up when New York opened up the vaccine lottery to teachers. . . . It was incredible to be able to get those first shots and just think, “Oh my God, at some point soon, this is going to be available to [the kids], and we’re going to be able to have regular classes and regular experiences again.”

Fortunately, life did begin to return to normal, and all students were required to return to school in person in the fall of 2021. Ms. Ramirez got her lab classroom back, and she no longer had to worry about preparing lessons and materials for online students. In January of 2022, all students had the opportunity to get vaccinated, and Ms. Ramirez was overjoyed to see the school lift its mask requirement.

It was incredible to be able to get those first shots and just think, “Oh my God, at some point soon, this is going to be available to [the kids], and we’re going to be able to have regular classes and regular experiences again.”

From January on, it was pure bliss. Absolutely fantastic. You could barely tell the difference between the end of the school year and another regular school year. . . . All of us are just so thrilled that this seems to be tapering off and that there’s a return to some sort of normalcy.

Ms. Ramirez reflected that her experience teaching during the pandemic should illustrate to society what she already knew—schools and good teachers are indispensable.

The role of school in our society has been highlighted. It is critically important that we have schools that are open and teachers that are excited to be there and see that their mission in life is to work with children and to be in the classroom with them, pushing them to succeed.

Don't Ask Me to Teach Science But Only to Kids

Mr. Grayson will always remember where he was when he knew that COVID was going to have a dramatic impact on his school and science teaching.

Ohio Governor Mike DeWine had a press conference on a Thursday afternoon. We had a science department meeting that same hour. So we were sitting in the science department meeting, and we had it on in the background. . . . We were talking about, "What are we doing next week? What's our planning like? How's this going?" But he's talking about how bad this outbreak is . . . then at the end of his press conference, that's when he was like, "Starting next week, no school, everything shut down." So we quickly pivoted in the meeting from talking about next week what we we're doing in class to how do we handle the next three weeks. Then my principal, who was a former biology teacher, looked at all of us and said, "Listen, we all know we're not coming back this year." And we were like, "Yeah, probably not." Being honest, he's like, "As science people, we probably know that, right?" So then we took a much wider view.

Although Mr. Grayson quickly understood the gravity of the situation, his sense of urgency wasn't immediately shared by his district. He recalled an instance soon after the shutdown where he pushed back against a proposed in-person, district-wide professional development (PD) session. While his pushback was grounded in CDC recommendations related to social distancing, the situation put him at odds with district leaders.

So there were a lot of times I would sit on Google Meet just to talk. . . . I'm trying to be a body for them to have some type of interaction because otherwise they turn off their Chromebook, and they sit by themselves at their house.

While remote, our district decided to call an all-district, in-person PD. . . . After the governor just shut everything down. We'd been remote for three weeks, and we realized we weren't coming back. So I sent a district-wide email like, "Here's all the things from the CDC that says this is stupid. Please don't do this." I then ended up with a disciplinary hearing because I apparently wasn't supposed to do that. . . . But I felt there were some misunderstandings, not just from the staff, but also from what are best practices here. . . . We have coworkers who live with immunocompromised people, who are themselves immunocompromised, or who take care of their elderly parents. There were some misunderstandings about what our responsibilities were. So I felt I had to advocate for us as humans. And the thing about it was, I recognize it was maybe a violation of chain of command and communication. Sure. . . . But I feel like best practices-wise, as a science teacher, don't ask me to teach science but only to kids.

The struggles Mr. Grayson experienced during this time weren't only related to school policies and practices but also to teaching itself. Online teaching eventually gave way to a

hybrid approach where some students came in person on select days and others chose to stay online. However, both scenarios required him to come up with entirely new ways of engaging students with science content.

It totally removed so many of the things that I think we love about science. Like the ability to be hands-on, the ability to give a kid different modalities to experience and express themselves, as well as the ability to communally converse and interact at the same time with the same type of stuff and create joint understandings, not just through dialogue but through those demonstrations and those hands-on interactions. It wasn't a pivot, it was a complete and total change.

As might be expected, these instructional changes required a significant amount of planning and preparation time.

I feel like that was probably my first year as a teacher again, from a level of having to reevaluate just about everything. . . . I started making screenshot tutorials. So I screenshotted every step for each lab, each digital lab and stuff like that. So it took a hell of a lot more prep time. It took a lot more time not just to evaluate what might be a problem, but to then address it or pre-address it, and then to also find ways to create new means of engagement.

Despite his many time commitments, Mr. Grayson took it upon himself to use his lunch and planning periods to distribute materials and supplies to his students' homes.

My district is really small. We're a little bit over a square mile. So I would be on a break, and I would just plan a route and just go drop stuff off.

He also devoted time to interacting with students who were isolated and eager for interaction. He explained that although teaching science was important to him, attending to student social and emotional health took precedence.

There were probably four or five kids who I don't think actually interacted with another human, another student, the entire time during remote. So there were a lot of times I would sit on Google Meet just to talk. It would be lunchtime, and all the kids in-person have to go to lunch. And the kids online said, "We're going to do lunch together here," which meant I didn't really get that full lunch. But I'm trying to be a body for them to have some type of interaction because otherwise they turn off their Chromebook, and they sit by themselves at their house. . . . I'll catch them up on science, but I'm not going to be able to catch up to the fact that they haven't talked to another child. So really, it required a lot more considerations for things than I would normally give, and it took a lot of energy, but it also paid off.

Mr. Grayson also noted that student isolation was coupled with a great deal of fear and uncertainty. This was especially true due to the high-poverty demographics of his school and prevalence of multi-generational households.

I work at a Title 1 school. 100 percent of my kids get free and reduced lunch, 99 percent are minority students. Probably I would say at least 80 percent of parents do not have anything beyond high school, and I would say probably around 50 percent don't have a high school diploma. . . . I know a lot of parents did not get jobs that were remote, jobs that were able to support their family. So they really had multiple levels of stress with economics, with health risks, a lot of multi-generational households. A lot of our kids who were remote were remote not because they themselves had any health risk or their parents, it's because they lived with three or four grandparents or uncles or something to that effect, and it was just not conducive for them to be going into an environment where there was any transmission risk. That created some, not just fear, but some real sense of vulnerability for these kids.

When we were remote, I ended every lesson like, "Make sure you cover your face with mask, wash your hands, and stay distant because whether or not you see it, it is real."

In an effort to alleviate student worries and influence positive student behaviors, Mr. Grayson addressed COVID in his science instruction. He was particularly diligent about answering their COVID-related questions, which ranged from virus mutations, to vaccines, to methods of transmission prevention.

There were a lot of questions about vaccines and stuff like that. . . . As kids this year were able to get the vaccine, it was like, "Well, what does it look like? How does it work?" Those questions came up more, so we would spend many lessons within our class time doing that, breaking that stuff down a little bit more. . . . I think there's so much misinformation, especially for our kids where they don't know how to fact check. They don't know what's right or wrong and they're like, "Well, I saw it on TikTok." . . . I'm not an immunologist. I don't have any credentials on that, but I have enough scientific understanding to be able to help explain things and interest to learn it on my own as well. Then also to be able to communicate some effective practices for how this matters for our health. When we were remote, I ended every lesson like, "Make sure you cover your face with mask, wash your hands, and stay distant because whether or not you see it, it is real." . . . There was a culture around here of like, "Well, I don't care. I know somebody that got it. They're all right," or "I know somebody that said they were sick, and they weren't even sick." So there were a lot of asymptomatic cases, and there was a lot of people who were symptomatic but ultimately recovered. Then we also had a lot of death, and not a lot of kids were talking about the death. Part of it is it's scary, but just trying to remind them, "I don't want to scare you, but whether or not you see it, it's real."

He also used the pandemic to teach students about the nature of science, providing opportunities for them to examine data and look for trends. In this way, he helped students understand the tentativeness of science and growth in scientific knowledge over time.

We used [COVID] as the introduction to the scientific method, and we continually checked in with that as developments were being made. And people were able to see changes and growth in what we were learning through science, as well as what we could eliminate as incorrect or not as significant learnings or findings. So really, it gave probably the most effective scientific method introduction I could have ever imagined. . . . When we were doing scientific method and I'd be like, "Okay. So now we have this data for this, and we don't have to wipe every bit of cardboard or let our mail sit outside for two days," stuff that they were catching. My seventh graders actually really loved it. I thought it made sense to them. They, again, could see the growth of scientific knowledge versus science is this hard codified fact that you memorize and you learn and you recite.

As the world slowly emerges from the COVID pandemic, Mr. Grayson is contemplative about the numerous challenges for teachers, students, and schools that remain.

Every place was broken and fractured in some way. So we have to do a much more concentrated effort to address this. Obviously, no one of us can do that. It was a global issue and it still is.

He pointed to examples of student learning loss and large gaps in student knowledge of science content and practices that need to be filled.

There are some issues of kids not knowing how to use rulers, kids not knowing what an experiment really looks like, how to fill in a data table, how to make a graph, how to read a graph. So a lot of more fundamental science practices that I always incorporated and included. Before, it was always like, "This is our general two weeks of you getting to know the practices." But now they had to be a month, and we really had to get deeper into the weeds with everything.

He also described readily apparent lags in student social and emotional skills and noted that teachers and schools generally are not equipped with the time and resources needed to help students recover these skills.

I think there are massive gaps in emotional development. . . . The middle school kids I have this year are nothing like the middle school kids I've had in the past. They're more like the early fifth graders, the kids coming out of fourth grade into fifth grade just as far as how they interact with each other. They're bigger, they're smellier, and they cursed more, but they definitely have the same playfulness, the same level of dialogue with one another, the same touching each other's stuff. It's problematic because I want to address it, but we don't have a school-wide program to address it. . . . So I'm not addressing their emotional needs appropriately. I know that. But I also don't feel that we have the tools to do that right now as a district. I know professional learning communities across the world are struggling with this. I don't know if anybody's got it.

Perhaps most importantly, Mr. Grayson reflected on the toll the pandemic had on him as a science teacher, noting that financial obligations were the driving factor in his decision to remain in the profession.

I'm not going to lie, there were probably about \$45,000 worth of reasons why I didn't [leave the profession.] I took the teaching grant in undergrad, and I was like, "I really have to do one more year because I've made every fiscal plan along with this." I mean, I love the profession, but that year took almost all my love.

Concierge Teaching

Ms. Wright teaches science to students in 6th, 7th, and 8th grades at a Catholic middle school in Illinois. As COVID began rapidly spreading across the United States in March 2020, her school made the decision to immediately move to remote instruction. During this time, Ms. Wright was working almost 12-hour days in an effort to assist every student possible. This included planning online science lessons, nightly meetings with other teachers on her team to discuss what students across the school were struggling with, reviewing student assignments, and delivering instruction during the school day.

Although the school day for us goes from 8 until 2, in those three months, March, April, May and into June, I'd say most of our days went until eight or nine o'clock at night. Because then we would regroup and meet. We would talk about what was working, what students seemed to be struggling with on a daily basis. And then we would be figuring out how to post things for the next day, how to look at any evidence that students were sharing, because we were trying to still hold them accountable for the work that we were doing. And we were devising plans that would work in this new format.

This excessive workload continued into the 2020-21 school year, and Ms. Wright began to feel the weight of what she described as "concierge teaching." She explained that she and other teachers at her school regularly sacrificed their own personal time and mental health to meet student needs. For example, all teachers in her school were loading daily instructional materials onto carts and taking instruction to the students instead of having students move about the school, a logistical strategy for reducing COVID spread. Additionally, teachers were regularly preparing make-up or work-ahead assignments for students who were absent due to illness, family commitments, or family vacations.

So there was probably never a week all year, and I have 150 students that I see daily, that a family wasn't going to be gone for two, three days a week. And they were asking for assignments ahead of time, asking for assignments afterwards. So we still were providing concierge teaching, on demand, depending on what they needed.

As travel became more available, many of our families were making up for lost time and taking vacations they canceled or put on hold. So there was probably never a week all year, and I have 150 students that I see daily, that a family wasn't going to be gone for two, three days a week. And they were asking for assignments ahead of time, asking for assignments afterwards. So we still were providing concierge teaching, on demand, depending on what they needed.

Constantly changing school sanitation guidelines, based on evolving knowledge of the virus, also impacted Ms. Wright's science instruction. She noted that maintaining safety guidelines meant making daily changes to planned instruction, sometimes at a moment's notice.

We would get new directives as to, "Okay, you can do this, but now this has to be reported, or eased up or we didn't have to report it." But then around the holidays, it would spike again, and we'd have to go back and refollow the guidelines. So it was keeping track of which guidelines were in place so that lessons could be planned. I try and plan out lessons for a unit at a time, but usually they would be adjusted daily because of guideline concerns.

Because of her desire to provide students with high-quality science instruction, Ms. Wright struggled to take time away from teaching during the pandemic. Even after the school day ended, she felt the need to constantly be working, whether it was planning for the next day or researching a new topic that she thought her students might find interesting.

There was always something else I could be doing. I never felt like I did it all. So I was always feeling like, "Okay, if I just spend a little more time, I could research geology and try to find a way to make it interesting for the students who are sitting in front of a computer."

I'd always be going back to my computer. I was tethered every waking minute of every day. . . . There was always something else I could be doing. I never felt like I did it all. So I was always feeling like, "Okay, if I just spend a little more time, I could research geology and try to find a way to make it interesting for the students who are sitting in front of a computer." Because offering them a video isn't very worthwhile. They can't have a hands-on experience. What can we do to make this engaging or make a STEM experience out of it and get them involved?

The 2021-22 school year finally brought some relief as all students returned to the school building in person and full-time. Ms. Wright's workload generally returned to what it had been in school years prior, and she expressed relief about being able to return to a pre-pandemic classroom atmosphere.

Supporting Students Who Got Left Behind

Ms. Simpson is a 7th grade life science teacher at a middle school in rural Alabama that serves a high-poverty student population. Due to the COVID pandemic, her school decided to shift to an online format following spring break 2020. However, many of her students did not have access to technology or reliable internet at that time, which limited their ability to access lessons or attend live virtual instructional sessions. As a result, Ms. Simpson estimated that she was able to interact with only 20 percent of her students during a typical virtual school day, and for only 20-30 minutes at a time.

[I couldn't assign] much work because of connectivity issues with families and those sorts of things. So we would meet with our kids, and we would try to do a meeting with them if we could, and we worked through email the best we could.

Because of the disparity in technology access, the school decided to freeze student grades for the rest of the school year. Ms. Simpson had already covered most of the essential life science standards, so she focused on engaging her students with a series of shorter ecology lessons during the remainder of the year.

We pretty much just froze everybody's grades where they were, and it was really just to keep kids from falling too far behind. . . . Luckily, we had covered most of our standards by that point and were just left with some ecology type things. So, it was just something they could do in 20-25 minutes, and we moved on.

The 2020-21 school year began in a hybrid format where students attended school in person two days per week and were online the other days. Unfortunately, technology access continued to be a problem in the district, and many of Ms. Simpson's students still were not able to participate in science lessons that occurred virtually. Compounding this problem were the vast numbers of students who had to quarantine at home due to illness or exposure.

So many kids were out. I mean, I had some kids that were quarantined four and five times just from contact. Once one kid would get sent home, then it was like half of your class was sent home. We still had to simplify things because the kids who were sent home on quarantine once again may not have had internet access.

Ms. Simpson made it a priority to cover the content standards she deemed most critical and reteach concepts that students missed out on during the previous school year. In addition, she simplified her instruction to better fit with the hybrid format.

So we started out with the hybrid, and the problem was trying to keep kids at the same pace. We really had to go back and reteach the most important concepts—characteristics of living things, cells, cell structures—so we could move on in the year with everything else. . . . So, we just tried to streamline and stick with the basics, and that's hard. There were no labs, really no hands-on activities. So it was

really more of some notes, some online interactives, some videos, and those types of things.

Although it was very difficult to deliver science instruction during this time, Ms. Simpson felt it was her responsibility to teach about COVID. She and her students talked about a number of topics, including hygiene basics, virus reproduction, and virus resistance. As a result, she felt like her students took a greater responsibility for their own health and the health of others.

I have noticed that I have an exorbitant amount of kids with mental health issues. I think the quarantining, the being at home, the not being able to interact, the stress, has made it much, much worse for my kids.

I think a lot of kids did experience impacts, because a lot of my kids, being low income, have a lot of family members with a lot of health issues. They don't eat well. There's a lot of obesity. There's a lot of diabetes, those sorts of issues. So, I think that did impact them on them realizing how their actions could help their family members as well.

At this point in the pandemic, Ms. Simpson also noticed that a lot of her students were struggling academically and emotionally.

It was mentally exhausting for a lot of them. I have noticed that I have an exorbitant amount of kids with mental health issues. I think the quarantining, the being at home, the not being able to interact, the stress, has made it much, much worse for my kids. We also had more than 150 kids that were failing multiple subjects out of 800 kids.

Ms. Simpson dedicated herself to supporting her students during the 2020–21 school year in any way she could. However, this sustained effort was both exhausting and time consuming.

It was immensely exhausting. And I'll be honest, the kids were so needy and clingy. For a lot of them, because of the kids I teach, coming to school is where they get fed two meals a day. For a lot of our kids, school's their safe place. So emotionally, psychologically, it was very exhausting because the kids are just so needy, wanting hugs, even though you weren't supposed to, but they just really needed it, or needed to talk to an adult they felt safe with. And then I would come home, and I had my own fifth grader to deal with and a farm and a husband. There really was no downtime.

The 2021–22 school year brought some pre-pandemic normalcy as students returned to school in person. However, the effects of COVID persisted as students struggled with learning loss and engaging in appropriate social interactions.

There's a lot of behavior issues that I feel like are a consequence of the pandemic. These kids' social skills are lacking. They are emotionally behind. They have not had

full, consistent school years, so they emotionally have not grown like they would in a normal school year.

A lot of our kids, school's their safe place. So emotionally, psychologically, it was very exhausting. . .but they just really needed it, or needed to talk to an adult they felt safe with.

Further, COVID continued to impact families within the school community more broadly. The pandemic placed enormous stress on parents who worked long hours to provide for their children on meager incomes and led to some families being torn apart.

I've had a lot of kids that have been pulled from the home and put in a safe place because of the pandemic.

Reflecting on these incredibly difficult years, Ms. Simpson noted how important teachers were in providing students with stability in their lives, especially during ever-changing and uncertain times.

Just seeing how much the kids really do need their teachers and love their teachers, and realizing that we are their stability. We are their role models for what "normal" looks like. . . . Helping kids to build social skills, building kids up who've been beat down. . . . Being able to build them up and let them see that they can be successful and that they are worthwhile and smart. That one helps a lot at the end of a long day when the kid just smiles and is so happy, and they're so proud of themselves that they've accomplished something, because they've been told they can't.

Life Lessons

Ms. Williams has been a middle school science teacher for over 30 years in a suburban area of West Virginia. Similar to many other places in the country, her district went fully remote for most of the Spring 2020 semester due to the COVID pandemic. This was

I used some lessons from the Smithsonian, some things from the CDC. I did lessons on viruses, and we went into a lot of depth because they had a lot of questions.

followed by a hybrid schedule of alternating groups of students during the 2020-21 school year before returning fully in person for the 2021-22 year.

As she navigated science teaching during this time, Ms. Williams felt that it was very important to talk to her students about COVID. In the early stages, she allowed her students to ask questions about COVID, which often focused on the basics of viruses and transmission.

There were Zoom meetings where they were asking questions. Of course, at that time, none of us knew the full extent, really, of anything. Even though that wasn't part of my curriculum per se, we talked about viruses and transmission and similar viruses to COVID-19. . . . I told them, "You've got to just play it by ear because viruses, they have no rhyme or reason. They do what they want."

Additionally, she taught her students about the importance of consulting credible sources of COVID-related information. To this end, she provided them with information from sources such as the CDC and NIH, and together they would examine data related to COVID case numbers.

We talked about where they would get their information from. I was like, "Social media is not it. That's not where you need to be looking. And don't look at just one source." So I would give them different sources. They really liked that, where it would show the worldwide data of where cases would be showing up and everything.

As the pandemic continued to unfold, Ms. Williams drew on instructional materials that became available through organizations such as the Smithsonian and the CDC to focus on the importance of wearing masks.

I used some lessons from the Smithsonian, some things from the CDC. I did lessons on viruses, and we went into a lot of depth because they had a lot of questions. And it's hard for them to grasp the concept that we're talking about something that's really not a living thing, but it can kill you. It was hard at first, but I had several different activities: the type of virus, how it was spread. We even did testing with masks, showed them several videos of slow-motion sneezes. That gross stuff is great.

She also used the pandemic to stress the nature of science to her students. She presented them with what was known about COVID at the time while also emphasizing that the knowledge base would change as more information was discovered.

So mostly [I taught] the structure of the virus, type of virus it is, how it was related to other SARS viruses that have been around, and what could be done to prevent it at the time. . . . But I always reminded them, "This could change. We may learn something new and different tomorrow." . . . They learned how science works. It's not that somebody wakes up one day and, poof, they know everything about something. There's a lot of trial and error and a lot of mistakes that can be made, but that's how science happens.

Reflecting on her COVID-focused teaching throughout the pandemic, Ms. Williams hopes the scientifically accurate information she shared with students was able to provide them with a sense of comfort and reassurance during a worrisome time.

They learned how science works. . . . There's a lot of trial and error and a lot of mistakes that can be made, but that's how science happens.

The information and just having communication with them [was important] because COVID was really scary. . . . I hope I gave them some reassurance and comfort that they are going to understand this. They are going to figure it out. The sun will come up tomorrow. It's going to be okay.

However, she also acknowledged that the pandemic provided her students with life lessons and skills that could not be taught in a science classroom.

I told them, "If you've gone through this, you've learned more about how to deal with things in life than anything I could have taught you in science. You got more out of the lessons that you learned from dealing with COVID and how to be resilient and flexible and stick to things and know that it's going to work out."

Uniquely Prepared for Online Learning

When COVID emerged during the winter of 2020, schools across the country quickly moved to online instruction. Although this sudden transition was incredibly difficult for many teachers, one middle school science teacher in rural Pennsylvania was uniquely prepared for the situation. This is because Ms. Trudy had over 15 years of experience teaching at a cyber charter school.

As the traditional schools in the district closed for two weeks to prepare for online learning, there was little Ms. Trudy's school needed to do differently. However, to remain on pace with these traditional schools, her school implemented a continuity-of-learning plan. Under this plan, Ms. Trudy was required to spend a full month reviewing previously covered concepts with her 7th grade life science students, focusing specifically on topics that she felt would best prepare them for future courses.

COVID lent itself so much to life science and actually just because that's what every kid kept wanting to talk about and everyone was so concerned about it. So we taught again about viruses and how viruses attack living cells.

And we also talked about preventative measures, the hand washing, those kinds of things that were all on the CDC website.

So for the month of April, I did continuity of learning and reviewed concepts that were taught from September through March. And I really focused on main, big overarching ideas in science and concepts that would build into high school sciences. We reviewed cells again, plant and animal cells, cell processes, ecology concepts.

In May of that year, her district decided that teachers could continue with their usual content, and Ms. Trudy went back to teaching what she had initially planned for the end of the school year.

I think in the month of May they flip-flopped, and they said, "Oh no, you can teach regular content now." So then the last quarter of the marking term, when I was teaching life science, we were teaching human body systems. So I picked up with human body systems and taught that through the end of the school year.

Not only was Ms. Trudy comfortable and familiar with online learning platforms and software, but her students also had the benefit of having used the same resources previously.

Everything was done online of course, but it always has been for us. So students still jumped into the learning platform that we used at the time, and all of that was kind of business as usual for me.

This familiarity with online teaching gave Ms. Trudy the luxury of some flexibility in her curriculum and some extra time to rework her curriculum to fit in COVID-related lessons. For example, using the CDC website as a guide, she discussed timely COVID-related topics with her 7th grade life science class, such as viruses and ways to prevent

transmission. Ms. Trudy also noted that her students were persistently asking questions about the virus out of concern and curiosity.

[COVID] lent itself so much to life science and actually just because that's what every kid kept wanting to talk about and everyone was so concerned about it. So we taught again about viruses and how viruses attack living cells. And we also talked about preventative measures, the hand washing, those kinds of things that were all on the CDC website. And so I used the CDC website and our school nurse as my resource on anything COVID related.

With the start of the 2020-21 school year, Ms. Trudy moved up to 8th grade physical science with the same students she had taught the previous year. Many traditional schools at that time were opting to do hybrid instruction. However, the challenges of this approach, including mandatory hygiene practices, quarantines, and frequent closings due to large clusters of COVID cases, incentivized larger than usual numbers of students to enroll in Ms. Trudy's cyber charter school.

There were so many school districts in Pennsylvania that were closing the school for five days, then reopening it, and requiring masks, and then closing the school, and then doing this, and doing that. And so there were some parents who sent [their kids] to our charter school just because of the consistency.

Despite this uptick in enrolled students, Ms. Trudy and her students were able to proceed through instruction with relative ease. She continued to focus on COVID in her science instruction, even enlisting the help of medical professionals to teach about the topics of vaccines and immunity.

So when the vaccines came out, we went back, and we retaught about why we get vaccines, what vaccines do, how they help us build up immunity, the purpose of them, what other vaccines have they had, what's their experience with vaccines, what do they remember about them. And so I tried to encourage positive talk around the vaccines and how vaccines help people develop immunity. So that was timely in 2021, in the spring. I had a nurse in as a guest speaker and that kind of thing, just because I think as health professionals, they had the most up-to-date information on everything.

However, even though her students were used to learning in an online environment, they still felt the effects of the pandemic. Ms. Trudy noticed that students were increasingly experiencing mental and physical struggles due to the ongoing presence of COVID in their lives.

I think from a mental health perspective, they struggled just as much as anybody else because they're at home learning with their families and someone in their family gets sick or maybe a grandparent got COVID or their cousin got it. And then they're very worried about it or they got it. Their whole family got it. And they were

down for the count for two weeks. So I think it was as stressful as it was on everyone else. But due to their younger age it, may have been a little bit more so because they really didn't know how to deal with that type of thing. I mean, nobody did. It was difficult for them.

For the 2021–22 school year, Ms. Trudy returned to teaching 7th grade life science. Although she was generally able to go back to “business as usual,” Ms. Trudy also continued to incorporate COVID into her instruction because she felt it was important and relevant.

Everything was business as usual, but we did cover viruses. I brought the nurse in, and she gave up-to-date COVID information, talked about the vaccines and boosters for the children, and things like that.

Additionally, as the school year progressed Ms. Trudy felt that her students’ mental health was improving as restrictions and severity of the virus decreased.

I think that they were doing better. A lot of my students were able to get the vaccine, and they did. I think that by then people had come to grips with it all and had a better understanding.

If this pandemic has taught us anything, it's taught us that everyone needs a general understanding of science, particularly science that impacts human health like this and the relevance of it. It pushed science into the forefront a little bit.

Ms. Trudy reflected on the fact that her experience teaching during the pandemic was unique compared to many other teachers across the country. She explained that interacting with her students regularly offered a reprieve from the pandemic, which in turn improved her own mental health.

I was thankful for the distraction of teaching. I was so glad that I was able to teach and have my job because I could focus on my students and not be glued to CNN and not see all these numbers and the graph of the death toll climbing. So I was thankful that I was able to teach and have that be my focus. At that time, with all that craziness going on, I could focus on something that was positive.

Ms. Trudy also noted that the experience of teaching during the pandemic highlighted the importance of scientific literacy and the need for science teachers who can provide accurate, timely scientific information.

If this pandemic has taught us anything, it's taught us that everyone needs a general understanding of science, particularly science that impacts human health like this and the relevance of it. It pushed science into the forefront a little bit. I think that, in general, we need to have a solid understanding of it. I still have a very positive view of science teaching in general. . . . I still think that we provide a service to our students and our students really need it.

I Believe That Knowledge is the Antidote for Fear

It was March 2020, and Ms. Brewington was excited about her sixth-grade science lab activity on plant transpiration. She had spent the previous evening visiting five different grocery stores in her southern Californian town to purchase enough celery for her students to participate in the lab and just gotten everything set up when an announcement was made over the intercom that school would be transitioning to online learning beginning on Monday.

It was March 13th, or Friday the 13th, and I remember having everything set up, ready to go, and then having to completely regroup that weekend and learn all sorts of new technology to be able to teach online the following Monday. So we went from hands-on learning to trying to transition that into Zoom lessons over a weekend.

Mrs. Brewington went home that weekend and set to work watching tutorial videos about how to use online learning management systems. She also began modifying her assignments to be computer accessible and creating videos of science demonstrations.

I mean, it was a sharp curve, but I managed to learn Zoom, Teams, and Google Classroom in a weekend with a lot of help from YouTube tutorials. I pretty much tried to modify what I was already going to be teaching. . . . I remember setting up a lot of demonstrations that the students would be doing on their own. And I would just make YouTube videos of me doing the science experiment, and they would watch and ask questions about it.

A few weeks into online teaching, Mrs. Brewington heard from the district that they would not be returning to in-person instruction for the remainder of the year. This news prompted her to find ways to make her remaining science lessons as hands-on as possible. Specifically, she modified a number of lab activities so students could perform them at home using everyday objects.

I did take some things that we were going to do as a class and try to find ways they could use household materials, so they didn't have to go out and buy anything, to do some hands-on labs. They thought it was great. They were happy to do something hands on, because I don't think in a lot of their other classes they did hands-on. . . . I knew how much the kids loved doing hands-on stuff while we were in person, and I didn't want them to go the rest of the year without, so I came up with some things, and I searched online for a lot of ideas, too.

In addition to incorporating this hands-on approach to virtual instruction, Mrs. Brewington took advantage of their unit on the characteristics of living things to discuss viruses. She wanted her students to understand various terms related to COVID because she knew they were hearing them

I believe that knowledge is the antidote for fear, and I feel like I really opened up a lot of dialogue and, with a lot of questions and answers, hopefully I reduced some of their anxiety.

in their daily lives. Additionally, even though a COVID vaccine was not yet available, she wanted her students to have a scientific understanding of what vaccines are and how they work.

At the time, we didn't have a vaccine yet, but as a student in a school, they've gotten a lot of other vaccines. So I knew one would inevitably be coming, and I wanted to preempt that with how it works. So I think they really appreciated it because I know it was kind of the elephant in the room. . . . I made sure I wasn't "You should get a vaccine," or "You shouldn't get a vaccine." I was just like, "Here is how it works. If you decide to get it, this is what you can expect."

Ms. Brewington was able to help minimize student fear of COVID by openly discussing the topic and allowing students to ask questions.

I believe that knowledge is the antidote for fear, and I feel like I really opened up a lot of dialogue and, with a lot of questions and answers, hopefully I reduced some of their anxiety.

Additionally, once students began receiving the vaccine, Ms. Brewington was able to alleviate their fears by helping them better understand the negative side-effects they were experiencing. She used the situation as real-life example of how the immune system works to defend the body against invasion.

The students proudly came in and told me when they got a vaccine or described their symptoms to me to let me know their immune system was working. Because I think a lot of them were under the impression that the vaccine made them sick because they didn't feel well and I was like, "No, it's actually a really good sign that you have a healthy immune system and that your body is fighting to build a response."

Students returned to campus for the 2021-22 school year. Because safety protocols were still in place to prevent COVID transmission, Ms. Brewington was not able to immediately go back to her pre-pandemic ways of teaching. However, she continued to find creative ways to provide students with opportunities to learn together in hands-on ways. Notably, she was able to secure a grant to purchase supplies so that students could have lessons outdoors.

I didn't go over their heads at all with the information that I was giving them. I was giving them some pretty sophisticated information in an incredibly easy way to understand.

I spent more time than normal getting them to collaborate in small groups and working in a lot of fun things as well. Not just doing labs from day one but playing games and trying to stay off the computer because they were just tired of it. . . . I applied for a grant to be able to take my students outside and have outdoor science classes. So they all got cushions and clipboards and some learning materials that they could do outdoors.

Ms. Brewington also found that even though the pandemic had been going on for nearly two years, her students were still very interested in talking about it. She continued to allow students to ask questions about COVID, noting that many of their questions centered around viruses and vaccines.

Their interest level was extremely high obviously because it's very relevant and pertains to them personally. So I think it's probably one of the most engaging topics of the year. They have so many amazing questions, "Why you need to get a new flu vaccine every year. Why sometimes it works, sometimes it doesn't." So they understood if presented at the right time, after having all that background information about our immune system and how to contract a virus, how the virus replicates and things like that, it all makes sense to them.

As she reflected on teaching throughout the pandemic, Ms. Brewington was proud of her ability to explain complex science concepts to her students in a manner that they could understand.

I think it was Einstein who said, "You have to know something really well to make it as simply put as possible." And I feel like I was able to do that really well with my sixth graders. I didn't go over their heads at all with the information that I was giving them. I was giving them some pretty sophisticated information in an incredibly easy way to understand.

Disconnected

For teachers and students across the country, the COVID pandemic brought about many changes. Ms. Lopez, an eighth-grade science teacher at an urban middle school in California, began feeling the impacts of the pandemic when her school district made the decision to pivot to online learning in the spring of 2020. This quick shift was difficult because it required her to put in long nights creating lessons that she could use the next day.

I was basically creating curriculum every night to try to adjust to the new mode of teaching. Maintaining rigor, for one thing, was really difficult.

The district decided to remain online the remainder of that school year and the beginning of the 2020–21 school year. Ms. Lopez explained that the remote learning environment limited teachers' ability to form relationships with their students and she felt very disconnected from her students during that time.

We never got a chance to form relationships in-person. That's just how we started. It was online, and whoever showed up would be there. So I would have discussions with maybe out of a class of 30, some kids, maybe five or six of them would show their videos, and they would be responsive.

Online instruction also limited her ability to have engaging and meaningful discussions with students. Ms. Lopez noted that she typically encourages her students to be creative and tailors her instruction to student discussions. However, it was nearly impossible to have those types of discussions or quickly answer student questions when teaching online.

I think a lot of teaching science is in the moment, when we're all working on something together and the kids ask a question, and you're like, "Okay, let's pursue this." It was really hard to maintain that in a Zoom format. When I normally walk around the classroom, I can just like, "Hey, how about try this way or something?" Whereas online, it was like, "Okay, come back to me and show me what you did." It just wasn't quite the same.

[Talking about COVID] provided an arena for them to ask questions. . . . It gave them a place where they could ask if they wanted to, and they did ask questions.

As a result of online learning, Ms. Lopez found that the gaps in engagement that had existed prior to the pandemic widened. Students who were typically engaged and interested in school continued that trend, and students who had previously struggled continued to struggle.

I think this really exacerbated whatever gap that we saw before. Certainly, there were kids who were still interested. They showed up every day. They asked questions, they participated, they were curious. And then, the ones that tend to require more effort to be engaged, they were just not as engaged. And then, the

ones that we really struggled with typically in the classroom, they just tuned out. It was playtime for them.

However, Ms. Lopez did find that informally talking with students about COVID helped improve their engagement because it provided a safe space for them to ask questions.

[Talking about COVID] provided an arena for them to ask questions. . . . It gave them a place where they could ask if they wanted to, and they did ask questions.

The district eventually transitioned to a hybrid approach during the spring of 2021. However, Ms. Lopez noted that hybrid was even more difficult than being fully online because she had to teach students that were in person and remote at the same time.

It was tiring going through the online classes one after another. When you're just sitting in front of the computer, it's just really hard. It takes a lot of energy. Midway through the school year, we switched to asynchronous and synchronous, so some kids came into school, but then we had to teach kids that were online at the same time. That was super tough. That was really hard to do.

She recognized that school administrators were aware of the extra stress that teachers were experiencing but expressed disappointment that they did not offer personalized strategies or resources to ease the burden.

They kept telling us, "We know it's stressful, we know it's really hard, please show grace, please take care of yourselves" and then they would say, "Here's this package thing someone just sold us. This is the way we should online teach." And so, it wasn't really personalized. They did try to give us technology, but the way they taught us how to use the technology wasn't very personalized. It was like, "Here, watch this online video." So as much as they acknowledged that we were stressed and really struggling, they just tried to check off boxes and give us stuff to do.

I think my concern is, how do we get the kids back on track again? How do we get kids to feel confident about school?

For the 2021–22 school year, Ms. Lopez and her students transitioned back to in-person instruction. She was immediately struck by the impact online and hybrid instruction had on student behaviors. She quickly realized that her students were not used to being in a classroom and, as a result, behavior problems increased dramatically compared to years past.

We were pretty confident going into [the school year], and we were really looking forward to having an actual class where we could form our relationships and get back on track again. But it actually turned out horrible. I think what we didn't expect was, we knew there would be gaps in education, but what we experienced was kids who just weren't used to being in the classroom. And so, behavior was a huge issue, and we really struggled as a school and as a district with discipline because the argument was, "The kids had been traumatized." And so, how do you carry out discipline given that scenario? We really struggled with that all year. That

was a distraction in the classroom. I felt like kids really weren't used to doing work at all. Homework was just a pipe dream for me. They actually really pushed back on it. They just wouldn't do it. We really struggled with getting the kids really the academic skills to get back on track. Even by the end of the year, I still felt like some kids were really struggling. They hadn't really gotten back into school mode.

Additionally, she found that parents were starting to withdraw their involvement and partnership in schooling.

I did feel a distancing from the parents. The parents weren't as involved or interested. . . . Certainly, over the pandemic years, that relationship between the families and schools was hard.

Looking forward, Ms. Lopez has concerns for her students' futures and questions about how to lessen the educational and behavioral gaps that COVID widened. Yet, despite the challenges, she holds on to her passion and love for teaching.

I told myself a long time ago that if I get too bitter, that I should move on. It's not good to be a bitter teacher. Certainly, during the pandemic, online teaching, and asynchronous and synchronous teaching, it was just really tiring. I did think about, maybe there are other things to do, but never seriously. So I think I just still love teaching enough. I think my concern is, how do we get the kids back on track again? How do we get kids to feel confident about school? How do we get them to learn the skills they need to actually sit down and work through a problem without giving up so easily?

We Have to Always Follow the Evidence

In the spring of 2020, Mr. Levy was a 7th science teacher and department head at a junior high school in suburban western Michigan. He was following the news of the emerging COVID pandemic, so he was unsurprised when the school decided to switch to an asynchronous virtual approach following spring break. With the fear, uncertainty, and stress of the emerging pandemic and the change in learning format and routine, Mr. Levy recognized that his students were in no condition to learn detailed science concepts. Instead, he prioritized their mental health and physical activity by creating lessons that would get them outdoors.

I wanted them to go explore a park close by them, go for a walk and observe nature with their immediate family members. . . . I loosely tied it to the standards, but they were mainly elementary standards, like, "What do you observe? What do you notice? What could this mean?" I just wanted the kids to get outside and do something and get out of their house versus just sitting by a screen all day long.

Some in leadership questioned Mr. Levy's less rigorous approach given that he was the science department head. But Mr. Levy's decision was based on the reality of the situation, and he successfully defended his actions.

Our curriculum director sent me an email . . . "Why are you teaching this material? Because that's not part of your standards." I didn't realize there would be any accountability. My response was totally honest. I basically told her, "The kids are highly stressed right now. They're not caring about the fine aspects of science. . . . I'm thinking of the kids' mental state versus what are they really going to learn the last eight weeks of school."

I view my job as to never try to persuade kids to think a certain way, but to have an open mind and look at the facts.

When the 2020-21 school year started, families could choose to send students to school in person or remain online, and all but a handful of Mr. Levy's students returned to the classroom. However, this arrangement presented a new set of challenges because Mr. Levy was responsible for planning and delivering science instruction to both groups of students. He took an approach where students in the classroom performed hands-on labs and then shared photos and data with the students at home so that they could still do the analysis. However, he was aware that this approach was only sustainable if he and his students stayed well. He knew COVID case numbers could surge at any time and force a return to virtual-only instruction, or he or his own children could get sick, causing him to be out of the classroom for two weeks at a time. Therefore, he diligently worked ahead, planning lessons and activities that could be carried out despite changing circumstances.

It made me question what I was doing and try to make it as efficient as possible. Realizing, "Hey, I need to get through certain material, because I don't know what

tomorrow will be, like if all of a sudden we're going to be online again." . . . So as a science teacher, I just tried to make sure that I was ready for anything to happen. . . I'd try to be two to three weeks ahead fully planned, as organized as possible in case I had to step out of the classroom for a couple weeks.

As he made thoughtful, fact-based instructional decisions, Mr. Levy also made it a priority to develop that skill in his students. Specifically, he carved out time to help his students consider the varying, often contradictory, pieces of information they were hearing about COVID.

I view my job as to never try to persuade kids to think a certain way, but to have an open mind and look at the facts. So, I would show them two sides. Like, "Hey, this is in the news, and this is in the news, and they're obviously opposite. So, what evidence supports both sides? And then what are some fallacies of both arguments?" And try to have them come up with a conclusion for what might be causing different things to spread or different things to appear. I think one benefit was just for the kids to be more cognizant of what they're hearing and not just take everything that they see or read as fact.

Among his in-person students, Mr. Levy noticed a range of opinions on the severity of COVID, from blasé and unconcerned to fearful and avoidant. In response, he shared scientific information about the virus and its spread and historical information about past pandemics. The class looked for trends in the case data on the Johns Hopkins website and made predictions about what would happen to case rates after holidays. Whether motivated by fear of the disease or simply wanting to avoid another shutdown, Mr. Levy felt his students were all giving more thought to the consequences of their actions and making decisions accordingly.

Science is always changing and medicine's always changing. We go with the evidence supporting things at that time, and we might find new evidence tomorrow or next year that might change our train of thought. But we have to always follow the evidence.

You could tell that all the decisions were a little bit more conscious. Like, "Do I want to walk out right now, or do I want to wait until the crowd dissipates?" You could see that most of the kids, they're smart enough to think, "How could I be as safe as possible while still being at school?" Because when they came back in August of 2020, they were thrilled to be back at school. They were like, "Man, that was a long time since March when we were at home, locked inside, couldn't see my friends." So they were just glad to be back at school and they just made the best of it as they could.

Mr. Levy's school required all students to return in-person in the spring of 2021, then opened without any COVID-related restrictions for the 2021-22 school year. In Mr. Levy's opinion, teaching essentially went back to normal, with just a few small changes brought on by COVID. For one, Mr. Levy was mindful that living through the pandemic affected his students. Some students were still particularly anxious about becoming sick, so he

softened his stance on group work assignments, recognizing that it was important for students to feel safe at school.

Normally, I like to force kids to be in groups just because I think so much of life is knowing how to deal with people, especially if you don't like them. But I thought, there's still kids out there that are traumatized by all this, and especially kids that willingly chose, "Hey, I'm going to wear a mask all year even though I don't have to." You could tell that me forcing them to be in a group might be too much for them. So I always provided the out. . . . I never chose groups this year, and I never forced groups this year.

The other change influenced by COVID was prioritizing teaching critical thinking. COVID continued to be a socially and politically fraught topic in the world in 2021–22, so when his students discussed it at school, he prompted them to base their claims on evidence.

Whenever I would hear a kid make some really random untrue statement, . . . I would always call him out on it and say, "Hey, tell us more about that, and where did you hear that?" And try to make them back up their thought. On the flip side, I would also do that with kids who would say something that I view as true. I would say, "Hey, give me some evidence to support that as well." So they're still needing to back up all their arguments they're making with evidence. They were realizing that nobody in the class was able to make some random statement and expect me or anybody else to view that as true, because I was always going to call them out on why they believe it or where they heard it and to give me support about that. And I think that cut down on some of the misinformation being spread.

Mr. Levy modeled critical thinking and evidence-based decision making constantly throughout the pandemic. And though living through the uncertainty of COVID was difficult, Mr. Levy helped his students understand that by being in school during the pandemic, they were not only learning science— they were experiencing the process of science.

Hopefully, down the road, we'll look back, like, "Wow, that was a cool and a crazy time to live through, because here's all that we learned from it." . . . Science is always changing and medicine's always changing. We go with the evidence supporting things at that time, and we might find new evidence tomorrow or next year that might change our train of thought. But we have to always follow the evidence.

Part of a Community

When her school turned to virtual instruction in the spring of 2020 due to the COVID pandemic, Ms. Kim and her students were remarkably well prepared. Ms. Kim was familiar with Google Classroom, and students in her 7th and 8th grade science classes knew how to use the platform to access assignments she would post for them. Her students were also used to self-guided learning because Ms. Kim regularly used the “grid method,” an instructional approach where students work at their own pace through a prepared set of activities. However, her community in rural Kansas was not prepared for this shift online. Ms. Kim explained that there were vital community-level technology issues that needed to be addressed before any virtual learning could occur.

Our biggest challenges were getting devices to all the students and also providing Wi-Fi for our community. [Our town]’s fairly rural, it’s about 9,000 or so. They ended up working with the local Wi-Fi companies to provide Wi-Fi across the community. But the biggest issues were when more than one student was on a device in the home.

Once the students had devices and Wi-Fi, Ms. Kim set up weekly grids with virtual lab simulations and activities. She also had an optional weekly check-in meeting. However, participation was low, and the number of assignments turned in dwindled. Ms. Kim empathized with the students and prioritized addressing their stress levels over their academics.

We would have check-ins during the online sessions where we’d ask the students, “How are you feeling about this? If you had to say your mood, which emoji is your mood?” . . . It was hard to know what to expect as far as, “How do you grade on this?” You can’t really fault the students for not getting their work done in the middle of all this chaos.

In 2020-21, Ms. Kim and most of her students were back at school in person. In the classroom, masks and social distancing were required, which ignited heated arguments that mirrored the arguments around COVID nationwide. Ms. Kim knew the science behind the virus and was in favor of masking indoors for safety. However, she also knew masking all day was difficult for students, so she allowed her classes to take frequent mask breaks outside. Unfortunately, one of her well-intentioned mask breaks was recorded by a community member, who claimed the video was evidence that the school was not taking students’ safety seriously.

One time I was on a brain break and took the kids down to a park a couple blocks away from the school. Kids had their masks off, and they were outside, but they were walking closer than six feet, and we saw this car go by us really slowly. The people had their camera up and they were filming us. And then you see on Facebook, “The school’s not doing what they need to do!” That was disheartening, because we were bending over backwards to try to do what we could do. And people were always

looking for something to point a finger at and to be derogatory toward the school system. That was hard because as educators, our heart and our souls are loving on these students and helping them to have a future.

To Ms. Kim, this experience highlighted that COVID was not only a scientific information issue, but also a social behavior one. Therefore, she started having discussions as a class about how to function in a community when you have disagreements.

There was such a division there for a while, even nationally—vaccinated and not vaccinated, mask and no mask. The students pick up on that, and they get angry and in-your-face and very opinionated. I think the discussions helped them to at least understand that it's a personal decision. Everybody has to look at the facts and make their own decision. And just because someone's different, you shouldn't shame them for that. They have a right to make that choice. . . . We've got to learn to have these discussions where we disagree on things and are able to hear each other out, respect each other, and try to find the best path for our society. So being able to do that in the classrooms is important, which is kind of the first society they know.

As the pandemic dragged into the 2021-22 school year, Ms. Kim saw student social and emotional problems worsen. COVID prevention measures were lifted, and, on the surface, life looked more normal. However, the combination of COVID and other serious current events dominating the national news, such as gun violence and racial inequities, took its toll. She noticed many students had become depressed, withdrawn, and apathetic towards school.

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Even when they were back in school, they wouldn't do the work to a very high quality. It's like they thought, "Well, I missed two weeks, and nobody seemed to care. So, whatever. It doesn't really matter. Education's not important." . . . And I think it's not just COVID at this point, it's all the other things that are happening in the world. The school shootings, the racial tension, the presidential election, all of those things stirred a lot of [stress]. The kids really care, and they're listening to adults talking. They're listening to the media, and they take a lot of that on their shoulders. . . . Some of their behavior is not really because they don't want to be at school or they're not putting in effort, it's because of the burdens that they're trying to process.

Parents' attitudes toward education also shifted during this time. Instead of working together as a team, Ms. Kim felt that many parents were mistrustful and judgmental of the teaching profession.

[Parents had] this attitude toward education: "Anybody can do it." You had people that were wanting to homeschool their kids, and after about two weeks, they were

sending them back to school because it didn't work for them. Everybody thought that they could do a better job, and they found out quickly they couldn't. . . . It was a struggle with lack of parent support. There were other teachers in our school that were [getting] some criticism for how they taught. And then [teachers] were demanding that their students step it up, and the parents were not really backing the teacher and pushing the student to get their work turned in.

After two years of COVID-related struggles, Ms. Kim was worn down and burned out. She even considered leaving the profession, but eventually decided the stakes were too high to quit during the upheaval of the pandemic.

We were so focused on making sure everything was high quality, and we wanted everybody to do their best and didn't want any gaps. We all took a lot on our shoulders. You go home at night, and you think of what you could do differently or better, and you don't take care of yourself. You don't eat. You don't exercise. You're just totally absorbed in what's going on with work. It was difficult. In fact, I considered making it my last year. . . . You just feel like maybe there's somebody younger with more energy that needs to have this role. But I've decided to give it at least one more year, because who wants to make this kind of decision when you're in in the middle of a war?

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Ms. Kim views teachers as an integral part of children's well-being—not in opposition to the community, but as part of the community. She modeled this way of thinking in her teaching throughout the pandemic, challenging students to respectfully live in a society with people who hold different views. Ms. Kim hopes that parents and the broader community can do the same, coming back together around common goals as the pandemic comes to an end.

I think if we could all just learn to appreciate each other as professionals and as community members, [recognizing] that we're on a team where we're wanting the best for their children, and we are open to discussions. . . . Hold people accountable, but don't shame people because of things that they feel are not right. For the students, we want them to have a strong future, and we realize that the world that we have right now is what they've got to grow up into. We want them to have healthy lives and happy lives, so let's work together for that.

I Questioned Why I Was Even There

Mr. Flanagan was used to conducting multiple labs each week with his 7th grade life science and physical science classes in rural Oregon. So when the COVID pandemic caused his school to transition online in March 2020, Mr. Flanagan started scrambling to pull together some semblance of science instruction for the remainder of the school year.

That first month or so, it was quite chaotic to say the least. . . . I spent hours and hours every day trying to find material that I could use to present online or take existing material and adapt it to using online.

Though he tried hard to provide a positive learning experience, class attendance was very low, and of the few who showed up, even fewer participated actively.

Some students would pop in and out from day-to-day, but it was a small core of students that would show up. And a lot of them wouldn't have cameras on. You might ask them questions, there would be no answer, so I'm not sure they were there. . . . And by the end, it was still the same core students showing up. A few of them had dropped in and out, but it was tough.

The 2020-21 school year brought new challenges. Students had the option of learning in-person or virtually, and Mr. Flanagan was responsible for providing instruction to both groups of students simultaneously. Although this hybrid teaching format was very difficult to navigate, he noted that his biggest challenge was student apathy, which was dramatically more pronounced than in previous years. Although students were physically present, many lacked motivation to put forth effort to complete assignments.

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The kids didn't want to work at all. . . . I would have 10 percent or 15 percent of the students turn in the lab, and so that was extremely difficult. . . . It was just like they showed up because they were told to be there and that was it. So that was extremely frustrating. I questioned why I was even there because at that point, it felt like I was just babysitting them for the hours that they were there.

Eventually, Mr. Flanagan decided the time and effort to set up labs wasn't worth it anymore, so he stopped them altogether.

Halfway through [the school year], when the kids weren't doing labs, I stopped doing labs. They take too much time to set up, too much time to grade. I'm like, "Why am I wasting my time when they're not going to do it?" Some of the kids, they like to get back there and play around a lab, but not do the follow-up questions, conclusions, the thought process that goes behind it. And to me, at that point, I was just wasting time.

For the remainder of the school year, he decided to try some new approaches in hopes of engaging his students. However, the new strategies were also met with limited success. Mr. Flanagan indicated that he was increasingly frustrated and even began to question his own skill as a teacher.

There wasn't a lot of learning going on, and I tried changing things around, trying different techniques and stuff. Yeah, it didn't work. . . . It was demoralizing. Up to this point, I was a decent teacher. But going through this, it made me question why I was even there.

The 2021-22 school year offered a fresh start with all students back in the classroom. Mr. Flanagan began the year doing hands-on labs as he had prior to the pandemic. Unfortunately, he was once again disappointed by his students' limited engagement with the material, so he stopped doing labs halfway through the second quarter.

The kids would ask, "When are we going to do another lab?" And I said, "At this point, we're not." I said, "You're not doing the labs. You're going back to the lab and playing around, but you're not doing the follow-up work," where, in my perspective, is when they think about what happened and explain and that type of stuff. And I said, "We're just going to do some worksheets and lecture."

It was demoralizing. Up to this point, I was a decent teacher. But going through this, it made me question why I was even there.

But Mr. Flanagan is not, at heart, a "worksheets and lecture" teacher and believes that fully participating in labs fosters deeper understanding and critical thinking. Therefore, despite the challenges, he once again implemented labs at the start of the fourth quarter. Although student engagement was not optimal, he did see limited improvement.

You got a few more kids that were doing it. But when I say a few, I think I was up to about 50% of the kids turning in some work.

Reflecting on his teaching throughout the pandemic, Mr. Flanagan lamented that student engagement was disappointingly low compared to the work he put in to plan for and deliver science instruction. And despite his efforts to utilize a variety of teaching strategies, he felt that he consistently fell short. Worse still, he had the sense that the general public did not recognize his hard work.

There were a lot of people that thought, "You're not doing anything. It's just all online," [not] understanding the time that it took to try to come up with material. . . . I wish they could understand, I guess, the difficulties of trying to get the kids back into a learning mode.

Overall, teaching science during the pandemic left Mr. Flanagan weary of the lack of return on his effort.

I think that was the most frustrating for me. Putting in the extra time, that was fine. But when you put in the extra time and then nothing gets done, it is frustrating.

That's Why You Hired Me! Because I Know Some of This!

Ms. Reeves is a veteran science teacher at a suburban high school in Minnesota. As a result of her scientific background and personal interest in science, she took the initiative to begin learning about COVID as soon as information about the virus was available.

I have a master's degree in molecular biology and worked as a cytogeneticist for 12 years before I was a teacher. If there's one thing in the world that - I don't want to say paranoid, but I know enough about viruses to know they're the thing that I'm most afraid of. Do you know what I mean? I have huge respect for what a virus could do. So, I was very curious from the beginning.

Therefore, it wasn't a huge surprise to her when her school moved to online instruction in the spring of 2020 in efforts to socially distance students from one another. This transition wasn't easy, but Ms. Reeves noted that she and her colleagues quickly pivoted and did what they could to make the transition as seamless as possible for their students.

So I remember the last day with the kids was March 17th, because it was St. Patrick's Day. And it was the last day I was with them. And I remember saying, "It won't be long. Don't worry, we're going to be okay. We're just going to try this virtual stuff." . . . And I want to say teachers were rock stars right then. Because they were in a world that they were completely unprepared for. And you know what? At the end of the day, we pulled it off. It's rather amazing that we did that. But we were given one week, and then we had spring break. And so starting in the beginning of April, we went right into virtual learning with kids.

As online learning got underway, Ms. Reeves noted that some of her colleagues did not seem to understand the seriousness of the situation and did not agree with the importance of distancing. This caused some tension in the school and put her in a position where she had to push back against practices that were not aligned with the scientific knowledge available at that time.

As we got into fall, and I realized it would be virtual, I had teachers and administrators that were insisting on in-person meetings. And I have some health concerns, so that I'm like, "I really don't feel comfortable doing in-person meetings." I called my principal, who had been my friend forever, and I said, "You know what? I'm very concerned about this. There's absolutely no reason staff has to meet in person. This isn't like we're working with kids. Meeting with kids I think would have higher priority in person." And he went in a direction of being suspicious of all of this, "It's not that bad. It's just the flu." And then I'm saying, "I know about this." And at which point he told me to stop throwing my credentials at him. And I'm like, "That's what I have to offer! That's why you hired me! Because I know some of this!"

Despite the challenges of online learning, Ms. Reeves was fully committed to providing her students with the most comprehensive, up-to-date information about COVID that was

available. She also used the pandemic as an opportunity to teach about the nature of science, particularly the tentativeness of scientific knowledge and its tendency to change as new information emerges.

I always talked about COVID, always. I am an AP Biology teacher. I teach them about viruses. I tell them that these are scary things. We don't know where this is going. I teach them science. I teach them that science changes as new data comes in. We're talking about, "Is this going to work? Can you keep a virus out?" I mean, we talked about all of this.

As the pandemic persisted into the following school year (2020–21), her school retained the online learning structure it had adopted the previous year. However, there was a lot of pressure from parents and others in the community to get students back into classrooms. Although her school board voted to keep remote learning in place until a vaccine was widely available, Ms. Reeves expressed frustration at the lack of concern shown for teachers at that time.

I think what really got me was I've always felt this community has always really supported me. I have good relationships with my parents. They know my background, and they trust me with their kids. But we had parents, about February it blew up, that were picketing board meetings wanting us to go back. And the vaccine hadn't come out yet. And like I said, I'm not a young teacher. I had some reasons that I didn't feel comfortable going back. . . . And they were insisting that we come back. And I think that's the part that really took me down, to have these parents doing that. I've given them so much, and my life wasn't worth a few more weeks of inconvenience? . . . But wow, that was brutal. That made me look at my value.

Her school eventually transitioned to a hybrid approach where students attended school in person on some days and continued with remote instruction on other days. Consistent with her previous instruction, Ms. Reeves expanded her focus on COVID to include emerging topics, including masking and vaccines.

The nature-of-science unit had a huge COVID section that had masks and all the things. We jumped into it right away. In fact, one of the things we did was we took different kinds of masks and were trying to blow out candles and see which ones kept the air. It was a nice little way to look at science, and very relevant at the time.

But all of a sudden, my science became political. And I resented that. . . . I am not interested in what you think about it or what your opinion is about it. That's not what we're doing. Just because you don't like it doesn't mean you can't believe it.

However, differing public opinions about the severity of the virus, necessity for precautionary measures, and efficacy of the vaccine increasingly made their way into Ms. Reeve's classroom. Although she aimed to simply provide scientifically accurate information about COVID, she explained that it was difficult to do so without getting caught up in the politics of the situation.

I don't know why it was hard for me to stay away from politics. I don't teach politics. I don't do social studies, come on. But all of a sudden, my science became political. And I resented that. . . . I am not interested in what you think about it or what your opinion is about it. That's not what we're doing. Just because you don't like it doesn't mean you can't believe it. I mean, it's just that's the way it is. And so I became very, very frustrated with vaccines and things like that becoming political. That made me crazy. And I guess what bothered me the most is I studied science. I mean, I have two master's degrees and a doctorate. I've studied science forever. And to have people not believe what I tell them was just kind of like, "Are you kidding me, because you read something on Facebook? Are you kidding me?"

Ms. Reeves recalled multiple instances where she received direct pushback from parents and students as a result of her COVID instruction. However, her answer to this criticism was always to put science at the forefront and use it to defend her position.

I had one student who gave me some grief at first. He was telling me that vaccines were causing more disease than COVID, but I had all the data. And he brought his data in, and I'm like, "Okay, this is a great opportunity for us. Remember how I tell you in science, we have to look at our sources? Okay, let's look at your sources." And we really picked it apart. And all of a sudden, I had a new convert. Because my children aren't stupid. They're really bright. And they know I'm teaching them science, and they can figure this out for themselves. "What's a good source? Who do you believe? Who do you not? Now we're learning."

Over time, the cumulative effects of the pandemic made science teaching progressively more difficult. In addition to logistical and political concerns, Ms. Reeves noted that many teachers struggled with the isolation that accompanied online and hybrid learning.

I think emotionally as teachers, that was really rough. Teaching is a funny profession, because I always tell people you have to have an ego. Because you can't get up in front of a class if you don't have an ego. Get serious! Who's going to stand in front of 30 16-year-olds? You've got to believe in yourself. . . . You have to feel good about yourself. You have to feel confident. And you can do that better with other people. Sitting alone at a computer by yourself, it's hard to get to that place you have to be to teach well. So we were fighting - I don't know if you want to call that depression. I suppose that there was probably some of that playing out. Isolation is not good for teachers. It's kind of a team sport.

Although the 2021–22 school year brought back some measure of normalcy, the lingering effects of COVID remain. Specifically, Ms. Reeves reflected on how the pandemic once again positioned science teachers at the center of a larger social issue. She also expressed disappointment with the widespread lack of respect for

We're right in the center of so many issues, COVID is just one of them. . . . And from both sides, everything comes down on top of teachers, and we're supposed to do the right thing. And no matter what we say, it's the wrong thing.

teachers that accompanied this monumental event, despite teachers' incredible efforts to help their students succeed. Further, looking ahead, she expressed concern for the future of the science teaching profession.

We have gone from being the good guys, to the bad guys, to the whole end of the deal. . . . We've got to be careful with teachers. Because I'm coming to the end of my career, and I am very, very concerned that there isn't going to be anyone to replace me. Because we have made this profession so ugly, and I don't know why. We're right in the center of so many issues, COVID is just one of them. There are so many issues in this world, and teachers end up in the center, right? Politics is [raking] us over the coals. . . . And from both sides, everything comes down on top of teachers, and we're supposed to do the right thing. And no matter what we say, it's the wrong thing.

A Forum to Speak their Minds

Mr. Hill is a high school Earth science teacher in the southern portion of New York. In March 2020, he was preparing for a scheduled professional development workday when he got word that he would instead be spending the day coming up with a plan to complete the school year virtually due to COVID.

Oddly enough, Friday, March 13th, we were scheduled to have a superintendent conference day. . . . The Wednesday or Thursday before, they sent us a new email like "All you're going to be doing on Friday is working on figuring out ways to teach remotely." Which is something none of us had ever really done before.

As a science teacher, Mr. Hill found virtual instruction particularly challenging because it meant he would no longer be able to provide students with hands-on experiences.

I teach physical science, and . . . if I was in my room, I would typically be modeling something. I would be showing them something, or they could be handling it. So having to go remote and not being able to physically touch a rock and feel its texture or. . . seeing with your eyes, holding with your hands. Not having that definitely was a drawback.

Given the abrupt and difficult switch to online learning, New York chose to cancel Regents exams⁸ for the year and enact a Do No Harm policy⁹ to give students a higher chance to pass their courses.

In New York state, we have Regents exams. So, in Earth science there's a big final that covers the whole year worth of work. Well, the Regents exams were canceled for that year, so students were graded only on how they did during the year. And New York state came up with a Do No Harm policy. Basically, the state didn't want students to fail because of difficulties learning remotely. We wanted to give them the best chance possible of passing the class, and so we modified our grading policy; it was weighted more towards what was happening from what they did from the beginning of the year versus the end of the year.

Without the pressure of preparing for Regents exams, Mr. Hill had more flexibility in his instruction. Although COVID did not fit in his Earth Science curriculum, he chose to give his students a space to discuss COVID-related topics such as social distancing, masking, and vaccinations.

⁸ Regents exams are standardized assessments given in New York for core high school subjects (e.g., science and mathematics)

⁹ The Do No Harm policy was established as a means of ensuring student grades were not negatively impacted as a result of the rapid transition to virtual learning, particularly for students with limited access to devices and/or internet that would allow them to participate in virtual learning. Under this policy, student grades prior to virtual learning were weighted more heavily than their grades during virtual learning.

In the Earth science curriculum . . . there's nothing specific to do with diseases, pandemics, things like that. But periods were extended, so we did often have time to just talk with each other, decompress, if they wanted to share how they're doing, their feelings, things that were going on, things like that. And then we would even share our concerns or our issues with the rules that were being handed down as to what we can and can't do and whether it made sense. "Why do we have to be six feet apart here? Why do I have to wear a mask here? But I go out there and there's no mask." And then once a vaccine became available. . . . then "Do we have to have the vaccine? Why? Why not? And is it a true vaccine?" So, it wasn't part of my curriculum, but if there were people that wanted to talk about it, I had time to talk about it.

The following school year, 2020–21, Mr. Hill's school opted for a hybrid schedule where approximately half of the students would attend school in-person and the other half would attend class virtually on any given day. Even though he was now interacting with students in person, Mr. Hill opted to continue using online materials in an effort to keep online students engaged and to maintain physical distance between in-person students. However, the arrangement wasn't ideal, as it meant that he still wasn't able to provide students with hands-on science experiences.

So even though they were in the room, I still was using a lot of online resources. . . . It was good, but it was not as good as it being there in their hands in front of them with their own two eyes. So it was still a matter of trying to find the best models and examples of them to help explain a concept or to help explain what it is that we're talking about.

Although his schedule and instruction were still far from typical, Mr. Hill found out that New York opted to reinstate Regents exams for select courses, including Earth science, during the 2020–21 school year. Mr. Hill did his best to prepare his students for this exam. However, he was concerned about students' ability to perform well given the challenging circumstances. Therefore, he was relieved when, in the end, students were given the opportunity to not count the grade if it would hurt their course average:

I felt that [my science teaching] was pretty good, better than the previous year, but if you were to judge me on my students' Regents results, you would say differently. But there are so many other things that go behind that Regents exam that I, as a teacher, have no control over. However, they were given the option if they didn't like how they did . . . they could not count the grade.

Despite the pressure to cover Earth Science content and prepare students for exams, Mr. Hill continued to give his students opportunities to discuss COVID as knowledge of the virus expanded and regulations continued to change.

COVID came up if there were things going on, like we might have heard someone was sick or new regulations that came out. And maybe talk about the regulations, "Why they're there? Do they make sense?" Of course, to most students, they didn't

make sense. . . I'm like, "Okay, so life is kind of taking a twist and we're dealing with this now. But it's not always going to be like this, so learning can't stop."

I gave my students a forum to speak their minds if they wanted to. . . And so it gave them the opportunity to express their feelings.

The 2021–22 school year brought back a measure of normalcy as all students in the district returned to full-time, in-person schooling. However, safety procedures such as social distancing and minimizing shared materials persisted in order to mitigate the spread of the virus. In his science classes, Mr. Hill was able to reinstate hands-on labs on a limited basis while continuing to use some of the online labs from previous years.

This past year, everyone had to be in school. The only time that you weren't in school is if you tested positive and you had to quarantine, but when you were home, you were expected to be online via Zoom. But otherwise, the school, the building was open. We still had certain restrictions. We tried to keep them a certain distance away from one another. . . . Because I couldn't really share materials, the labs were either paper labs or they were online labs. But not as many online labs as before. I only chose certain online labs, for example, identifying rocks and minerals. Since they couldn't handle [the rocks and minerals], I felt doing the online labs where they could still see the picture of them and stuff like that would be more useful.

As with years past, Mr. Hill continued to address student questions about COVID, even though the topic was not related to his required content. He noted that student questions at this time were often related to new practices and policies they were being asked to follow.

It's not my curriculum per se, but once in a while, a conversation would arise because of a rule the school was enforcing or some regulations that the CDC hands down to the states and then the state health department hands down to the local health departments. Which then makes its way to the school, and I try to explain, if they ask, "Why are we doing this? What is the point of this?"

The 2021–22 school year also saw the reinstatement of Regents exams for all subjects. Mr. Hill noted the transition to being back in person full-time and being held to pre-COVID expectations was difficult for students, some of whom were rushing to complete labs so they could qualify to take the exam.

In New York state, in order to take a science Regents exam, there's a lab component. And you have to have a certain number of minutes of lab to qualify. . . . I had students coming in, making up labs literally the week before the Regent exams were supposed to happen to qualify to take the Regents. And I'm emailing parents, I'm talking to the students, and it was literally pulling teeth.

Despite working relentlessly to prepare his students, Mr. Hill experienced one of the lowest Regents passing exams in his career. He indicated that this outcome was discouraging, not as a metric of his teaching, but because he knew low scores would present a roadblock for graduating students.

I had one of my lowest passing rates in a long, long, long time. And I tried to do the best that I can for my students. But as a teacher, it's disheartening to know that. And I think that most of my students did really put forth effort. I felt bad because there's passing the class, which the student did pass the class, but then there's Regents credits, which in New York state, in order to graduate, you have to have Regents credit in certain areas to do that. . . . If they don't pass it, then that kind of puts them a step back from the ultimate goal of graduating.

Even though the pandemic presented a host of challenges, Mr. Hill was proud of the resiliency of his students and their ability to overcome obstacles.

Learning through the pandemic for students definitely helped them see that they can move above difficulties if they actually tried, because they were never forced to do certain things, and here they were forced, and they actually found that they were able to do it.

And despite the lack of alignment between his required content and the topic of COVID, Mr. Hill feels that one of the most influential things he did as a science teacher during the pandemic was to provide his students with a space to express their thoughts, doubts, and concerns.

I gave my students a forum to speak their minds if they wanted to. It actually helped them work on their debating skills because you always say pick a position but support your position. So here it's not just, "I don't like this." It's "Well, why don't you like this?" And so it gave them the opportunity to express their feelings. A lot of times when students are quiet, it's because they feel that they're not going to be listened to or heard, or people won't think that what they have to say matters. And I think I've opened that up to students to go ahead, share what you want, and let's talk about it.

Lost in (Cyber) Space

Mr. Stephenson teaches high school astronomy, geology, environmental science, and physics courses in a suburban school in Utah. In March of 2020, his district received news that they would need to create a plan for finishing the remainder of the school year online.

It was about the third week of March . . . all of our districts in Utah said, "Okay, everybody's going to have to stay at home until we figure out what's going on." And the state of Utah gave a lot of the autonomy to the district, saying, "You guys know best. You make a plan to figure out how you guys are going to do this."

The district immediately began training all teachers on how to use either Google Classroom or Canvas, relying on instructional technologists to assist teachers with this transition and quick three-day turnaround. Mr. Stephenson was proud of the way his district handled this abrupt change.

I felt like they immediately said, "Okay, we got to do something, make a plan. We got to get everybody online, either Google Classroom or Canvas." They gave everybody about three days off to prepare themselves for online teaching . . . and they just said, "Teachers, come to school. Do training on Google Classrooms or on Canvas. Find somebody in your building that can train on that." There's about five tech people that kind of bounced to the different schools, the geographic areas of the district. And they were assigned to go to those schools and help the teachers start putting things online and learning how to record webcasts and how to hold Zoom meetings. . . . We just plowed forward, at least in our district. I was really proud to see how we handled it.

Throughout the remainder of the school year, Mr. Stephenson delivered virtual, asynchronous instruction by recording his lectures and posting them online. However, he quickly realized that this method of instruction no longer afforded a means to engage his students in hands-on activities or respond to their questions quickly and efficiently.

There was a really strong disconnect. I didn't have that communication with the students, and I felt very disconnected from them, and didn't realize how lost they were, how burnt out they were, how unmotivated they were.

I recorded my lesson and said, "I assume you're going to watch this just like you're listening to me in class and then do the assignment as directed." But we couldn't have that in-person communication, that immediate question-and-answer feedback, as well as the hands-on lab assignments or activities. So I had to look for digital, virtual labs to supplement what we would've done in the classroom. . . . And then instructions on the assignments. It was hard to clarify the instructions. If I thought it was clear and the students didn't understand, there's that delay when trying to email your teacher and then get that feedback.

In addition, the lack of real-time communication with students made it challenging for Mr. Stephenson to gauge how his students were doing with virtual learning, leading him to feel disconnected from them.

I think the most difficult thing for me was not knowing where my students were at. There was a really strong disconnect. I didn't have that communication with the students, and I felt very disconnected from them, and didn't realize how lost they were, how burnt out they were, how unmotivated they were.

The district decided to bring students back on campus for the 2020-21 school year, while still offering an online option for students who preferred to stay at home. Mr. Stephenson felt that bringing students back was helpful for rebuilding relationships and communication that were lost during virtual instruction.

Starting the fall of 2020, our district decided to have everybody come back to school but required wearing masks. If a parent wanted to opt out of allowing their child to come to school in person, they could do online classes. The vast majority of us were back in person. I think made a huge difference, where you had that teacher-student communication and connection in person. I think that made it a lot better.

With students back in the classroom, Mr. Stephenson took multiple opportunities to discuss COVID, including measures to prevent its spread. He explained that these lessons were valuable for introducing students to the importance of basing science on evidence and not opinion.

We were able to have a lot of conversations about COVID during that time. . . . There's people debating already whether masks work or not, the cloth works or not. And so, we watched another video from Be Smart, hosted by Joe Hanson. . . . He recorded in slow motion, using the Schlieren effect, what happens when you sneeze or cough without a mask and then with a mask. And he did cloth versus N-95. . . . Then we had this conversation about masks and where's the evidence that shows that they work and where's the data. And trying to pull out those science principles, saying, "We need to make conclusions based upon evidence rather than just our opinion."

Mr. Stephenson also used the topic of COVID to reinforce students' use of the science practices. For instance, he would periodically show COVID case numbers in Utah as a context for reading and interpreting graphs.

Periodically throughout the year, I would pull up the COVID numbers that were recorded by the state of Utah, and we'd just watch the graph. And it was a great opportunity to focus on graph reading, . . . and you need to get familiar with reading graphs. And just talk about cause and effect. How we saw numbers going up around Halloween and then Thanksgiving and Christmas. We saw these big

peaks during that time, so “What would you infer would be the cause? People going out? Family getting together?” Throughout the year, we would still have these conversations about what’s going on and talk about their opinions and their thoughts, and we need science to help quantify the how much and the how bad.

As a science educator, I feel it is my duty to teach and help the students think critically, logically, use data to come to these conclusions, know how to research information.

During the 2021–22 academic year Mr. Stephenson felt that school was truly getting back to pre-COVID conditions, and he was happy to be able to provide students with normalcy in school. He continued to address COVID with students as conditions improved, noting the effectiveness of this strategy for helping students examine data. He also expressed feelings of pride when he witnessed students applying the data analysis skills he had been teaching.

As we started talking about these new variants that were coming out and how contagious some were, . . . I said, “Okay, let’s look at our peak here in March when we shut down.” I think 32 people in Utah tested positive, and we shut down. And then we come back to school, and we have 1,500 active cases. . . . And yet in the 2021–22 school year, we did away with the mask. It was optional, and the district didn’t shut anything down.” But one student said, “Well, let’s look at the hospitalization rate.” The deaths did not spike. They stayed flat, and the hospital enrollments stayed flat as well. And so he said, “Well, with that data point, it seems like what we’re doing is just fine. We don’t need to shut down. We don’t need to require masks again because of these data points.” And I thought that was a very powerful application of what I was trying to teach students.

Reflecting on his science teaching during the pandemic, Mr. Stephenson felt that he was able to move student learning forward, despite a challenging set of circumstances. In particular, he was able to instill in his students the importance of data-driven decision making.

As a science educator, I feel it is my duty to teach and help the students think critically, logically, use data to come to these conclusions, know how to research information. . . . There’s so much information out there, and I said, “Well, let’s look at the data,” and tried to teach the kids about what is healthy. It was like, “The writing is on the wall. Do we need to debate this anymore? Look at the data. Take your emotion out of it, set it on the shelf, and think logically and say, ‘Are these people with the vaccine and the booster, are there as many people getting sick?’ Answer’s no. Are there people getting sick? Sure, but not as many.” Where I could, I felt like I tried to do my best to inform them of what is real by using those science principles.

The Bridge

Mr. Gifford is a 7th grade life science and 8th grade physical science teacher at an urban middle school in California. His students started asking him questions about a new virus at the beginning of 2020. Because he knew very little about the virus himself, he decided to incorporate research about the topic into his instruction.

One of the things I really value about my class is that students will bring in these science-related questions. Sometimes it's highly silly questions, like "What would happen if two bees stung each other?" And other times it's "Hey, I'm hearing about this virus in China, what's up with that?" And at the beginning, I remember sort of saying, "Well, I don't know." I actually learned about COVID-19 from a student who brought it in as a question. And so, in the spirit of scientific inquiry, we did some research. Let's go to evidence-based sources, including the WHO, the CDC, local health agencies, and let's see what we can find out.

By March, he and his students were shifting to distance learning because of COVID. Once online, Mr. Gifford made the choice to shift his focus to COVID-based instruction as opposed to his normal course curriculum. He believed that the once-in-a-lifetime pandemic was extremely relevant to his students' lives and a unique opportunity for him to lead his students through the scientific processes of research.

Our classes would center around looking at the number of [COVID] cases, sort of an introduction to virology and the immune system and how that works. . . . It became this big case study of what scientific inquiry looks like and for students to be able to see that scientists don't have all of the answers already, but how are we working using the tools that we have to answer questions. And that quickly became a big part of class was how to build better critical thinking tools.

In addition to looking at the relevant foundational topics of COVID, Mr. Gifford engaged students in discussions about how the pandemic was affecting certain communities more than others and how they could lead the charge in keeping their own community safe.

Let's center the experiences of the folks who are going to be impacted by this first and worst. And then always the conversation would come back to, "What can we do to help? What can we do to keep ourselves and our community safe?" We built plans around that that tried to balance our physical and mental and social and community health. We made our own masks at home back in the early days when we were being told to make cloth masks because there was still a supply chain shortage of N95s at the time.

Mr. Gifford also chose to focus heavily on COVID because he recognized that students were struggling to cope with the uncertainty of the pandemic. He noted that students came to him for answers that were, at the time, still unknown.

This was a time that was highly uncertain for all of us, but I think especially so for young people who are still developing patterns of resilience and how to cope with the unknown. And students coming to me as not a scientific authority in the main world, but their scientific authority, and having to sit with the answer “I don’t know any more than you. All I can do is look for the best available evidence.” That’s hard for students to hear.

I wanted to give them a safe environment in which to ask questions because this is the defining event of their times. It’s something they hear about all the time. And being able to process what’s going on with a trusted adult who they know will steer them in the direction of reliable evidence, that is good for them not just as learners, but for attending to those emotional needs.

As the pandemic persisted into the 2020–21 school year, online instruction shifted to hybrid instruction, with small groups of students coming to school for instruction on select days of the week. COVID was still a major topic in both of Mr. Gifford’s 7th and 8th grade classes at that time because students still had a lot of questions.

However, he noticed that students’ questions changed. While earlier questions focused on what the virus was and where it came from, their questions later became focused on COVID vaccines.

The big question then was vaccines and the development of vaccines, the safety and effectiveness of vaccines. And so we spent a lot of time looking at both the scientific processes by which a vaccine is developed and then also health and safety and the regulatory process.

Mr. Gifford explained that his goal was to give students a safe space to ask the questions they had. In a time when everything students heard was focused on the pandemic, he sought to give students accurate information to alleviate their anxiety.

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In the 2021–22 school year, Mr. Gifford’s school was finally able to return to in-person instruction for all students. As student concerns about COVID calmed, Mr. Gifford no longer felt the need to incorporate the topic in his instruction to such a great extent. However, he did continue to weave COVID into his science curriculum in places where it naturally fit.

As time has gone on, we have been stepping back from COVID a little bit, letting school just be school and not being in kind of crisis mode. I still want to, as a science teacher, be communicating the best available evidence and empowering

students to seek that for themselves. We still are talking about COVID, but it might be less than before. Or now that I've had more time to integrate it into the curriculum, it might feel like less of a, "Hey, we're pausing the regular class to talk about this," and instead we use the window of this experience to teach us something about this thing in science that we're already learning.

Reflecting on his instruction during the pandemic, Mr. Gifford noted that the support he received from his administration was key in his decision to address COVID. Specifically, his administrators allowed him the freedom to step back from his normal curriculum and address this very timely, important, and relevant scientific topic.

I felt very supported in terms of what I needed to do in my curriculum, how I needed to take a step back. And at the end of day, for an 8th grade student in the spring of 2020, is it more important that they know the history of atomic structure, or is it more important that they know how to better safeguard their family and community health during a global pandemic? My administration was really supportive in that flexibility that they gave me.

Mr. Gifford also reflected on the fact that he was able to successfully incorporate COVID into his instruction because he focused on information that was relevant to what students cared about.

I would say I served first as a messenger and a listener, deeply paying attention to what students cared about related to the pandemic, what's on their mind, what are they hearing. . . . And whether that was spending a lot of time looking at masking or vaccines or translating that information coming from the CDC or the WHO or actively responding to misinformation.

As a result of his COVID-focused instruction, Mr. Gifford was able to serve as a bridge between his students and the scientific community allowing them to find and evaluate scientific information on COVID in a safe and unjudging environment. Further, by providing his students with accurate information, he was also able to have an impact on their parents and families, providing an opening for students and families to have conversations about what they were experiencing.

During the pandemic, I had a very critical role as a bridge to young people between the scientific community and their understanding of what was going on in the world.

During the pandemic, I had a very critical role as a bridge to young people between the scientific community and their understanding of what was going on in the world. And this was surprising—it's not just a bridge to young people, it's a bridge to their families as well. It's young people saying, "Oh, I had a conversation with my parents last night about wearing masks in the grocery store," or "We had a conversation about the development of the vaccine," or "My dad was really worried about side effects from the vaccine, but we talked about this thing that we explored in class, and now they're less worried."

I Got to be My Own Little Local Dr. Fauci

Ms. Gordon is a biology instructor at a small university in Kentucky who teaches online biology courses for high school students seeking college credit. In the early stages of the pandemic, Ms. Gordon noticed that her students were becoming increasingly curious about COVID and wanted to spend class time discussing the virus.

We went to the CDC, Hughes Health, Mayo Clinic, WebMD, Johns Hopkins, and pulled up those resources from their websites.

At the beginning of the pandemic, when we didn't know anything at all about it, I got a sense from my students that they began to question science. "What was this new bug? Am I going to catch it? Is it something that's real? Is it something that's fake?" A lot of them were asking me questions, and that grew more and more as 2020 went on. They didn't want to talk about the textbook. They wanted to talk about the pandemic at that point.

Student curiosity persisted as Ms. Gordon began the course virology unit. Specifically, her students wanted to discuss the virus and its legitimacy as a health concern since there were so many reports of fake news. She quickly noticed that discussing ways of protecting against COVID, such as masking, became very politically charged.

When we got to the virus unit, they wanted specific information about COVID. They didn't want to talk about SARS, MERS, anything else. They wanted to talk about COVID itself. The primary question was, "Is this all fake?" Because they were getting fake news, and they wanted to know if it was just something that was totally fake and didn't apply to them. They weren't going to get it. They never went anywhere. Nobody wanted to wear a mask where I am, period. It was a personal freedom. And suddenly it became a political issue rather than just a medical issue.

To address student concerns about fake news surrounding the pandemic, Ms. Gordon taught her students how to locate credible sources of information.

I did a lesson on Zoom on where to find credible sources. We went to the CDC, Hughes Health, Mayo Clinic, WebMD, Johns Hopkins, and pulled up those resources from their websites. And then I told them, "This is Fox News, this is CNN, and we don't want to go there for our news. We want reliable sources. Go to the medical resources instead of the average everybody's-news-day sort of thing."

Despite her best efforts, tensions in her biology classes continued to rise throughout the rest of the semester. Ms. Gordon noted that she often found herself intervening in heated political debates about the effectiveness of masking.

I would have to sometimes separate the two factions—wear a mask, don't wear a mask—because they would just get on each other. It would become a political discussion instead of a health question, and I would have to verbally separate

them. They wanted to talk about COVID, or they wanted to talk about the politics of COVID, one of the two. Keeping them all in line and keeping them doing what they needed to do was difficult.

During the second year of the pandemic (2021–22) Ms. Gordon continued to discuss COVID and address student concerns about the virus using the same medical sites as the previous semester. She also supplemented her preceding instruction by giving students opportunities to explore COVID-related data and share their opinions about COVID-related topics.

I helped to enlighten people who were panicking and scared to death by pulling together resources for them that they could understand and assimilate, gave them a calm voice with solid facts behind it to back it up, and didn't play the politic game.

[My sources were] straight from the medical profession because they don't talk in scary language. They talk in facts. And if you just view the facts rather than the hype, then you can understand things better, and you don't get your emotions pulled on. . . . Some research-based assignments, "Write me a two-page essay. Watch these videos that I'm getting from the Hughes Health Network," and things like that. In discussions, "What are you thinking now? Has your wearing of masks changed over the course of this class? Why or why not?" That sort of thing.

Although COVID discussions during class were not always easy, Ms. Gordon indicated that they helped alleviate a lot of student stress and fear.

I'm pretty sure the majority of [my students] gained, a sense of, "This is a major pandemic, this is something that is serious and deadly, but if I follow proper protocols, I will be relatively safe." And I think that our lessons helped alleviate some of the scare factor that was part of COVID in the early times. I think they got better at realizing what is fake news, what is correct news, which is a big part of it. . . . They stopped being so terribly afraid, and that's because the numbers came down, there was a vaccine available, people were starting to come out, life started getting back to normal, in their opinion. I still have the unit in the virology chapter on COVID, but I'm also updating the course material, keeping it fresh, keeping it new, keeping it real, as they say, trying to get the most interesting resources that I can find.

Further, she explained that her COVID-focused instruction led some previously resistant students to take proactive measures, including wearing masks and getting the vaccine.

I hope that my lessons helped them not to be so afraid and to be proactive. A couple of my mask deniers went to wearing masks. Some of my anti-vaxxers went to, "Okay, fine, I'll get the shot," and they got their two shots.

Reflecting on teaching throughout the pandemic, Ms. Gordon feels that she was able to fulfill the role of a public health educator by presenting her students with facts and resources related to the virus, and in doing so, provided students with a sense of relief.

I helped to enlighten people who were panicking and scared to death by pulling together resources for them that they could understand and assimilate, gave them a calm voice with solid facts behind it to back it up, and didn't play the politic game. I think, considering how many students I had, I reached a whole lot of people with, "This is what COVID is, this is how you can transmit it, here's what you need to do to stay safe," that sort of stuff. I got to be my own little local Dr. Fauci.

Turning Obstacles Into Positives

Ms. Meier was teaching chemistry and physics courses at a rural high school in Illinois when the COVID pandemic swept through the nation. In March 2020, her school transitioned to fully remote instruction in an effort to slow the spread of the virus and stayed that way for the remainder of the school year. At the beginning of the 2020-21 school year, the school shifted to a hybrid schedule

where students who elected to receive in-person instruction came to the school building in the morning, and students that elected to receive remote instruction were taught during the second half of the school day. Ms. Meier noted that remote and hybrid instruction brought about a number of significant obstacles. One of the biggest was a lack of student access to reliable technology and internet service.

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Our students were really disconnected. We're a very rural community for the most part. And therefore, some students didn't have any access to online learning. The district had not provided any technology tools to our students. We had not provided any laptops. We had not provided any iPads or anything like that.

Another obstacle Ms. Meier and her colleagues faced were the limited capabilities of the free online platform (Google) that her school adopted, limitations she suggested might not have been so apparent had her school chosen to invest in software specifically designed for remote learning.

We didn't have any platform. As instructors, we didn't know what to do or how to do things. We were told via email and correspondence that we should be using Google platforms like Google classroom, Google docs, et cetera. . . . I really felt our district, and I think a lot of districts around tried to take the free way out for a lot of platforms rather than saying, "Look, we're going to invest since this is now our new teaching method for the year. We're going to invest in Blackboard or we're going to invest in Canvas, or we're going to invest in something that's an educational software meant for remote learning." They didn't do that. I'm not bashing on Google. It was free. It was better than nothing. But with free often comes a lot of limitations on support and limitations on how to put different types of assessment and different types of assignments out there.

Although this free platform provided difficulties for many teachers, Ms. Meier found its limitations were particularly problematic for her chemistry instruction. In particular, the platform was not conducive to entering, using, and manipulating accurate chemical equations.

A lot of the software that we had doesn't allow for superscripts and subscripts. And so when you're trying to write chemical formulas and chemical equations and math

equations, it doesn't accept what you want. And two C and C squared are not the same thing. So there were a lot of formatting issues.

Although the online platform itself was challenging, Ms. Meier also had to devote a significant amount of time to finding online resources that aligned with the content she was required to cover, and she had to adapt these resources for remote and hybrid learning. And even when she found an appropriate online resource, she usually needed to modify it so that her remote instruction was consistent with her in-person instruction.

Oh, [planning time] doubled it without a doubt. Because to deliver in person, you can do it on the fly. You can say, "These are the things I'm going to cover, but the students are going to lead the discussion, and we're going to go from there." You can't do any of that remote. So not only did I have to figure out how I was going to do my in person and deal with the management of that because of COVID restrictions, but then to the other side of it, the remote learning was horrific. You could say, "Okay, we're going to look at a Khan Academy video," but those don't necessarily match up with what you're teaching in class. So you have to decide, am I going to go with Khan and add this other stuff in for them or remove things because they don't cover it, or am I going to nitpick that apart? . . . It was just really hard because it doesn't fit perfectly.

In the 2021–22 school year, Ms. Meier's school transitioned back to in-person instruction for all students. Although she was glad for a more "normal" set of teaching circumstances, Ms. Meier realized that many of the obstacles she had faced eventually turned into positives. For one, she gained an appreciation of the benefits of technology and became much more comfortable using technology for various tasks.

My own use of computers has improved. . . . I don't mind using them. I've used them for spreadsheets and data processing and making documents and those kinds of things. And I wasn't afraid of doing this Zoom call today, but had you asked me about a Zoom meeting two and a half years ago, I'd have been like, "A what? A who?"

Growth is good. Experiencing new things is good. As a teacher, I've always tried to participate in things that would help me grow my profession, grow my content area. That's been important to me throughout all of my teaching. . . . Anything that makes us grow and helps us better use the tools around us is a positive.

Second, online learning pushed Ms. Meier to find engaging resources that her students could interact with in a virtual environment. Although these resources were essential for online and hybrid instruction, they continued to be valuable once students were back in person. For example, some resources provided opportunities for students to orient to hands-on labs they would eventually be performing in the classroom, while others engaged students in activities that aren't possible in the classroom due to lack of materials or safety concerns.

I was able to find some online resources for virtual labs, for doing some things that are a little less risky that kids can experiment with and play with before we actually go into a wet lab situation for chemistry. My Chem 2 kids like that because I've been able to find a few that use equipment we don't have, so they get to see what it would be like.

Despite the stress and difficulties brought about by the pandemic, Ms. Meier reflected on the experience as an unexpected opportunity for growth. While this professional growth might not have been something she was prepared for, she acknowledged that it will help her be a better and more effective teacher in the future.

Growth is good. Experiencing new things is good. As a teacher, I've always tried to participate in things that would help me grow my profession, grow my content area. That's been important to me throughout all of my teaching. . . . But anything that makes us grow and helps us better use the tools around us is a positive.

Balancing Act: Test Prep and COVID Instruction

Mr. Taylor has over 15 years' experience as a high school biology and environmental science teacher at a Career Technological Center in rural Ohio. In the spring of 2020, the state governor decided that spring break would last for three weeks while COVID "calmed down." However, it soon became apparent that COVID was not going to calm down anytime soon, and the decision to keep students at home was extended for the remainder of the school year.

The schools in Ohio went on spring break, right before Easter, somewhere around in there. The governor told us that spring break was going to be three weeks just to try and get things under control. Most of us figured out we'd probably have to alter things and started looking at online options and other things. But as the spring break dragged out, they kept extending the deadline. So, we had to convert most of our stuff to online learning, which ended up being the rest of the school year.

The transition to online learning was difficult for teachers and students in this rural district. Mr. Taylor explained that most students did not have internet service or a device they could use to access and complete online assignments (e.g., a computer or tablet). In addition, many students had to find ways to provide supplemental income for their families due to financial hardships caused by COVID, which took time away from their schoolwork.

With people getting quarantined and parents being out of work, a lot of kids had to go and help out. . . . We're kind of in Appalachia here, just on the outskirts of it. There's a lot of poverty, and a lot of kids just didn't have a choice to sit and do schoolwork all day.

Mr. Taylor also struggled with how to transition his lab-based science courses into an online format. Although many hands-on experiences went by the wayside, he was able to replace some with virtual options.

You couldn't do lab work, which is a good chunk of my stuff. We had a couple of online virtual simulation things we could do to get the point across, which it helped a little bit.

Adding to the challenge of preparing and delivering online instruction, the school district delayed making a decision about whether or not final exams would be administered at the end of the semester. Mr. Taylor devoted a great deal of time and energy to preparing students for these exams which, in the end, didn't happen.

They kept changing the rules on us. Some of my kids have to take end-of-course exams, and we were trying to get them ready for that in case they ended up taking them, which they ultimately didn't. And just the regular exams for our other

students, which they didn't tell us in time to not worry about it, so we were still trying to get them ready for a bunch of tests that ultimately didn't happen.

Because Mr. Taylor spent so much of the semester focused on exams, he was not able to address COVID to the extent he would have wanted to. Yet, he did carve out class time to discuss broader COVID-focused topics when he could, including characteristics of the virus, the purpose of quarantining, and what constitutes a pandemic.

I didn't really go beyond the basics of [COVID], "This is a virus. This is what's going on. This is what a pandemic is, what it means." And stuff that they'd heard of in the news, but probably didn't have explained to them. Why we were quarantining the way we were, that sort of thing. And hopefully, a vaccine. It was kind of a crash course in what a pandemic actually means, because they've never seen anything like this before.

Although Mr. Taylor was glad for the opportunity to share accurate scientific information with his students, he wished he could have had a broader impact in his community in this way. He noted that COVID became a heavily politicized subject in his town, and a majority of individuals did not trust what scientists were saying about the pandemic.

We live in an area where science isn't a major priority for a lot of people. And plus, I hate to get political, but we live in a pretty red state area, too. So if [community members] heard something on a news conference from a certain somebody, it was going to trump every scientist in the world, regardless of the evidence.

The following school year (2020–21) was held with a hybrid schedule that alternated groups of students. All students were provided with devices and hotspots as means to increase student participation, academic performance, and to make access to schoolwork more equitable.

We went 1 to 1 with devices. We also got a whole bunch of those [hotspots]. . . . That worked for most of our students. Most of them had some kind of device and a hot spot if they needed it.

A bunch of parents complained they didn't want us to say anything about COVID at all, because it was a conspiracy or wasn't real, or nonsense like that. . . . I'm like, "Buddy, I've got a degree in evolutionary biology. Why don't you leave the pandemic stuff to me?"

The 2020–21 school year also brought about the return of end-of-semester exams. Mr. Taylor focused all of his science instruction on topics that would be represented on these exams. This meant that he was not able to continue addressing COVID in his biology instruction because it was not aligned with required course content. However, he did teach about COVID in his environmental science class because the curriculum has a unit focused on the spread of diseases. He noted that he was able to use COVID as a real-life example that students could relate to.

We've talked a little bit about [COVID] in my environmental science class because there's a section there on human health and disease spreading. . . . So we just took what we were doing already, which was how viruses spread. So it was stuff we were already covering. It's just now we had a very obvious, real-life example to tie it to.

Mr. Taylor also noticed that integrating COVID into his instruction increased student interest in discussing protocols to reduce transmission and influenced some positive behavioral choices. However, he also observed that the political nature of the topic ensured that many students would not accept the seriousness of the situation.

Some of them, I think, did get something out of it now that they're really actually seeing some real-life consequences. You can't sit with your friends, you're wearing a mask all the time, you have to stay seated, stay away. . . . Some of them did get something out of it. I did have students asking me about masking and social distancing and that. And then of course, some of them are just going to dig their heels in and not listen, no matter what. But that's a danger of almost any science topic around here.

During the following school year (2021–22), students returned fully back to campus. Mr. Taylor continued to address COVID with students in his environmental science class as he had done the year prior. However, some parents began to pushback on science teachers discussing the virus in class. Mr. Taylor attempted to resolve this by reminding his community members of his background.

A bunch of parents complained they didn't want us to say anything about COVID at all, because it was a conspiracy or wasn't real, or nonsense like that. . . . I'm like, "Buddy, I've got a degree in evolutionary biology. Why don't you leave the pandemic stuff to me?"

Reflecting on his COVID-focused teaching throughout the pandemic, Mr. Taylor hoped that he was able to help his students better understand the situation and accept the validity of rapidly changing information as scientific knowledge expanded.

We tried to tell kids, "Here's what's going on," to be up front. "Here's what we know, here's what don't know. Things are going to change as we know more." I tried to be very clear on that. "Here's why we're doing this." So even if they didn't buy it, we'd at least try to understand it, or help them understand.

Harvesting Accurate COVID Information

In any given school year, Ms. Hall rotates among teaching environmental chemistry, botany, computer applications, AP Chemistry, and various agriscience classes at a rural high school in Michigan. When her district announced in mid-March 2020 that they would not be returning to school due to COVID, she began preparing worksheets and other written materials for her students to take home. Because her classes rely heavily on hands-on experiences, she modified activities for use with common materials students had at home or materials she could easily send home with them. For example, Ms. Hall had her students create miniature, self-contained ecosystems (known as “bio bottles”).

They had lots of questions for me. Being in science, teaching chemistry and botany with those kids, they felt comfortable asking questions of me.

I do bio bottles with the kids. In school, we do them in two-liter bottles and they do them in a group. But I sent them home with the directions and I modified it so they could go with water bottles or whatever other bottles they could find in their house.

The abrupt change was stressful for students, and they came to Ms. Hall with a lot of questions about how to stay safe. Ms. Hall attempted to alleviate student concerns by relating COVID to a previous situation where their district closed to stop the spread of the flu virus.

All the kids in schools have gone through norovirus before, the stomach flu, and we’ve shut down for it. We had shut down previously for that every other year. It goes through in February. And I’m like, “It’s the same thing. You guys want to make sure that if you have anybody sick at home, you’re washing and cleaning and taking those precautions.”

She also made sure to stay up to date with the most current information about the virus so she could provide scientifically accurate answers to student questions.

That [information] was all coming down from the CDC. And all the information I could get from those sites, I kept on reading to make sure that I knew for the kids. . . . I was giving them all the current information. They had lots of questions for me. Being in science, teaching chemistry and botany with those kids, they felt comfortable asking questions of me. And just [giving them] a health safety protocol—keeping your hands clean, making sure the surfaces are clean. This is before anybody was wearing masks, so the kids were asking about that, and masks were not available.

In addition to providing accurate information, Ms. Hall actively attempted to remedy the spread of misinformation, notably by providing reliable sources for students to refer to.

I was trying to give the kids good websites to get current good information from because throughout this whole thing, even back then, there was a lot of misinformation out. . . . I hope that I made it less scary for them and gave them a little bit of control about the things that they could do and control about the situation and making sure that, like I said, directing them to good information to find good sources to find good information. Kids trust teachers, and it's good to have somebody that you can trust in giving you the information that you need.

Ms. Hall's district continued with online learning at the beginning of the next school year (2020–21) before eventually adopting a hybrid model that provided students with the option of attending classes in person or online. During this school year, Ms. Hall used part

Kids trust teachers, and it's good to have somebody that you can trust in giving you the information that you need.

of her school budget to purchase an online platform, Innovative Creative Educational Videos (*iCEV*) geared toward virtual agriscience classes. The availability of video lectures, PowerPoint slides, and student assessments through *iCEV* relieved the burden of having to create these teaching materials from scratch.

I had iCEV. . . .It's a national resource for agriscience teaching and they have videos, and PowerPoints, and they have self quizzes for the kids. So I could assign a PowerPoint for them, and it had 35 questions for them to answer along with going through the PowerPoint.

Additionally, because Ms. Hall didn't have to devote as much time to developing online lessons, she was able to focus more attention on ways to make her classes interactive. To this end, she took students on virtual field trips, assigned virtual lab groups through Zoom, and prepared labs for them to complete at home.

For plant biology, I got these little transparent egg cartons, and I gave them each a different packet of seeds. They grew the seeds, and then I put them in lab groups on Zoom, which was nice because when we were all online, you could put them in a breakout room. Then they worked with one another, and they talked about all the different seeds from different plants and compared their growth rates. Then I sent them home with a leaf collection. So they all did a leaf collection in their backyards. . . . The other thing I was able to do was field trips with them. I just took them on phone Zoom field trips. So I took them to the greenhouse in town and up to Michigan State University around some of the greenhouses and the gardens out there. . . . And for animal biology, usually we do a lot of dissections. So I dissected seven different animals, I did that as a demo, and then gave them dissection diagrams, and then they had to make the animal with clay.

Ms. Hall also continued to discuss COVID with her students during hybrid instruction, frequently tying it to her required course content.

I taught about different ways that viruses are spread and then about the disease process. And then within those contexts would talk about how COVID would be similar or different to some of these disease processes that we see.

Once COVID vaccines became available, Ms. Hall also talked to her students about the science of vaccines. She did not shy away from discussing vaccines in her science instruction, even though it had become a heavily political topic in her community. Instead, when she received pushback, she made it clear that the topic was related to the standards she was required to cover.

Instantly, [the topic of vaccines] was so political, and a lot of teachers wanted to step away from it. . . . But if I had any questions from parents, I would just be like, "the standards."

By discussing the COVID vaccine with students, Ms. Hall was able to provide them with a sense of comfort in knowing what was happening, especially when they started to receive their own vaccines.

I had some kids come in at beginning the class and say, "I got my shot today." Just because they're happy. Because it gave them a relief because they understood how it worked. So, they felt comfortable talking to me about those kinds of things.

The next school year (2021–22) all students fully returned to campus. Ms. Hall continued to tie COVID into her course content. For example, she related COVID contact tracing to the process of food borne illness tracing that sometimes occurs in restaurants.

If you had listeria in this restaurant and how they track that down, then relating that back to how we do COVID tracing. I would talk to them about the amount of work our secretaries and our principal were putting in doing COVID tracing. . . . So, trying to make those connections back to what we were learning and how those processes work and why it's important that we have things like health departments and we should listen to them.

Relative to years past, Ms. Hall noted that she was more intentional about discussing COVID with students because she noticed an uptick in the pushback the scientific community was facing. She wanted her students to have the most up-to-date information and appreciate how much work was going into studying the virus.

I think it was a little bit more intentional [about addressing COVID] just because the amount of misinformation was even higher again this year, and more people were pushing against science. . . . And just showing the kids science and understanding the complexities of it and respecting the complexities of it and the people that work really, really hard to keep society going and healthy.

Ms. Hall noted that although there were ups and downs, she was proud to serve as an accurate and trustworthy source of information for her students throughout the pandemic.

I think I shared viable sources with the kids and information at times they needed it. I integrated it into my instruction. My kids trusted me, they asked me questions. . . . So I was very serious and felt it was my job to make sure that the kids understood why we were doing the things that we were doing and why they were important.

You Have an Expert in Us

Before transitioning to his current role as an Earth science teacher at an urban Michigan high school, Mr. Smith taught online at the community college and university levels. His familiarity with online teaching led him to post his high school curriculum on a self-created website and make it available for public use. So when COVID launched most of the nation into virtual instruction in 2020, Mr. Smith was prepared.

I had taught classes online at both a community college near me as well as a university near me, so for me to go online was actually very easy. Most of my subject matter is out there anyway on my site for public use.

Mr. Smith's school district strongly encouraged teachers to use Google Classroom to host their online instructional materials. However, Mr. Smith chose not to use Google Classroom because it did not work well with many websites and materials he was already using. Additionally, he did not think it was worth the time and effort to move materials from his current platform (Weebly) to a new platform. However, this decision was not well received by the administration, who envisioned more uniform online resources for students.

I use Weebly for all of my online instruction. I've had a web presence, no joke, with my class since 1996. So as far as having that information out there available to students, it was always there. I had online labs already geared up for just such an emergency. I personally did not go with Google Classroom. That did not make for a lot of friends downtown. They all wanted everybody on one platform. The problem was with Google Classroom. It was very restrictive, and it really didn't want to play nice with a lot of NSF or American Meteorological Society, AMS labs.

Despite this pushback, Mr. Smith forged ahead with online instruction. However, he quickly noticed that the existing gap between higher- and lower-achieving students was continuing to grow in this new learning format.

For the most part, those students that did well face-to-face did well during the first couple months of the pandemic. Those students that typically didn't come to class anyway, they didn't come to virtual. Those students that didn't do homework, they still didn't do homework virtually.

As online learning continued into the 2020–21 school year, Mr. Smith saw a major, “long-time coming” change in the school district—a 1:1 initiative that provided all students with a device to use at home and a hotspot to those with limited wi-fi access.

The district finally went to a 1:1 initiative with technology. That immediately helped everybody. Now normally, with a 1:1, people always bring up the access to the internet. The school district also provided hotspots for all those students that didn't have internet access. They finally figured it out. I have been preaching for 20

years that we need to do this. But once COVID hit, [the district said] we need to do this now. But that was a major positive. So now students actually have the technology and have a way at home to deal with the technology.

With technology needs addressed, Mr. Smith found that his students had a much more consistent online presence and were comfortable learning virtually, two things that many of them had not previously experienced.

Those students that were online phobic, that went away. So now when the students come in and see my websites and see everything is listed, no problems whatsoever. I'll be honest with you, I was the only science teacher out of 20 that had something like that pre-pandemic. So the students usually had culture shock to somebody that was actually online technology wise. That student anxiety is all gone now.

The district released that they were getting \$6.3 million from the federal government to go back to face-to-face, but it just didn't sit well with the veterans. It's like your life, students' lives, long COVID symptoms, or money.

However, while he felt very comfortable teaching online, Mr. Smith realized that other teachers were struggling. In particular, he started to notice differences between veteran teachers who had an online presence and those who were newer to the profession, especially when it came to new grading software that was being recommended by the administration.

The veteran teachers, we just said, "We're not dealing with this. We've had our online presence. We know how to do this. We're just going to deal with the craft of teaching." It was really those teachers that had 10 or less years of experience that had a complete meltdown due to malfunctioning software.

Moving into the 2021-22 school year, the district decided to have teachers and students return to the classroom, a decision that Mr. Smith explained was largely driven by monetary incentives.

The district released that they were getting \$6.3 million from the federal government to go back to face-to-face, but it just didn't sit well with the veterans. It's like your life, students' lives, long COVID symptoms, or money. And that's literally what it boiled down to just plain and simple.

This controversial decision to return to in-person instruction led many of the experienced teachers in Mr. Smith's school to transfer to a virtual high school in the district.

Once they tied money to seat time in class, that was it. There were a lot of staff that said, "We're just going to go to the virtual high school. We're not dealing with this anymore." The list of transfers was half a mile long, and that's not an exaggeration. People said, "No, we don't want to get in front of the kids. We're too old. Most of us have medical issues. We don't want to get COVID."

For those teachers who remained, the rapidly shifting district suggestions and mandates were increasingly frustrating. For example, the return to in-person instruction prompted a host of safety policies and procedures that largely fell on the shoulders of teachers to enforce and carry out.

To be honest with you, COVID was first and foremost the first day of school. When you come in, here is your bottle of hand sanitizer. Everybody's going to use it. If you use the bathroom pass, everybody's going to hand sanitize as soon as you come through the door. If you want to go to the bathroom next time, you're hand sanitizing. As far as desks go, instead of having the students clean their desks, when I would notice that there was somebody out with COVID, I would clean their desk just so it wasn't going to transmit between one class the next.

Yet, despite this focus on COVID precautions, the district experienced record numbers of COVID cases, with up to 30 percent of students absent at any given time. Mr. Smith explained how difficult it was for him to watch his students go through round after round of illness and quarantine, especially when his school could have made the choice to continue remote learning.

So that was more impactful going back face-to-face, not because I couldn't do it or anything like that. It was just literally watching the students drop like flies. And it's a little disturbing when we could have stayed mobile, when we could have stayed at home.

Above all, Mr. Smith wished that the district had relied on teachers and valued their opinions as the pandemic unfolded. Although teachers were the ones interacting with students on a daily basis, they were not consulted or asked to provide input on what would be best for them and their students.

They hired somebody with a doctorate that was supposed to make the decisions, but they didn't have the experience in the classroom. They didn't have the experience in the school district, and they were doing things left and right. And there were a lot of us that had the experience and were never consulted. The district said, "Nope, we have an expert." But you have an expert in us. And that was really the most disheartening part about it. Those of us that had a clue, those of us that already taught online, those of us that had years of experience were just pushed aside.

Starting Over

Ms. Goodall was a high school physics teacher in an affluent, suburban Illinois high school when the COVID pandemic forced schools all across the country to shift to online instruction. Ms. Goodall's school discouraged teachers from discussing COVID as part of their regular instruction. Therefore, she focused on keeping instruction as "normal" as possible for her students, continuing to cover planned content and seeking out means of providing interactive experiences.

A few students thanked me for being the only teacher still actually doing work. I tried to keep it as normal as possible in terms of what I would do in physics.

For example, for the topic of electricity, she added several online simulations, some that she had used in the past and others that she sought out online or via colleagues.

I mostly just had my kids working on digital and virtual simulations for physics. We were in our electricity unit at the time at the end of the year. We stretched out the electricity unit a little bit. The University of Colorado PhET has really nice simulations. I had already used those, so I already had labs that I could do for electricity. We just did all those, and a couple of my colleagues had made other ones for switches, and we found a few other websites and used those.

I think the most difficult part was those kids who were not well off were stuck at home because they're living with mom and grandma. Or if they're homeless. In a school of 6,000 kids, when most people are pretty affluent but there's one or two per class who aren't, that becomes starkly real.

Because Ms. Goodall's school had an abundance of financial resources, she was able to purchase Pivot Interactive, a website with interactive science simulations that students could use at home. For her light and sound unit, Ms. Goodall explained that the website provided opportunities for her students to manipulate and change relevant pieces of interactive, filmed science simulations, an activity that helped them stay engaged and learn content while online.

For sound waves and light waves, I had my school, being quite affluent, purchase Pivot Interactive, which has a lot of science labs where students could click buttons and make selections and actually make changes on their boards. My students were able to do some labs that way and still learn a really good chunk of physics content.

Ms. Goodall was also able to use school funds to sign up for Go Formative, live whiteboard software that allowed her to observe students working through problems in real-time and chat or comment on their work. She noted that this software provided another means of interaction between her and her students and provided her with real-time feedback about what students were understanding and what they were struggling with. The ability to see students working in real time also provided evidence of student participation and engagement.

I used Go Formative, which is kind of a white board virtual lab app. I could assign a problem, and I could see everyone working through it in real time, and I could comment on it in real time, and I could send them chat messages and Zoom in real time. It at least got them doing a little bit of physics, and then I felt comfortable giving them credit for today's work, and everybody got an A that showed up.

Although Ms. Goodall was able to find ways to keep teaching physics, she quickly realized that her students needed more than content. It was clear from Zoom interactions that many students were struggling because of the significant challenges they were facing in their home lives. Further, Ms. Goodall recognized that student struggles were often tied to socio-economic status.

I think the most difficult part was those kids who were not well off were stuck at home because they're living with mom and grandma. Or if they're homeless. In a school of 6,000 kids, when most people are pretty affluent but there's one or two per class who aren't, that becomes starkly real. When you can see in their background that their home life is very different than your home life.

Although she longed to help, Ms. Goodall did not feel prepared to deal with the social and emotional well-being of her students. However, she did her best to support them through some of the lowest times in their lives.

I was not being prepared for that social, emotional well-being of my students, because we didn't know what each person was doing at home. We didn't know what was going on in their life. And they only open up so much at the age of 16 and 17. The ones that did open up, I would sit on Zoom for hours with them if they needed to talk. But I could only do so much too from my own house. I have to start my next class. Having to hang up on a kid occasionally to start a class, "I'm sorry, I have to go, but please call guidance. Call this number." Calling their parents later to just say, "Hey, check in with them." That was rough.

The beginning of the 2020-21 school year brought the birth of Ms. Goodall's third child, so she was away from teaching until November. Her school hired a long-term substitute teacher that was fully remote with students until her return. In planning for her maternity leave, Ms. Goodall once again drew on the readily available school funds to put together supply kits that were sent to students at the beginning of the year.

We had spent all summer planning, and I had come up with a bunch of really good hands-on labs that the kids could do with equipment we bought on Amazon. Per class, each teacher had enough money to buy whatever we needed. I sent home bouncy balls, rulers, springs. I bought \$300 worth of stuff per class. Each kid essentially got a bag with physics equipment so they could do real physics. We were able to use a bouncy ball. We had five or six different marbles. We had a couple of different rulers that had tracks built in. Having all that money available to us, we were able to buy and essentially write our own at home physics labs. We

sent home a ton of stuff, so my sub had all that equipment to work with, to use some of it while I was on leave.

There were more kids needing mental health support than I've ever seen before. . . . Students who were more introverted, you could tell were really struggling with those social skills they hadn't needed to use in two years.

Soon after her return, her school made the decision to transition to hybrid instruction where small groups of students attended school in person on alternating days. Although Ms. Goodall was once again able to see students in person, she felt that student motivation was lacking. In particular, students who were in person during the school day were not engaging with content because they were essentially doing the exact same activities in the exact same ways as those who were online.

Half my students were in the classroom, half were at home. I would check in with my Zoom kiddos. They would be doing the online version of the labs that we had set up with the at-home equipment. The kids in person would be bringing in their at-home equipment and using the same stuff in person, but they were allowed to work in groups of two if they felt comfortable and wore masks. There were a couple of activities and demos that I would have the kids in person show to the kids at home. I tried to incorporate the in class and at home kids together. But we were mostly instructed that you were not allowed to do separate things for the kids at home and the kids in person. . . . I essentially taught the class like they weren't there, which is what we were required to do.

The return to in-person instruction also caused Ms. Goodall to experience extreme anxiety and depression, as she was constantly worried about bringing the virus home to her young children.

Our school tested everyone all the time, so, in theory, I should have felt safe. But I did not. I had a lot of anxiety, a lot of depression. From November to December is a blur if I'm being honest. I just had a baby. I could never go to the doctor with COVID, they never let you in. In January, I got put on antidepressants for postpartum anxiety and depression, which was probably triggered by COVID and all of that stress added in.

Looking for a new start, Ms. Goodall began the 2021-22 school year at an urban high school in Milwaukee. Although she was in a new building with new students, she soon recognized that these students struggled in many of the same ways as her previous students. These struggles were especially apparent as students returned to the classroom full time.

There were more kids needing mental health support than I've ever seen before. . . . Students who were more introverted, you could tell were really struggling with those social skills they hadn't needed to use in two years. These students had COVID in eighth grade, ninth grade, sophomore year. And so, now they're juniors with no social skills, so that was hard this year.

However, despite some social emotional challenges, Ms. Goodall found that her students were interested in the physics content she was covering, most likely due to the excitement over experiencing hands-on instruction again.

I will say it seemed like the kids appreciated physics more, the hands-on stuff. I took away a lot of the virtual stuff that I had done previously before COVID because I'm like, "Nope, we needed to do everything hands on. I have equipment." Now, the computers analyze some of the data for us, but I made them make graphs by hand. I made them find the slope by hand. Then, I showed them how to use their calculator for it. Some of those skills that they just didn't need during COVID, I'm like, "Nope, we're going to take data by hand just to make sure you guys kind of get back in this groove of what science is."

The supportive environment in Ms. Goodall's new school also gave her the confidence to address COVID in her instruction. Even though her curriculum was not directly related to COVID topics, she decided to address any student questions and talk through some of the data they were interested in.

When the vaccines came out, when the boosters came out, the kids had questions, and I felt comfortable just having class discussions about that. When a kid would say something like, "Oh, COVID's not real," or "The vaccine's going to make you sick." I'd be like, "Listen guys, when the medical community can get together and work together on something, amazing things have happened. You got opportunity to see that here." I only do it with data. I won't do it unless I have data that they can analyze because I feel like that's my in as a physics teacher. . . . Our school got air purifier things, so I had no problem pulling up those air purifier things webpage and be like, "Let's look at what they're saying their particle filter's doing here." This is physics. Air movement is physics. It's not the physics we do, but it relates to speed and momentum and energy transfer.

After two years of frustration and stress, Ms. Goodall was thankful for a new start and return to some measure of normalcy. However, reflecting on her experience during the pandemic, Ms. Goodall now recognizes that the tribulations she went through did help her grow and improve as a teacher.

I got to rewrite everything. I think that's always a good thing for anyone. I redid everything, my notes, everything, literally everything from scratch, new Google Classroom, new slides, everything from scratch instead of reusing some of my old stuff. I feel like that helps. It makes it a little more personal year by year. As a middle-aged teacher who's been teaching now for 16 years, some of my stuff gets dated. Everything's now been made virtually. All of these students who had mental health stuff, I was like, "Here you go. Here's all of this unit virtually." I have a calendar. It's very organized. It has reading links, movie links, choose your own adventure. How do you want to learn? Here's a video of me lecturing three years ago. I still have all of that content for kids who are out, so that's nice.

Keep Looking for the Truth

Ms. Davis is a high school science teacher in upstate New York. In early 2020, she was teaching Earth and Environmental science to sophomores and juniors when the New York Department of Education sent everyone home to complete the school year online due to the COVID pandemic. Although this transition was challenging for other staff members, Ms. Davis was able to move forward seamlessly because she had already been using online resources and approaches in her science instruction.

I told the kids, "You are the ones that are going to face all these problems. If you let this slide, it's going to be affecting you. So, it's your responsibility. What are you going to do? Maybe you need to speak up, but how are you going to speak up? You have to learn it. You have to get the knowledge. You have to know how to use the numbers to justify your conversation so that they don't look down at you like you are only a kid."

I really had no problem using the online virtual classroom because my kids already used blended learning a bit. Using Google Classroom wasn't a problem for me.

Ms. Davis had already been discussing COVID with her students prior to the shutdown because it was making headlines on a daily basis. As a science teacher, she recognized the seriousness of the situation and wanted to be proactive in preparing students with strategies to stay safe.

I'd been telling the kids before it started that you have to take precautions, wash your hands and all this. Then introduced to them what is so specific about this pandemic and that type of thing. . . . We talked about different perspectives in terms of taking care of themselves physically and mentally.

Ms. Davis was also aware that the amount of information being spread about COVID was overwhelming and, in some cases, even contradictory. She encouraged students to conduct their own research on aspects of the pandemic they found interesting, hoping that it would help them stay up to date and find answers to their own questions.

I also want the kids to not just listen to the news, but then do some research on their own. Specifically different aspects they may be interested in to keep themselves informed. . . . Because it's like every day even the experts are telling you different stories or different facts. It was very confusing already. It's like, "Which message am I going to give them?" I may as well just give them different areas they can think about and then have them look for answers themselves.

Providing students with the skills to seek out information related to COVID and the confidence to voice their concerns provided many with a source of comfort. This was especially helpful given the vast number of students that were dealing with the consequences of COVID in their personal lives.

They are the ones that know how to ask questions if they don't know about it. They are the ones that will discuss their concerns and let us know what they worry

about. Because as time goes on, some kids, they really faced the situations. Like their family got infected or their parents got infected, and there were deaths. For those kids who've been getting some information or know where to find information, their coping skills are better.

As online instruction persisted into the 2020–21 school year, Ms. Davis continued to center her lessons around COVID when she could. For example, she and her students used the Johns Hopkins website to access and analyze data about viral transmission worldwide.

We used the website that Johns Hopkins was making to demonstrate exponential growth and then compared the different countries so that they know what's going on in the world. . . . We used that as a jumping off point to see what they thought, and if they were the ones making the policies, whether the data could help them out.

The pandemic also provided a shared experience all students could relate to and gave Ms. Davis an opportunity to help students learn about the nature of science.

It's really something that's affecting them hands-on. So, it's very intimate because everyone has at least one person in the family or in the school personally being affected by COVID. . . . Then, of course, on top of that, different facts or different news coming up each day. It really gave them the idea how science works. A lot of times the knowledge evolves, and the experiment doesn't guarantee anything. Then you just have to keep looking for the truth.

Ms. Davis explained that most of her students were very eager to learn about COVID and willing to take measures to prevent transmission. Her students were also generally eager to receive the vaccine once it became available.

They definitely wanted to get the vaccination. The high vaccination rate in our school is really great because they got the knowledge about it. Also, they knew that masking is really helpful for protection [from COVID].

During the 2021–22 school year, instruction largely went back to normal since all students had returned to campus. Although Ms. Davis no longer deliberately integrated COVID into her science instruction, she did continue to receive and answer student questions.

Reflecting on her science instruction during the pandemic, Ms. Davis hopes that her decision to regularly discuss the pandemic helped students take notice of the impacts of this event, both locally and globally. Further, she hopes her students are now better equipped to take a stand and use their voices to influence future public health decisions that will ultimately impact their lives.

I told the kids, "You are the ones that are going to face all these problems. If you let this slide, it's going to be affecting you. So, it's your responsibility. What are you going to do? Maybe you need to speak up, but how are you going to

Speak up? You have to learn it. You have to get the knowledge. You have to know how to use the numbers to justify your conversation so that they don't look down at you like you are only a kid."

Call of [Handwashing] Duty

Mr. Johns has been a high school science teacher at a small, rural magnet school in Louisiana for over 17 years. Leading up to COVID, he taught human body systems and chemistry classes to students across the district who traveled by bus to his campus from other schools. Mr. Johns had been hearing talk of school closures in late March of 2020. Shortly after, he got word from his district that they would be closing for a short period of time. However, no one was prepared when the decision was made to keep schools closed for the remainder of the school year.

We got the announcements that school would be canceled for, initially we thought, just a short time, maybe a week or two. It was all kind of just last minute where we were canceling school indefinitely. And then the announcements came out about how we needed to have assignments posted for the rest of the year essentially.

The rapid transition to online learning created significant technological difficulties. For one, the district did not have a 1:1 computer program, meaning that not all students had access to computers they could take home. Additionally, being in a rural area, internet connectivity was limited. Therefore, due to lack of technology access, the district chose to make the remainder of the year optional with asynchronous assignments.

The lack of technology and internet connectivity was a barrier for some to be able to continue. And so because of that, our district made everything in the spring of 2020 optional. So we used the students' grades that they had earned so far as their second semester grades.

Since Mr. Johns had already been utilizing Google Classroom to post lecture slides and other online assignments, the transition was not particularly burdensome for him. However, he noted that teachers were generally expected to work through this transition to virtual learning on their own, with limited or no district support.

We had a week to a couple weeks where we were supposed to have stuff posted and then have assignments for the rest of the year, but it was all kind of on our own. We didn't have any training about any of this. Certainly nothing in person that prepared us for it.

It was a time when there was all kinds of information flying around about what's best and what's recommended and not recommended, so trying to be a reliable source of information was part of the goal there. Just trying to be a good source of information for students.

Given that his science instruction typically included numerous hands-on experiences, providing engaging online instruction was challenging for Mr. Johns. He dealt with this issue by attempting to find virtual replacements or cutting out some labs completely. However, he soon found that supplementing his lessons with online alternatives was not very effective for student learning.

Our human body systems class, it's Project Lead the Way, the curriculum's online, so it wasn't a huge transition to go virtual. However, it does involve a lot of hands-on lab activities, which we had to either go find virtual replacements for them or just skip over those parts. So it wasn't the same experience as they would've gotten in class. Chemistry was difficult, it was very lab-based. So there are a few simulations and types of things we can do online, but I think it was not nearly as effective as being in person.

This struggle to provide effective science instruction was amplified by the added planning and instructional time required to take up the topic of COVID. Mr. Johns indicated that it was important for him to provide students with access to accurate information from reliable sources during a time when quite a bit of misinformation about COVID was being spread.

I did pass along a few tips about how to prevent the spread of COVID, what social distancing looks like, handwashing, sanitation, and then some of the CDC guidelines about quarantine and those kind of things. . . . It was a time when there was all kinds of information flying around about what's best and what's recommended and not recommended, so trying to be a reliable source of information was part of the goal there. Just trying to be a good source of information for students.

The following school year (2020–21), the district abided by federal guidelines and began with instruction completely online. To alleviate some of the challenges from the previous school year, the district was able to provide all students with a laptop. Although internet access was still a barrier for some students, instruction was much smoother than in the previous school year. Mr. Johns held short synchronous classes with students in the morning and then assigned them work to do on their own in the afternoons. He also held office hours for students who sought out help.

I think we had a shorter schedule where it was about a 30-minute synchronous class, and then we were supposed to have assignments for the afternoon, and we had office hours and stuff where they could get extra support.

Although attendance was no longer optional, Mr. Johns explained that student engagement and participation in his classes was almost nonexistent.

One of the issues with online was the students. A lot of times they would log on, but they wouldn't even show their faces, so I didn't really know who was paying attention, who wasn't. I would ask questions, and no one would unmute and answer them. It was just not very interactive.

As federal and state COVID guidelines shifted, the district transitioned into a hybrid schedule where students were split into two groups and alternated between days of in-person instruction and online asynchronous assignments. However, as students began

returning to school on the hybrid schedule, the district set health and safety guidelines, including the addition of intense sanitation procedures both in the classrooms and for the entire building. Mr. Johns explained that these guidelines provided a lot of extra work for teachers and conflicted with their teaching responsibilities.

It was a challenge to sanitize the desks between classes and those kinds of things . . . Then a lot of times, I'm trying to get this lesson plan and get it set up just right and get on the Zoom, and I'm supposed to be sanitizing desks, and so there's some small-time commitments where, "Do I devote this time to make sure my Zoom class is ready, or do I sanitize?" And so some of those decisions, "Do I sacrifice instruction for making sure the desks are sanitized?" those kind of things. We also had a temperature-scanning station, hand-washing station, and sanitizing station coming into the building. So I was manning those duties two or three times a week in the mornings. So the students got off the buses, [and we were] making sure they were wearing their masks, checking their temperatures, escorting the ones whose temperatures were too high to the isolation room and getting them checked out, all that.

Because virtual instruction was a key piece of the hybrid schedule, Mr. Johns devoted a vast amount of time to adapting his instruction to this new way of teaching.

I would record the lab activities and they would watch the video instead of actually doing it. We would do a lot of that. It was a lot of time that I would spend in the evenings trying to put together lessons and Google Slides that students could interact with. So it was a significant increase in time commitment to move a lot of the stuff that we've done in person and try and find a way to do it online.

In the later part of the 2020–21 school year, all students transitioned to being back in school full time. As a result, safety precautions became increasingly important. Mr. Johns began devoting class time to discussing why masking was important from a public health standpoint, which helped his students see the value in following COVID protocols.

I think students then can take this information that they gain in school and even share that with their families and friends, and those they interact with. That they can promote a more informed population, then we think we can have a better response if anything like this happens in the future.

These things we were learning about related to their experience with the pandemic and why we were wearing masks. . . . I think especially knowing just how it's spread, how the viruses work, and how it was easily transmissible through respiratory droplets. It was a little added motivation and understanding of, "It's not just a rule we're asking you to follow, it's actually for your protection and for others' protection as well." And I think they were more eager to at least buy into it than just the requirement by itself. . . . Students having an understanding of how the disease is spread, how their behavior and their compliance with wearing masks and different things helps protect people is helpful.

In-person instruction continued throughout the 2021-22 school year, and Mr. Johns described feeling that things were getting back to normal. In particular, he was happy to return to lab activities he had effectively used in the past.

I was glad to have students back in person to be able to return to some of the hands-on lab stuff that we have been able to do in the past. So yeah, last year was as close to normal as we've had in a while, so I enjoyed that part of returning to some of those allowing students to work in the lab and do lab activities.

Mr. Johns also continued to incorporate COVID into his instruction as a way to help students connect science to their lived experiences.

I brought COVID up again when it was appropriate. . . . I think that's a helpful way to learn. They can take the topics we're learning, and they can see how it applies to their situation that they've been through just recently.

Looking back, Mr. Johns expressed optimism that the knowledge about COVID gained by his students can impact in the community at large, both now and into the future.

I think students then can take this information that they gain in school and even share that with their families and friends, and those they interact with. That they can promote a more informed population, then we think we can have a better response if anything like this happens in the future.

Science Doesn't Believe Anything

Mr. Henley is a high school chemistry and AP Biology teacher at a small, rural school in Wisconsin. He and his science colleagues had been closely following the news related to COVID and knew that it would inevitably reach their community and school. Therefore, they attempted to proactively prepare students for online learning days before receiving official word from the district that they would not be returning to campus.

We'd started hearing about shutdowns and school closures and things like that. So, we started really telling kids, "Bring your textbook home so you have access to that. You have an online textbook, make sure you can access these things so you're at least aware of what's going on." Then it was on a Friday that we got notification that we wouldn't be back that Monday.

Mr. Henley and the other members of his department soon realized that the school shutdown was not going to be temporary, so they began making plans for virtual learning for the remainder of the school year. However, this was a difficult task because their courses included a great deal of lab work that would need to be substituted with other options or cut completely.

It became apparent that this wasn't just going to be a 10-day or two-week process, . . . and teachers had the expectation that we were going to plan and get things lined up for the rest of the year. So, we did a whole lot of planning in terms of calendaring and what are the things that we should or can do? In a lab class, obviously there are certain things that you can't do at all, so we'd pull in virtual things.

Mr. Henley chose to hold synchronous lessons in the mornings followed by independent work time in the afternoons. During the synchronous portion of the day, Mr. Henley taught students about COVID because he wanted to ensure they were hearing accurate and up-to-date information. In AP Biology, he wove the topic into topics he was already responsible for covering, such as evolution and immunology. He found that COVID provided a current, real-life example that students could relate to. It was more challenging to incorporate discussion of COVID into his chemistry instruction because it didn't fit as well with his standards. However, Mr. Henley chose to answer student questions as they arose and focused on teaching students about the nature of science as it related to the pandemic.

Every day there was something new on the news about numbers of [infected] people or possible vaccinations. We tried very hard to incorporate those into part of our curriculum. . . . As questions came up, we would discuss, "Here's what a vaccination does, and here's how it works." We would certainly include those in the AP Bio class. It was much more like we're talking about evolution, so we would talk about evolution of viruses. We're talking about immune systems in immunology, so

we could talk a little bit about T-cells. In chemistry, less so, but still the nature of science and how we do things . . . but most of those were student-generated things or something that would be in the news, and we would discuss it a little bit more impromptu.

More specifically, Mr. Henley was able to use the nature of science to explain why the health and safety guidelines kept changing as more information about COVID became available. He explained that these discussions helped alleviate some of the misinformation students were being exposed to.

In our district, everyone had very specific guidelines, . . . but they were medically vetted in terms of what our procedures were. We would talk about this and why that was the case and what we know. And then kids were like, "How can this change?" I told them, "We're learning new things, and this is the nature of science." So, I think it was important that kids could get someone who is—I'm not going to call myself an expert, but I know more about science and medicine than they do. I can relay some accurate things that they might not get from home, and certainly some of them did not get from home, especially when we get into vaccinations and efficacy and mRNA and all that. Kids would be like, "Well, I heard . . ." and so I could hopefully dispel some of those misconceptions or those misrepresentations of what was actually happening.

Trying to do synchronous and asynchronous at the same time was the biggest challenge of the pandemic.

Despite his best efforts to talk about COVID from a purely scientific standpoint, Mr. Henley began to receive pushback about the subject from parents and students. He recalled a particular incident where a student recorded a class session where he was teaching about COVID. This video was given to the student's father, who then shared it with the school principal and school board claiming that Mr. Henley was indoctrinating students with ideas based on a personal political agenda. The school principal ultimately supported Mr. Henley, pointing out that his teaching was aligned with district policies.

I tried very hard to accurately represent from a science and medicine standpoint—what we know versus feeding into the social anxiety and the hysteria that politics tended to direct towards it. . . . It was unfortunate because that came into the classroom because some students were fed this by their own families and their circumstances. Some were like, "Masks don't work," or "I'm not going to wear a mask" or "It's against my rights." I did have an incident where I had a student that recorded me. And the dad was a big person that was talking to the school board and sent the audio to the principal. . . . Dad said I was pushing political agendas and telling my kids they had to be vaccinated and things like this. And the principal listened to it and was like, "That is our district policy. This is a choice that you and your family will need to make."

The 2020-21 school year brought a new set of challenges as Mr. Henley's school shifted to an alternating hybrid schedule before eventually bringing all students back on campus.

Trying to do synchronous and asynchronous at the same time was the biggest challenge of the pandemic. Teaching all from home at the same time was doable in terms of management of things and equity and all of that, but when we tried to do both A-day/B-day, that did not work well. And then ultimately, at the end of January, we came back, and we were all full time.

As he navigated the changing forms of instruction, Mr. Henley continued to discuss COVID with his students. In particular, he was committed to keeping students informed about new information related to the pandemic as it emerged. He also continued to emphasize the nature of science as more information was discovered.

I was a good bridge between what they would hear from media, from family, and social things and what their doctor or other healthcare provider would actually tell them. I was a lot more accessible.

If there was some new brand-new information out, then I'd say, "Hey, this is science in the news. This is an important thing to be aware of." Kids would also ask, "How come things have changed?" "Oh, well, because we know more, we're learning this and this and this." We talked about everything from vaccinations to why boosters are necessary. Just as part of recognizing the nature of any disease and changes of viral coats and things like that.

Mr. Henley saw that by discussing COVID, specifically the vaccine, his students began to have a greater understanding of their immune responses and were not as susceptible to believing in the widespread misinformation.

I think [I provided] reinforcement of a lot of the standard-of-care medical practices that were being done and medical recommendations in terms of vaccinations and boosters. "You got sick from the vaccination. Why is that? Your immune response was doing this. Aren't you glad you got the vaccination compared to actually having two weeks of this?" They were like, "Oh okay, so when I got the COVID shot, I didn't actually get COVID. . . . The symptoms that I felt were my body's immune response." The kids started to recognize some of the science behind what's happening rather than some of the misconceptions that were traveling around the internet.

Students and staff returned for a normal, in-person school year in the fall of 2021. Although COVID was less prevalent, Mr. Henley chose to continue discussing COVID-related topics with an emphasis on the nature of science. He explained that his goal was to stick purely to the science, emphasizing to students that science is its own entity that is based in fact, not politics or religion, and is continuously changing.

I had to be careful because (A) you don't want to pull any politics and (B) you don't want to infringe too much upon a student or family's beliefs. But in science we say,

“Science doesn’t believe anything. Science is based on evidence and facts.” And so we try to really reinforce what science does and doesn’t do. Science doesn’t care about your religion. Science doesn’t care about your politics. Science cares about what we know and what we learn and where we go from here. . . . Trying to represent science for what it is, learning based on evidence and changing our conceptual model of how it works, that was important for kids to get.

Thinking back on his time teaching during the pandemic, Mr. Henley believes he provided his students with accurate science information, even when it was not easy to do so. He was able to help students sift through the information and misinformation they were hearing and provide a safe space for students to ask questions.

I was a good bridge between what they would hear from media, from family, and social things and what their doctor or other healthcare provider would actually tell them. I was a lot more accessible. . . . I was able to share what was medically accurate and appropriate without trying to inflame it with what you hear in politics and social stuff in a nonpartisan scientific way. I think that was really important for kids to hear. And it was also a pretty safe place. There was never, “You should get your vaccination,” but “Here’s what vaccinations do. This is why they can help. This is why they can be important and what happens if you don’t.” That was important for kids to be able to ask questions in a hopefully non-threatening place and get some accurate answers.

Periodically Relating to COVID

Ms. Casey is a high school chemistry teacher in a suburban school district in Arizona. She was enjoying spring break with friends in late March when she received news that COVID had reached her town and they would not be returning to school.

We were on our two-week spring break, and I was traveling, and news comes out that COVID is this big thing. And we're like, "Can we fly home? What should we be doing? What is going on?" We got home safe and sound, and they just didn't open school again after spring break.

The kids who kept coming to the virtual class were the kids who wanted that connection with their teachers, wanted that connection outside of their classroom. So even if I was only providing companionship for a few kids, it was totally worth it.

Following the decision to close schools and transition to online teaching, Ms. Casey's district set new policies regarding instruction and teacher availability. The district also enacted a new grading policy aimed at making virtual learning more equitable for students who did not have access to devices or internet.

Our guidance was that we would be available to students on video for an hour or two a day and then just be available through email for the rest of the day. We weren't allowed to give work that would decrease their grade. We were only able to give work that would increase their grade.

Ms. Casey spent the rest of the semester creating online chemistry lessons that she thought students would be interested in, focusing on topics such as energy production in car engines, power plants, and batteries. She also provided her students with a few lab activities that they could complete at home.

I tried to focus on what kids would find interesting and what they could learn about on their own, through guided research, through videos, such as how car engines work and how gasoline provides enough energy to make a car go. . . . I tried to have them do some at-home labs, and a couple of kids took me up on that. When we were learning about energy, I had them burn snacks at home, Doritos [and] Cheetos, and measure the temperature change of water, so a calorimetry experiment. But the number of laboratories we could do was extremely limited.

Ms. Casey initially did not include COVID in her instruction because there was limited information available. However, this changed as the semester progressed, and Ms. Casey eventually transitioned to explaining the chemistry behind things such as soap and hand sanitizer for disease prevention.

We didn't have any real knowledge of COVID, so I couldn't use COVID as a way to teach, but I started using it more as we went on. . . . We did talk about hand washing and hand sanitizers, about why soap is effective against COVID.

Although Ms. Casey did cover COVID in her instruction, she spent even more time focusing on her students' social and emotional needs. She indicated that her goal was to help her students better handle the stress of the pandemic and to provide companionship for the students that needed someone to connect with.

We were talking about how they were coping. It was more mental health things that we were talking about—so social and emotional learning. I think the biology teachers did a little bit more of what viruses are and stuff like that, but I wanted to provide a little bit more of an escape, was how I approached the content. The kids who kept coming to the virtual class were the kids who wanted that connection with their teachers, wanted that connection outside of their classroom. So even if I was only providing companionship for a few kids, it was totally worth it.

The following school year (2020–21), Ms. Casey's district continued with online instruction but required teachers to teach from their classrooms rather than at home. Teachers were also required to utilize a new video conferencing platform (BigBlueButton) that had enhanced privacy settings. However, Ms. Casey and her peers soon found that the platform could not handle large groups of students with their cameras on during the sessions.

We actually started completely online, and our principal required us to come to the school to do our virtual teaching, so I was in an empty classroom with my computer. We transitioned from Zoom to a different video conferencing platform called BigBlueButton. It was supposed to be safer and encrypted and stuff like that, but if too many kids turned their cameras on, it crashed.

And as an added challenge, students were becoming weary of online instruction. Ms. Casey found it very difficult to engage students with the content or encourage them to collaborate with one another in an online environment.

I tried to get students to work together in breakout rooms to learn science, but it was really hard to get kids to talk to each other in the breakout rooms, especially if they didn't know each other previously.

In the spring 2021 semester, the school district transitioned to a hybrid schedule that alternated two groups of students between in-person and online instruction. This new arrangement required Ms. Casey to teach both groups simultaneously, which she indicated was an overwhelming task that severely decreased the amount of content she was able to cover.

There was some pushback from students. Sometimes they were just so tired of hearing about COVID, I think, and there were definitely some students that were very resistant to wearing masks.

I would have 12 students in my classroom, I would have the other 15 on the computer, and I would be teaching both groups at the same time, which was mentally and physically exhausting. The students during that year, probably only got 65 percent of the chemistry I would've taught them in a normal year.

Even with the difficulties the school year was presenting, Ms. Casey continued to discuss COVID with her students. In addition to talking about the chemistry of soap, as she had the previous year, she also talked with her students about the effectiveness of various types of masks.

We did talk about how masks filter in terms of particle size and intermolecular forces between the paper masks and the cloth masks once we had that data. . . . I also talked about more of the structure of the virus and why soap was able to break down the outer layer of the virus. . . . If we had a concept that related to the use of masks or the use of hand washing, I would bring COVID in as an example of this chemistry phenomenon happening.

By creating a link between chemistry and COVID, Ms. Casey was able to help students reason with the safety precautions that were in place and correct any misinformation.

They gained a little understanding of why we need them to wear masks and wash their hands, so some reasoning behind the systems that were in place. I think that they could also bring this information to their parents because there was so much misinformation out there.

However, as the pandemic persisted into the second school year, some of Ms. Casey's students experienced COVID fatigue and began refusing to wear masks.

I didn't get any pushback from parents about teaching about masks or hand washing or anything like that. There was some pushback from students. Sometimes they were just so tired of hearing about COVID, I think, and there were definitely some students that were very resistant to wearing masks.

The next school year (2021–22), everyone returned to campus, and Ms. Casey was eager to teach chemistry as she had prior to the pandemic. She quickly realized, however, that conditions were not “back to normal.” After some serious conversations with students about their experiences, she began to appreciate the many ways that COVID had impacted them academically, behaviorally, and socially.

Kids were not ready to learn at pre-pandemic levels. We tried to jump into what I wanted them to do. And after a few weeks, we had to have a circle time, “What is going on? Why can't you guys do the things that I expect from you?” And they're like, “We are stressed. We don't know how to learn. We're addicted to our phones.” Their brains were not ready to handle it, and they didn't have any maturity over the last couple years. My juniors were acting like freshmen. My sophomores were acting like eighth graders and just the amount of behavioral issues and defiance, I had never had before.

Ms. Casey used information students shared with her to modify her expectations and meet the students where they were. She explained that this change in approach created a more positive classroom environment.

They were happy because we had that circle time. I needed to hear from them what they needed from me. And so, when we did slow down and make it a little bit more achievable, there was a sense of community in my classroom again. . . . It got a lot warmer and friendlier, and they were willing to work together better once I slowed down and lowered my expectations. They felt heard and cared for because they were.

Reflecting on her time teaching during the pandemic, Ms. Casey felt proud that she was able to use chemistry as a way of providing her students with accurate information about COVID. She was also proud that she was able to create a safe environment for students to ask questions, voice their concerns, and form their own opinions.

Students saw me as a trusted source of evidence. What was nice is they knew that because I had science knowledge and experience, they could get trustworthy information from me about the COVID pandemic. They also felt like I was a safe space to bring their concerns, whether their family was acting in ways that they didn't know was safe, whether they disagreed with their family on vaccination, or anything like that. They looked to me as an expert to help them form their opinions and help them gather evidence to deal with COVID in their everyday life.

Many Reasons to Avoid Talking About COVID

There was definite discomfort with bringing [COVID] up in anything but a very glossed over, "Hey, this is happening in your life right now." . . . I didn't feel comfortable putting any opinions or ideas out there. Even if it's fact, even if I believe it, it's not something that I think that the vast majority of my students would be receptive to or their families.

In March of 2020, Ms. Bullard relocated from the Midwest to North Carolina and was able to secure a job teaching 9th grade biology at a suburban school for the 2020-21 school year. Ms. Bullard began the school year with a hectic schedule that included two alternating groups of students virtually and in-person, as well as a fully online class. However, she quickly realized that her schedule was impacting her pacing, causing her to slow down in an effort to accommodate in-person and online students. Her

students were also struggling with the self-discipline to complete their online assignments, which further stalled the amount of content Ms. Bullard was able to cover.

Everything was taking longer with having to do it in a split group, and then also with the time management and self-management of students. The days that they were remote . . . rather than doing the lessons that I had posted for them to do, . . . they would think it's not school, like, "I'm not at school, so I don't have to do school." I was constantly having to back teach everything to be like, "Okay, these notes should be filled out, and we're moving on." And they would not have a clue what I was talking about because they didn't do the assignments that I had posted for them.

In addition to adjusting to her new school and teaching schedule, Ms. Bullard was informed that the state would still be requiring end-of-course testing for biology students. Although students could fail the exam and still pass the course, she was still held accountable for their scores as part of her teacher evaluation.

The one thing that was particularly difficult is the state still required students taking biology to take the end-of-course exam at the end of the school year. . . . In 2020-2021, it was my first year teaching in North Carolina with a state-based test that I didn't write.

Because she was focused on preparing students to take the biology end-of-course test, Ms. Bullard did not dedicate class time to teaching her students about COVID, specifically because viruses and virology are not included in the state biology standards.

We have such limited time to cover all of the standards anyways, and I'm losing time because they're not doing what they need to do, and I need to cover these things, and they have to take the test at the end of the year. I would've liked to have brought it in a little bit more to guide the curriculum, to be like, "This is happening to you right now. Let's talk about how this fits into biology." But if you really think about how the standards are written, viruses and bacteria don't have specific state

standards. There's nothing in there that I need to teach them [about viruses and bacteria].

Ms. Bullard noted that the constantly changing information and guidelines also made her wary of attempting to educate her students about COVID for fear that she might provide incorrect information.

I did not feel comfortable educating about things that our nurse should have done. . . . There was somebody that knew what the rules were, what the quarantines were, what the hand-washing right thing to do was, but it changed so often. What we could and couldn't do changed weekly for a time, and it changed differently for my school than it did for other places, and it changed differently for North Carolina than it did for the US as a whole. And so it was too hard to keep up with what was actually current.

In addition, Ms. Bullard was very afraid of ramifications the topic could have on her teaching position. She knew that the pandemic had become highly politicized in her community, and she wanted to avoid any pushback or negative interactions with parents.

I didn't want it to turn into people's parents contacting me and saying that they're anti-vax and I talked about vaccinating and how good it was in class and now their child wants to get vaccinated. I did not want to step on any political toes by bringing it up in that way, because that's where it goes. In rural North Carolina, people come with masks and hats that state their political opinions. And if you're on the other side of that, it can get nasty. And so I didn't feel like it was my place to tell you what to do or give you information about it because it would've been something that would've come back on me and probably been negative.

As the effects of the pandemic lessened, the 2021–22 school year became more normal. Students returned to school in-person and Ms. Bullard was able to return to more typical and effective ways of teaching. However, the pressure to teach to her standards and not overstep her bounds with regard to COVID instruction remained.

There was definite discomfort with bringing [COVID] up in anything but a very glossed over, "Hey, this is happening in your life right now." . . . I didn't feel comfortable putting any opinions or ideas out there. Even if it's fact, even if I believe it, it's not something that I think that the vast majority of my students would be receptive to or their families.

A Million Small Conversations

Dr. Stone is a high school environmental science teacher in a suburban New Jersey town. He learned of COVID in early 2020 and began devoting a great deal of class time to helping his students track the spread of the virus.

We were using the Johns Hopkins Coronavirus tracker for the months leading up to lockdown. We were actually looking into it every day, trying to understand the causes of it.

He also took it upon himself to help students understand the origins of COVID and combat misinformation that was being rapidly spread on social media platforms.

One of the very last lessons we did in class [before lockdown] was basically using an article from the New York times that talked about the wildlife trade and the potential source of the coronavirus. Kids were bringing in their conspiracy theories or what they had seen on TikTok and things like that. And I was just kind of weaving that into each day so we could pay attention to what pseudoscience is versus science.

Unfortunately, it did not take long for COVID to reach their community. In March 2020, the school district implemented online instruction for two weeks, which soon became the remainder of the school year.

The incredible lack of hands-on activity was one of the hard parts, and it was just really augmented by the fact that we were at a computer with no contact. . . . It really just amputated any kind of energy to do science.

We were supposed to be home for the two weeks, then they extended it to the end of April, and then they extended it just to the end of the year. So, it wasn't a complete "go home for the rest of the year," but it didn't take too long until it was.

Dr. Stone was instructed to post online assignments and hold daily office hours. However, he quickly observed that most students did not attempt to complete the work or take advantage of office hours for academic purposes.

Kids just vanished, and for different reasons. They were not just ignoring school, but kids were not coming to office hours. Some were coming to check in and say "Hi" and that's about it. Some really needed a little bit of adult support, someone to talk to. But as far as the instruction, it became an opportunity to just really throw something out there and see what would come back.

The combination of various factors, including inability to participate in hands-on lessons, lack of synchronous online instruction, and limited student motivation resulted in a significantly higher course failure rate than usual.

I ended the year with 30% or 40% of students failing my class. The incredible lack of hands-on activity was one of the hard parts, and it was just really

augmented by the fact that we were at a computer with no contact. . . . It really just amputated any kind of energy to do science.

The school district decided that students would be split into two groups for the 2020-21 school year: those opting to continue with online learning and those who wanted to return in person on alternating days. Although this approach allowed some students to return to the classroom, Dr. Stone lamented that the combination of high student absenteeism, safety protocols, and continued inability to do anything hands-on made it hard for anyone to be upbeat about the arrangement.

We had plastic dividers, we had to rearrange our desk so that there was all the maximum distancing. We had masks on, and there's no hands-on activity because at that point, we're still concerned about anyone touching anything. And so, it was still an incredibly sterile, really traumatizing way to teach. I'm still teaching through Zoom. I'm still teaching through Google classroom. It's still digital. So there's really no purpose in us being in each other's presence. . . . I did some demo things here and there, but with something like environmental science, there isn't much to do at a lab bench. So it was really just maybe even more draining. . . . It was just a drag every day.

District leaders soon recognized that students were struggling academically and decided it would be better to bring them back to school. However, even in person, most students were still finding it challenging to engage in learning.

Eventually, there were so many kids that were at risk of failing, they started mandating that kids come back to school. But kids were wearing their hoods up, they were wearing their masks, they were wearing their headphones. . .so there was no contact, no interaction with a lot of these kids.

In an attempt to increase engagement, Dr. Stone reintroduced the topic of COVID into his teaching in hopes that students might be interested in looking at COVID from a scientific perspective given its impact on all aspects of their lives. Dr. Stone weaved COVID into a discussion about the Tragedy of the Commons,¹⁰ with a particular emphasis on helping students see the importance of following safety protocols as a way to look out for one another.

I taught a seminar at a local university on the origin of coronavirus. So, I was able to use a lot of the content that I uncovered to use in that course to really focus on everything from the origin of the virus, from a wildlife perspective, and from a public health perspective, in terms of the Tragedy of the Commons. For instance, "How do we look out for each other? Why aren't we looking out for each other?"

¹⁰ Tragedy of the Commons is referring to the concept of imbalance between self-interest and common good (e.g., overfishing for yourself while your community struggles with food shortages).

He noted that these discussions were impactful for students and provided a jumping off point for discussing other situations such as deforestation and wildlife trade.

It opened their eyes up to make connections between deforestation and wildlife harvesting. So like, "Oh wow. We keep interacting with so many different animals out there. Who knows what the animals have, and maybe we really should leave animals alone."

In the 2021–22 school year, students and teachers returned to school completely in person. Dr. Stone indicated that students were generally happy to be returning to a sense of normalcy, and he was eager to teach in ways he had prior to the pandemic. However, he quickly realized that students were not prepared to learn at a usual pace after being online and at home for so long. As a result, he slowed down his pacing to accommodate students as they reacclimated to school.

I noticed that lessons were taking two and three days each. Just a standard 55-minute period. And all of my lessons were designed to be done in a half an hour just to allow that room for needing help or that some kids like to take things further. But lessons were taking forever and ever and ever. And so we didn't get through enough stuff, and I had to cut out. I said, "We're not going to have to be able to do this lab, we're not going to do this lab."

He also incorporated more paper-based assignments, such as science notebooks, to give students a break from using computers.

I was having kids do more stuff on paper, on the other hand, to get them away from their computers for their sake. I mean, kids who are growing up, not drawing and not writing in pencil, I felt like a serious lag. And so I was having kids use science notebooks and doing assignments where they had to draw things and graph things in colored pencils, just for more creative outlets.

Additionally, Dr. Stone promoted socialization by providing choices on assignments, giving students opportunities to choose places and topics that they could speak about. He realized that COVID had caused many students to miss out on life experiences they might have otherwise had, limiting their ability to meaningfully relate to some aspects of the course content.

I used student choice a lot. . . . I knew the kids had so few experiences that they had so little to talk about, which is really weird. I mean, I can't imagine having a year and a half of life that there's nothing to talk about. So, I tried to change that up by giving them experiences to have.

And [I ran across] the phrase "a million small conversations" or something like that. So I took it very much to heart saying, "Okay, if everyone who has an ounce of knowledge or an ounce of authority can be the person that has conversations with people to help them understand how the vaccines work and why it's important to get them, I'm going to have as many of those conversations as possible."

Although COVID was exerting less daily influence, Dr. Stone continued to include it when covering Tragedy of the Commons because it had been so effective the previous year. He developed a second lesson focused on the shortages of items such as masks and hand sanitizer that had occurred during the pandemic.

They could see. . . why we ended up going through the shortages that we went through with toilet paper of all things. And people not realizing that there were meat shortages in the springtime. And so, by the time we got to the water unit, we were able to look at the rationing of water that's been going on around the world. And the water unit became an issue of availability rather than pollution. So, the pandemic constantly fed into this idea of public community and things like that.

Through Tragedy of the Commons, Dr. Stone emphasized that public health practices only work if everyone does their part to help. This theme also provided an avenue for encouraging students to wear their masks properly if they wanted to contribute to slowing the spread of the virus.

Even if they don't practice it, where it's not their perspective, they gain the idea that some people do look out for each other, and that is a possibility to make things better. Sustainability works if everyone's participating, if people are looking out for each other. . . . I would constantly stop to talk about, "This is why we still have to wear masks because everyone won't wear masks. So, it's constantly a tragedy of the commons."

Reflecting on his time teaching during the pandemic, Dr. Stone noted that he took the role of providing accurate information about COVID seriously, both in his classroom and within his community more broadly. He took it upon himself to have "a million small conversations" at key points in time, hoping that these moments would lead to larger change, greater action, and an eventual end to the pandemic.

My seminar at the college was just winding down as the vaccines were rolling out, and we were paying attention to what it was going to take in this political climate and social climate to vaccinate as many people as possible. And [I ran across] the phrase "a million small conversations" or something like that. So I took it very much to heart saying, "Okay, if everyone who has an ounce of knowledge or an ounce of authority can be the person that has conversations with people to help them understand how the vaccines work and why it's important to get them, I'm going to have as many of those conversations as possible." . . . And of course, the cognitive dissonance is going to be there. I have kids that don't think they can get sick. Kids think that the government puts microchips in [the vaccine] and all that stuff. So I was doing my best to be the face of public health, to help them understand on a daily basis how they could participate in ending the pandemic.

Tiptoeing Around Politics

In early 2020, Mr. Pate began discussing COVID with his high school biology students. He and his students were tracking the virus as it was spreading across the US, predicting whether it would reach their small Idaho town, and if it did, when that would be.

In Idaho, we're relatively isolated. I mean the population density is low. Things were heating up in other parts of the country, but nobody knew what was going on. And I remember we were talking about this in biology class. We talked about, "How bad is this? Is it going to get here? When is it going to get here in the event we got to the point?" We said, "Well, it's going to get to Idaho. We're not going to be isolated. Even though we think we are."

It did not take long for COVID to spread to their school district, and during their spring break in early March, the decision was made to go into a soft closure. The plan was for students to continue the semester online at home while teachers had the option of working from the building.

We went on spring break, and they told us, "You're not coming back into the school." So it got here really quickly. And we went into what was called soft closure. Most teachers did not enter the building. I had a few colleagues who were there every day. I was there about half the time, but no students were in the school, and everything went online.

Mr. Pate struggled with the abrupt transition to online learning. He did not have access to a webcam to record videos of himself teaching or to hold Zoom check-in sessions. Instead, he assigned work through Google Classroom and used an online program that correlated with his textbook.

For the most part, [instruction] wasn't via Zoom because I didn't even have a camera on my computer or anything. It was mostly Google Classroom. . . . And at least for biology, I had an online program that went with the textbook, so I could have them do that.

He also discontinued formally including COVID in his instruction because of the rapidly changing information available at that time.

Once we went into the closure that first spring, I didn't really talk about [COVID] in a formal manner. . . . I tried to keep students engaged and thinking about COVID but keeping it kind of light because no one really knew obviously what was actually unfolding.

As virtual learning progressed, Mr. Pate strove to provide his students with engaging lessons. He began assigning outdoor projects that provided students with a break from their computer screens.

I gave them a few outdoor projects, the kind of projects they could do out in their yard. Because the idea was that nobody was really going out in public and doing anything.

Later in the semester, he also prepared frog dissection materials for students who wanted to perform a lab activity at home.

A certain time of the year, we usually do frog dissections. I put out there for students, "If you want to do this at home, it's totally optional. Come by, pick up the materials, and you can do it at home. I'll send out instructions and materials."

I think what dragged a lot of people down was the amount of online material we had to prepare for the students. . . . [T]he amount of material you had to prepare online for every single assignment, it took so much time to prepare it because it was all in writing.

The 2020-21 school year began with students choosing to be in one of two groups: online or in person. The online students attended lessons and submitted assignments virtually, while the in-person students were split up and rotated days in school throughout the week. To attempt to keep everyone safe from COVID, social distancing rules were enforced, plastic shields were installed, and teachers had to sanitize desks between classes.

Students were able to opt in or opt out whether they wanted to be in person or online. And so we had this online component, and then we had the in-person component, and that changed throughout the year. If I remember correctly, it was only half the students were there at a time. . . . Social distancing was still big. You had these little plastic shields between me and the student. I was wiping down the tables with different cleaning materials between each class.

Mr. Pate noted that the amount of preparation that this new schedule created for teachers was demanding because it required every lesson to be digitized and accompanied with instructions. Even though the district provided teachers with Wednesdays for lesson planning, the time and detail this schedule required was a heavy burden on teachers.

I think what dragged a lot of people down was the amount of online material we had to prepare for the students. That's what our Wednesdays were supposed to be for. And it took an incredible amount of time. But the amount of material you had to prepare online for every single assignment, it took so much time to prepare it because it was all in writing. So you had to sit there and write out every single detail about how to do the assignment, how to submit it, what the expectations were. I mean really lengthy. The instructions are usually much longer than the assignment.

He indicated that students were also struggling at this time. Many were finding it difficult to manage online learning and the feelings of isolation that resulted from being at home alone. As a result, the district allowed students to transition to in-person instruction at the beginning of the second semester.

Then, at semester, students were allowed to make the decision to opt in or opt out. So when we switched the next semester. . . . The number of students online went

way down. Because there were a bunch of students . . . who were realizing this is not working. They're not learning a whole lot. I think they felt isolated. So they came back to school, . . . [and] we went to full size classrooms.

Despite the challenges that the school year presented, Mr. Pate reintroduced COVID into his biology instruction. He explained that he attempted to avoid political debates by incorporating the topic into informal discussions and into topics he was already covering, such as virulence.

We did talk about COVID. Again, we sort of did it informally, and, of course, many parts of the country had started getting very politicized. . . . I still used my labs with disease. I do sickle cell for the genetics, can talk about Ebola, talking about virulence. So, we talked about the virulence of COVID and how it seems to be changing over time, how it's spreading.

Yet this informal and nonsystematic approach seemed to pay off. For example, while completing an infectious-disease-spread lab, Mr. Pate noticed that his students were suggesting COVID safety protocols, like social distancing, as ways to prevent themselves from getting "sick."

I do a lab which is a hands-on lab with the spread of infectious disease. I could see a lot more students doing strategies. "Let's quarantine, let's do the distancing." So that was more there. And I think that was from their experience of what they were going through with COVID, et cetera. I think with that lab, makes them think about it, about the spread of disease much more.

In the 2021–22 school year, all students returned to campus full time. Mr. Pate and his colleagues were eager for things to return to the pre-COVID conditions but quickly realized that students were not prepared for the high level of expectations regarding their work or due dates. He reflected on how this mismatch between teacher expectations and student capabilities created quite a bit of tension.

I think teachers were trying to get the expectations back up to where they were, but what the students were willing to do was much lower. You have to meet them somewhere, but they just seemed overwhelmed by any kind of work you expected them to do. And almost like an attitude, "That doesn't matter if I do that or not, I can always do it later. I can do it online. I can do an alternative version." . . . And it's kind of this conflict between student and teacher happening.

Despite the new challenges presented by the shift back to in-person instruction, Mr. Pate found ways to continue to weave COVID into his science instruction. In particular, he used it as a way to discuss the nature of science with students as they reflected on how their perceptions changed as more information was discovered about the virus. Mr. Pate also emphasized

During this last year, we started talking about how the perceptions change and really, I think students kind of get this, is that's not that scientists are wrong. It's that as we get new data, we change our models, and we change our approach.

that it was not that scientists were wrong about COVID; there was just more that had not yet been discovered.

Sometimes talking about how the information changed as we went through the pandemic. And sometimes we would say, "Hey, remember when . . ." And we'd talk about that. What the ideas were on COVID. . . . During this last year, we started talking about how the perceptions change and really, I think students kind of get this, is that's not that scientists are wrong. It's that as we get new data, we change our models, and we change our approach.

Mr. Pate indicated that he hoped discussing the nature of science in relation to COVID would help students recognize that they are living in a time in which science is at the forefront of their lives.

Some students struggle because they think, "Well [science] is just memorizing a bunch of facts," and that's not what science is at all. . . . I think COVID from a science perspective is powerful because it's changing so fast, and they're living through the effects of it. Like really, it's right there in front of them.

However, reflecting on his teaching during the pandemic, Mr. Pate wishes he had not succumbed to fears of the repercussions of discussing COVID. Although he did include COVID in his instruction, he wishes he had done more.

Well, looking back, and I think I would probably do more. . . . I mean, unfortunately, things got very political. So I think there's a tendency to sort of back off and not talk about what could be taken as political ideas too directly. We were kind of told that we don't want any kind of shaming going on, mask versus non mask, this attitude versus that attitude. But I think I would definitely incorporate a lot more of the . . . spread of disease into the curriculum.

Battling COVID Misinformation

Ms. Britt is the science department head at a small private high school in Georgia. Throughout her twenty years of teaching high school biology, she has always kept up with science-related current events. As a result, she was concerned, but not surprised, in March of 2020 when her school made the decision to finish the year virtually.

March 2020, everything started to come down with COVID. Although honestly, I imagine like a lot of science teachers, I was already aware that something was going on. We decided to go full virtual. I was trying to guide kids to the end of the year virtually.

The abrupt transition to online learning was challenging for both Mrs. Britt and her students. She described efforts to develop virtually accessible materials and deliver them in a way that would keep students engaged, while at the same time promoting academic integrity.

I knew that they were getting a lot of misinformation from all around them. And so as much as I could, I tried to relay correct information.

Getting assignments done, getting quizzes, getting tests, we had to revamp everything. . . . Kids aren't bad, but even good kids, if you are not careful and don't do everything you can to try to dissuade them, they'll cheat. [Teaching] online is almost impossible. . . . Because you could insist, "Okay, I need to see your face," but keeping up with who is paying attention, who you can see their faces, things like that, is difficult. . . . It's so much more difficult to get difficult complex concepts across a screen.

As part of her online science instruction, Ms. Britt took opportunities to address COVID-related misinformation that was spreading through her community.

I knew that they were getting a lot of misinformation from all around them. And so as much as I could, I tried to relay correct information. I mean, not only that it's going on around them, but it's information they need to have.

Because vaccine hesitancy was prevalent in the community, Ms. Britt also used her science instruction to provide students with accurate information about mRNA vaccines and their efficacy. She explained that her aim was to encourage students to get vaccinated and reduce their fear.

My seniors, they're going to be 18, they can get the shot if they want. I think some of them did against their parents' wishes because they were like, "I think you know more about it than they do." For instance, one of the kids told me, "Well, my parents don't like the fact that the vaccine, they came up with it so fast." And I said, "What you got to realize is that basically every virology lab in the world, and anyone who has anything possibly to add, has dropped everything across the planet. Tens of thousands of hours were spent in a very short period of time. We had a crisis of

that magnitude, the world kind of pulled together the scientific community to get things done.”

As they transitioned into the 2020-21 school year, Ms. Britt’s school chose to adopt a hybrid teaching model where students had the option to attend school in person or virtually. In this arrangement, Ms. Britt was tasked with teaching both groups of students simultaneously, an arrangement that was less than ideal.

Dealing with the stress of extra duties, of making sure that the schedule we’re on is actually going to work while we are under COVID restrictions. I mean, it was just so incredibly stressful.

For the kids who were in the classroom, it was pretty much the same, except we were all masked and distancing from each other. And because of the masking, I probably went a little slower just to make sure that everybody knew what I was talking about. The kids online, like I said, trying to make sure they were paying attention. It was a lot of burden on all of us.

In addition to navigating the hybrid teaching model, Ms. Britt was still responsible for covering her biology curriculum. However, she still found time to weave COVID-related topics into her course units.

I would work COVID in as part of the topic. For instance, it’s an mRNA vaccine. We talked about that when we talked about transcription and translation during genetics. But I didn’t just derail. I mean, I got to have the kids prepared in the same way they were prepared before COVID at the end of each year. And so while I worked it in as much as I could, it didn’t change the overall sequence of topics that I taught or what I taught in each of them.

Ms. Britt also explained that she viewed COVID instruction as essential for addressing misinformation that was so prevalent at the time. However, she also received a lot of student push back.

I’d have kids say, “Well, I’ve heard this, and I’ve heard this, and then that.” You have to make sure to tell them, “No, that’s not how it works.” . . . There was addressing the misinformation, dealing with it, and sometimes having to say, “Here’s the information, but you have the right to make up your own mind about your own opinions.” Sometimes, just having to move on because that kid, for whatever reason, he doesn’t believe you, the pushback.

The 2021-22 school year brought all students back on campus for in-person instruction. Ms. Britt worked hard to give her students a quality education, despite the added time and stress of trying to follow COVID restrictions.

I was making sure that I gave them the same quality education that I’ve given students every year since I’ve taught. . . . Kids need me to get them to the end.

Dealing with the stress of extra duties, of making sure that the schedule we're on is actually going to work while we are under COVID restrictions. I mean, it was just so incredibly stressful. . . . You just had to stay late and make sure that what you had the next day was going to fit with COVID restrictions.

Reflecting on her instruction throughout the pandemic, Ms. Britt hopes that she has been able to provide accurate scientific information, both to her students and others in her community.

I think that there were a lot of people who came to me—teachers, students, parents, to talk about [COVID] because . . . I'm going to tell you the truth as far as I know it. . . . As a science teacher, specifically, I think that was a hat that we all had to don, whether we liked it or not. Because particularly for kids, we are their first contact for accurate information about science.

Personal and Professional Balancing Act

Ms. Aziz is a high school chemistry teacher in rural Illinois with almost 20 years of teaching experience. In spring of 2020, she was teaching two advanced chemistry classes when her school announced that they would move to virtual instruction for two weeks. Ms. Aziz

[M]any of the students told me, toward the end of that school year, that I was the only teacher still teaching them lessons. So many of the teachers had just given up. They realized, "I can't do this, I don't know what I'm doing. I'm over my head. It's not working well."

quickly rose to the challenge, learning new technologies and preparing the very best chemistry instruction she could. She was convinced that virtual instruction would only last two weeks, so she was shocked when the district moved to virtual school for the rest of the year. Ms. Aziz realized that she would need to figure out a substitute for the usual hands-on labs if she was going to get through the rest of her advanced chemistry topics. She first tried implementing labs that used common household materials, so that students could follow along at home. Unfortunately, the district was not pleased with this option due to safety concerns.

They cautioned against trying to have the kids do anything that involved science lessons at home that were hands on because, "What if they don't have the right equipment" and if they did have the equipment, "What if they got hurt with it?" . . . I had brought goggles home with me and a lab coat, and I was making glue from milk. I thought, "Well, they all have milk at home. We could make this glue from milk. How cool is that?" And then I was cautioned, "But what if they burn themselves on the stove? And what if they -- ?" Oh my gosh!

Ms. Aziz regrouped and implemented a different approach that addressed another problem she was facing—educating her own children.

I was expected still to be teaching for my students at high school, but I had four children at home that I was trying to help [with] their teaching. . . . It was just a nightmare come true.

She decided to do the lab activities at home with her children, recording the activities as she and her children went through each step together. Then she shared the videos with her students. She was frustrated that this format did not allow for the in-the-moment adjustments she would usually make in response to her students' needs. However, she knew that her students noticed and appreciated her efforts.

They told me over and over again, they could tell that I was trying really hard. . . . And many of the students told me, toward the end of that school year, that I was the only teacher still teaching them lessons. So many of the teachers had just given up. They realized, "I can't do this, I don't know what I'm doing. I'm over my head. It's not working well." But I had many kids say, "You're my only teacher still presenting lessons. Thank you for still presenting lessons to me."

However, she reflected on how difficult it was to balance her work life with her family life at this time.

All day long, I was monitoring my own children's learning and doing their stuff. And all afternoon and evening was working on my materials for school. So I went from teaching kids with my own children all day, and then [my husband would] get off work, and he'd start being with the kids, and then I could work on my lessons. So as a science teacher, it was very hard to find that balance between family and school. . . . It was really challenging for me as a mom of four little ones to be doing that. And challenging for my husband. My relationship with my husband? When did I even spend time with him? He was either parenting or I was parenting, or he was working and I was working. So, that was very challenging. But as a science teacher, just finding that balance, I think, might have been the hardest part between family and then my own work.

Just prior to the 2020-21 school year, the school's anatomy and physiology teacher retired and asked Ms. Aziz to take over. Though she had never taught the subject nor studied it herself, Ms. Aziz accepted the challenge. She threw herself into learning the new material and taught this new class while continuing to teach her usual chemistry classes. In addition, she had to adjust both courses to suit a new hybrid teaching format in which small groups rotated between virtual and in-person instruction. Ms. Aziz once again drew on her creativity and implemented a virtual lab partner approach as a novel way of keeping students engaged whether they were at school or at home.

I was doing virtual lab partners. So one person would be in the class doing the lab, the other one would be at home, and they'd be participating with the other one through the Google Meet. . . . And their partner was interacting with them. And then the next day, the other kids would come to class and . . . pick up the lab.

Ms. Aziz felt this was the best way she could teach a hybrid class, and she worked tirelessly to make it happen. However, there were many moving pieces to consider, including content delivery and testing.

I need to think about how the kids at home are doing this lesson, but I'm also teaching kids in front of me. . . . Okay, what about test day? I'm not having them do an online test because the kids hate that. In addition, how do I monitor that? The test day, half the kids are in class, so then these kids take the test this day. The next-day kids, what are they doing the opposite day? So trying to figure out how this all works together so that they're all still learning the same stuff, the same amount of stuff, but learning it in a different way on a different day.

When her district returned to in-person learning for the 2021-22 school year, Ms. Aziz agreed that it was the best thing for the students. She was eager to assess her students informally through their body language and expressions, as she did pre-pandemic. However,

she also kept doing some things she learned during the pandemic, recognizing the value they added even when teaching in person.

Not every kid can come to those after-school [test review] sessions, but I can video it, and I can record it. And so now, I have maybe 10 kids in my class at my review, but the rest of the kids, when they get home from their sports or their job or whatever, they go home, and they watch the video from the review. . . . It definitely enables the kids who are in a lot of activities, or maybe at home sick, to be able to participate a lot more, . . . and it's giving them more opportunities to get help when they need it, because they can watch these videos whenever they want to.

While Ms. Aziz was happy to see her students in person, COVID was a threat she took seriously, especially because her husband was at high risk for complications. She took every precaution she could and encouraged others at her school to do likewise by providing simple explanations of the science behind methods of preventing transmission and vaccines. However, she was also cognizant of the ways in which transmission measures, particularly masks, interfered with student learning.

What if one of the students gives it to me and then I bring it home to my family and I kill my husband? . . . I thought the kids should wear masks, and I thought the teacher should, but I did know we were missing things by wearing masks. . . . In the spring, it was like, "Okay, we're not going to wear masks anymore, because the kids don't have to wear them." And then you're frightened as a teacher. . . . So now I'm wearing the N95 mask every day to keep myself safe, to make sure I don't get COVID to bring home to my family. . . . So I was still wearing them, and I had this conversation with the kids saying, "Listen, I think there's value to you seeing my face. So when I'm up at the front of the room, I will take my mask off. But when I'm back by you, I will always have the mask on. Okay?" So that there's a nice balance.

Reflecting on her overall experience teaching during the pandemic, Ms. Aziz recalls how hard she worked to make her students' lives and her family's lives the best they could be. She faced challenge after challenge with creativity and persistence, and clearly saw the benefits of her efforts. However, she also expressed disappointment with teachers who did not put students' wellbeing on equal footing with their own.

I want people to know that the majority of us were working behind the scenes trying our hardest to do our best for kids. And with our own children at home, we were all trying to do our best. And that the majority of people really care about kids, and we're doing our best.

These teachers that didn't do a good job, they made the rest of us look bad. I think that parents can tell when the kids are just doing a project for the whole rest of the year, and they can also tell when a teacher is really trying hard. So it gave some of us teachers a bad name.

But overall, Ms. Aziz believes that most teachers did the best they could to meet the needs of their students during these very challenging times.

I want people to know that the majority of us were working behind the scenes trying our hardest to do our best for kids. And with our own children at home, we were all trying to do our best. And that the majority of people really care about kids, and we're doing our best.

Technology Turmoil

Ms. Keller is a high school biology and chemistry teacher at a large urban school district in Illinois. When COVID emerged in early 2020, her school made the decision to transition to online instruction for two weeks. However, two weeks eventually turned into the remainder of the school year and the first half of the subsequent (2020-21) school year. Because Ms. Keller's school is not particularly affluent, many students did not have access to the technology needed for online instruction. As a result, student participation was severely impacted by the long process of distributing technology, working out technology logistics, and adapting to technology problems.

Most of the kids didn't have technology or internet. Coming from a low income school, it just wasn't something that was available. . . . So they gave them Chromebooks and data plans were given out for kids that needed them, because most kids didn't have anything.

Most of the kids didn't have technology or internet. Coming from a low income school, it just wasn't something that was available. . . . So they gave them Chromebooks and data plans were given out for kids that needed them, because most kids didn't have anything. And actually there was a learning curve there because we realized that the data plans were not infinite. Kids were running video and using the computer for their own personal use, which I totally understand, and they were running out of data two weeks into the month. And then they were like, "Well I can't get on." And at the beginning it was like, "Encourage your kids to turn the camera on but don't ever force them or penalize them." But then it went from that to, "We need to save their data so they can get on as much as possible. So if they're running into that then don't turn on their camera." Plus connections weren't always stable. So the technology piece did make it challenging.

In addition to computers and internet access, many of Ms. Keller's students needed other supplies and resources to fully participate in schooling from home. Although funds were limited, her school did its best to provide students with these essentials.

We started doing a little bit of problem solving. Asking kids, "What do you need? You have a computer now, so what's the next piece?" And there were different things that they needed to be able to participate. So the school started dropping that kind of stuff off at places if there was money to buy things. Sometimes there wasn't money right in the beginning, and I know a donor chose to get noise canceling headphones. Because some kids are sitting in a house with three other kids. I'm talking to a kid and they unmute to ask a question and I can hear colleagues teaching siblings in the same room or somebody's watching TV or whatever.

Ms. Keller also felt as though her school was very supportive of teachers during online instruction, doing what they could to help teachers perform their jobs effectively.

My school was very like, "What do you need? What can we help you with?" They did modify the schedule a little bit so we had a little bit more planning time to try to figure out how to do everything remotely. But again, they were still trying to figure it out too. . . . But my administration in general was very, "Tell us what you need. How can we help you? Do need a whiteboard in your house? Do you need this? Tell us how you can help."

There were kids we could just never get in touch with. I never saw them or they would log on but never engage.

However, as the school regularly made changes to policies and procedures based on the needs of the school community, students received mixed messages about the expectations for attendance and work completion. Ms. Keller explained that it was difficult to set learning expectations that didn't place unrealistic demands on students or have negative long-term consequences.

That initial two-week break turned into, "Well, your grades don't matter. Everybody's going to pass. It's okay, it's a pandemic. You don't need to go to school." Kind of a thing. So most kids didn't go. . . . I'm not seeing any kids and it's frustrating. And it was this push and pull of not wanting to penalize kids long term, in the sense of grades and GPA, for a global pandemic.

The lack of consistency and stability made it very difficult for some students to engage in school at all, and Ms. Keller became very concerned about student mental wellness.

There were kids we could just never get in touch with. I never saw them or they would log on but never engage. And there were kids, as the pandemic continued, you could see them disengage and stop coming all together. . . . Some of it was struggling with their mental health and being isolated. Other kids were like, "My parents are at work. I'm not getting out a computer." And I get it. . . . But there were kids who would tell you that they were struggling. There were kids who wouldn't tell you they were struggling, but it was obvious through their pulling away, that they were struggling.

The lengthy stint online also took its toll on Ms. Keller, and she struggled to find enjoyment and fulfillment in teaching during this time.

I hated it so much. I mean, when you're used to being in a classroom with 20 high school kids, to go from that and being constantly busy and like, "Oh, I've got so much to do," to being stuck behind a computer all day, that was really tough for me. . . . And so it was the constant conversation with colleagues like, "How do we make this not suck?"

Despite the many challenges of teaching online, Ms. Keller decided to address COVID in her science instruction. During the early days of the pandemic, she devoted time to answering student questions. She also did her best to help students understand the process of science and help them be critical consumers of information.

Kids always have questions about anything or they tell you about all the things that they know. And we kind of worked through some of that. At the very beginning there wasn't a real lot to... You know what I'm saying? There wasn't a real lot to tell them. They were asking and it's just like, well we have to figure out what's actually happening because there's a lot of information that we don't know. And then trying to like, "Well, I heard it was this. And I heard it was this." And it's like, "Okay, right." But do we have any information to substantiate any of those random things that you were hearing or reading on the internet? So the beginning, it was a little hard because it was so unknown and everybody was extremely worried. And so it's just trying to get them to understand the whole scientific process now needs to play out. We need to figure out what's happening and all of this takes time. It doesn't happen instantly. All this stuff you learn about in school, people have studied it for a while a lot of it. So we don't have information. And that's hard for, as a source of information generally for kids, that's hard for them to hear I think too. Sometimes, "What do you mean? How does nobody know this?" And then they hear that corona viruses had existed. So they're, "If they existed, then why is this a big deal?" So it's a little bit of just trying to understand so much of what was going on.

However, as online school persisted into the 2020-21 school year, she addressed COVID less and less because the topic essentially saturated her students' lives.

And at that point, the kids were a little COVID-ed out already. "I don't want to talk about it anymore. It has dominated the news in my life." And when you're 14, that's a long time. They're like, "I'm over it. I don't want to talk about it anymore. It messed up my eighth grade year and all the fun social stuff that goes with that." So they were kind of over it at that point.

When she and her students finally returned to school in-person during the spring of 2021, the transition was anything but seamless. Teachers and students struggled to reacclimate and catch up from nearly two years of disjointed, atypical schooling.

When they came back, instantly, you could see the result of being remote for a year and a half at that point. . . I was like, "Oh, this is going to be a tough reset back to being in person all day long." because every single kid really needed a reset into what high school is like. How to use your locker. Where certain things are. Because nobody knew and they were all so unfamiliar. And at least from that point, it was a good selling point, "Nobody knows what's happening right now. So we can all take comfort in the fact that we're all on the same page here." But it was this struggle with coming back and trying to give kids a little bit of grace and leeway to adjust to a new routine.

Students also continued to express COVID fatigue, pushing back against any mention of the pandemic during science instruction.

If COVID even comes up, kids are like, "I don't even want to hear about that." We were talking about protein synthesis in one of my classes and talking about mRNA

and stuff like that. And at this the vaccine had been developed and everyone's throwing around mRNA like they know what that is. And I'm like, "Well, we know about this. I'm doing it just for a relatable piece of knowledge." But they're like, "Oh, don't talk about that vaccine. I don't want to talk." They're done. They're over it. They don't want to deal with anything COVID related.

However, Ms. Keller remained optimistic that things would eventually return to normal.

I struggled because I felt like kids weren't getting as much out of school, both socially and educationally as they normally do. But I was confident that that was going to be short lived. It was a little longer than I had hoped, but I was confident that eventually we would be back to normal.

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Topics covered related to COVID	X		X	X		X		X	X	
General virus information (e.g., what a virus is, how viruses reproduce)						X		X		
Safety Protocols	X		X	X		X			X	
Masking										
Vaccines										
Nature of Science (e.g., how scientific information evolves over time)										
How COVID relates to other science topics/events										
Evaluating sources of information									X	
Challenges of teaching during COVID			X	X	X	X	X	X	X	X
Insufficient planning time				X						
Enforcing safety protocols			X		X			X		
Lack of hands-on teaching/learning opportunities							X	X	X	
Students uninterested in talking about COVID										
Time and effort required to create engaging materials for remote instruction										
Lack of resources for remote instruction (e.g., computers, internet access)										
Student learning loss/lack of skills										
Pressure to prepare students for standardized testing										
Student misbehavior and social/emotional needs						X	X			
Personal health concerns				X						
Social isolation										X
From colleagues										
From students										X
Lack of respect or empathy				X	X			X		
Politicized tensions										
Pushback										
Parent/guardian										
Student										
Tension among colleagues										
Ways teachers supported students	X	X	X		X	X		X		
Addressed fear/anxiety about COVID								X		
Positive impacts of teaching about COVID on students			X			X				
Created engaging materials	X				X					
Delivered supplies		X								
Met student social/emotional needs						X		X		

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Topics covered related to COVID	X		X	X	X	X		X		
General virus information (e.g., what a virus is, how viruses reproduce)			X	X	X					
Safety Protocols	X		X	X	X	X				
Masking				X						
Vaccines	X				X	X				
Nature of Science (e.g., how scientific information evolves over time)	X			X						
How COVID relates to other science topics/events										
Evaluating sources of information	X			X				X		
Challenges of teaching during COVID	X	X	X				X	X	X	X
Insufficient planning time	X	X								
Enforcing safety protocols										
Lack of hands-on teaching/learning opportunities	X									
Students uninterested in talking about COVID										
Time and effort required to create engaging materials for remote instruction										
Lack of resources for remote instruction (e.g., computers, internet access)			X						X	
Student learning loss/lack of skills	X		X							
Pressure to prepare students for standardized testing										
Student misbehavior and social/emotional needs	X		X				X		X	X
Personal health concerns										
Social isolation							X			
From colleagues										
From students							X			
Lack of respect or empathy									X	X
Politicized tensions										
Pushback										
Parent/guardian										
Student										
Tension among colleagues	X							X		
Ways teachers supported students	X					X		X		
Addressed fear/anxiety about COVID	X					X				
Positive impacts of teaching about COVID on students			X							
Created engaging materials						X		X		
Delivered supplies	X									
Met student social/emotional needs	X							X		

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Topics covered related to COVID	X	X	X	X	X		X	X		X
General virus information (e.g., what a virus is, how viruses reproduce)				X	X		X	X		X
Safety Protocols	X	X	X	X						
Masking	X		X							
Vaccines		X								
Nature of Science (e.g., how scientific information evolves over time)	X			X						
How COVID relates to other science topics/events					X		X			
Evaluating sources of information	X			X	X			X		X
Challenges of teaching during COVID	X	X	X		X	X	X	X	X	X
Insufficient planning time		X	X			X	X			X
Enforcing safety protocols		X								
Lack of hands-on teaching/learning opportunities		X								
Students uninterested in talking about COVID										
Time and effort required to create engaging materials for remote instruction			X							
Lack of resources for remote instruction (e.g., computers, internet access)						X	X			
Student learning loss/lack of skills										
Pressure to prepare students for standardized testing		X					X			
Student misbehavior and social/emotional needs										X
Personal health concerns										
Social isolation	X		X							
From colleagues	X									
From students			X							
Lack of respect or empathy	X									
Politicized tensions	X				X					
Pushback	X						X	X		
Parent/guardian							X	X		
Student	X									
Tension among colleagues	X								X	
Ways teachers supported students		X		X	X			X		X
Addressed fear/anxiety about COVID		X		X	X			X		
Positive impacts of teaching about COVID on students	X		X	X	X		X			
Created engaging materials								X		X
Delivered supplies										X
Met student social/emotional needs										X

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Topics covered related to COVID	X	X	X	X		X	X	X		X
General virus information (e.g., what a virus is, how viruses reproduce)			X				X	X		
Safety Protocols	X	X		X		X				
Masking				X						
Vaccines										
Nature of Science (e.g., how scientific information evolves over time)	X		X				X			X
How COVID relates to other science topics/events	X						X			
Evaluating sources of information	X					X		X		
Challenges of teaching during COVID		X	X	X	X	X	X	X	X	X
Insufficient planning time		X		X	X	X	X			X
Enforcing safety protocols		X								
Lack of hands-on teaching/learning opportunities		X				X				
Students uninterested in talking about COVID										X
Time and effort required to create engaging materials for remote instruction										
Lack of resources for remote instruction (e.g., computers, internet access)		X								X
Student learning loss/lack of skills										
Pressure to prepare students for standardized testing					X					
Student misbehavior and social/emotional needs		X		X	X	X	X			X
Personal health concerns									X	
Social isolation										
From colleagues										
From students										
Lack of respect or empathy										
Politicized tensions					X		X			X
Pushback			X					X		
Parent/guardian			X							
Student			X					X		
Tension among colleagues										
Ways teachers supported students	X			X			X		X	
Addressed fear/anxiety about COVID	X			X						
Positive impacts of teaching about COVID on students	X		X	X	X		X			
Created engaging materials								X		X
Delivered supplies										X
Met student social/emotional needs										X