

Teaching K–8 Science Through Distance Learning: Specific Challenges and Successes During the COVID-19 Pandemic

Meghan Macias, Burr Tyler, Ashley Iveland, and Melissa Rego

This brief describes specific challenges to and successes with teaching K–8 science through distance learning during the COVID-19 pandemic as reported by administrators and teachers in surveys and interviews completed during spring 2021.¹

A companion brief, titled *Teaching K–8 Science Through Distance Learning: Overall Impacts of the COVID-19 Pandemic* and based on the same data, reports the following overarching effects of the pandemic on teaching and learning science in grades K–8 during the 2020/21 school year:

- » The COVID-19 pandemic exacerbated existing inequitable access to quality science education as teachers taught dramatically less science after school closures, particularly science that strongly fulfills the Next Generation Science Standards (NGSS).
- » Students were less engaged with and empowered for science learning.
- » In particular, teachers struggled to implement key features of the NGSS related to investigations and experiments.

This second brief expands on these findings and provides further insight into the challenges with distance learning during the pandemic and the associated responses from teachers and school and district leaders. We explain how teaching conditions

during the pandemic affected the specific types of instruction that are consistent with the intent of NGSS-aligned teaching standards. However, this brief goes beyond giving the diagnosis to presenting a variety of successes by teachers and districts.

The following findings are drawn from surveys administered nationwide in spring 2020 and spring 2021 and from interviews with over a dozen district science leaders and teachers who participated in the California K–8 NGSS Early Implementers Initiative, funded by the S. D. Bechtel, Jr. Foundation and eight partner school districts.²

Challenges and Associated Successes

Teachers were asked in a survey to select the main challenges to their remote science teaching during the 2020/21 school year. The response options had been raised by teachers through write-in comments on the initial survey in spring 2020, when in-person instruction had suddenly shifted to distance learning because of the pandemic. As shown in Table 1, more than three quarters of teachers selected “less hands-on, inquiry, and exploration and investigation” (88%) and “less student collaboration and discourse” (76%). More than half identified three additional primary challenges: “issues students face using technology” (59%); “low student participation, motivation, and engagement in science online” (55%); and “lack of science materials and supplies for students” (55%).

¹ This brief focuses solely on distance learning. We acknowledge that some districts used combinations of distance learning and onsite learning (i.e., hybrid learning) during the 2020/21 school year, which further complicated instruction.

² For more on data sources for this work, see Macias, M., Iveland, A., Tyler, B., & Salcido White, M. (2022). *Teaching K–8 science through distance learning: Overall impacts of the COVID-19 pandemic*.

Table 1. Teacher responses to the survey question “What have you found to be the most challenging about implementing successful distance learning for science specifically? Select all that apply.”

Most frequently identified challenges	Percentage of teachers selecting
Less hands-on, inquiry, and exploration and investigation	88%
Less student collaboration and discourse	76%
Issues students face using technology (internet, devices, platforms, skills, experience with technology)	59%
Low student participation, motivation, and engagement in science online	55%
Lack of science materials and supplies for students	55%

Note. This survey was completed by 193 teachers from 15 states. The majority of the respondents were from California and New Mexico.

Source: WestEd. (2020–2021). *Impacts of COVID-19 on K–8 science instruction: 2020–2021 survey* [Unpublished raw data].

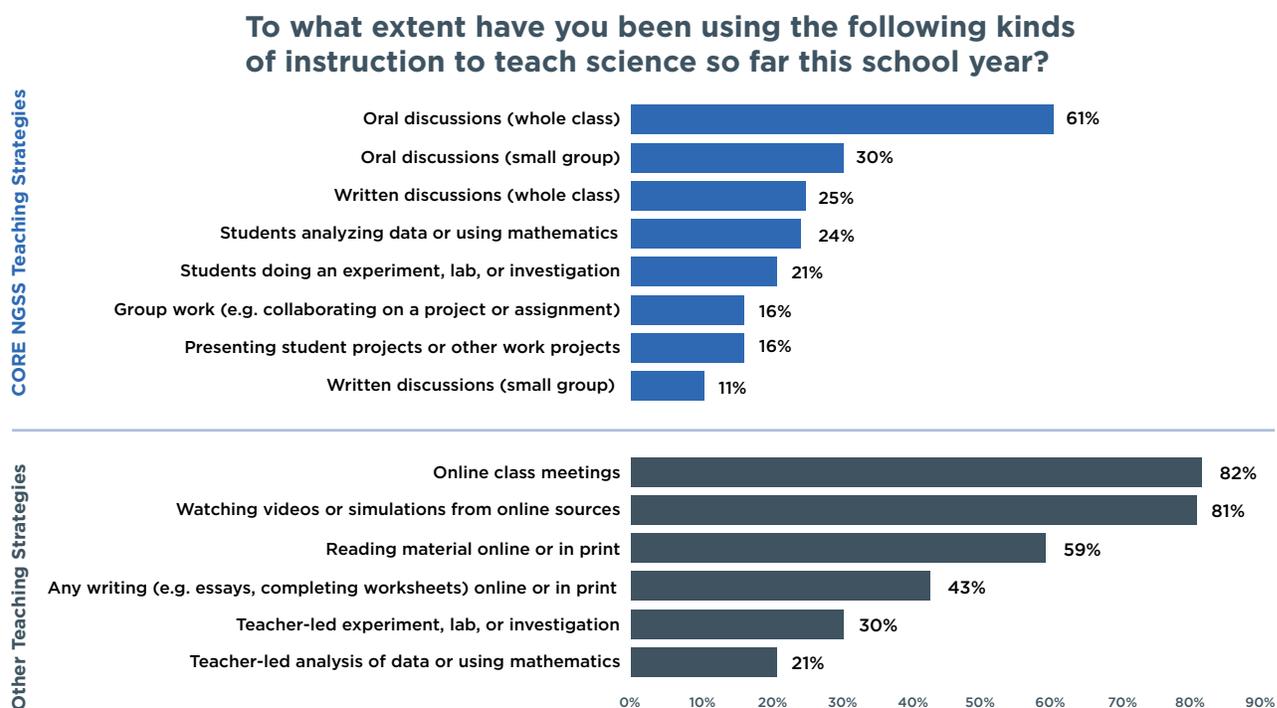
Next we discuss these challenges in more detail. Additionally, we describe how some teachers managed to advance science education in their distance-learning classrooms despite the challenges and how they were helped by some district and school leaders.

Less NGSS-aligned instruction, including investigations, collaboration, and discourse

Teachers reported using NGSS-aligned teaching methods markedly less often than they used other science teaching methods (Figure 1). From almost one quarter to more than three quarters of teachers (21% to 82%) reported using general teaching methods often or very often during 20/21 school year. In clear contrast, fewer than one third of teachers (11% to 30%) reported using NGSS-aligned teaching methods often or very often, the one exception being the 61 percent who used oral discussions with the whole class. However, some teachers struggled to engage their students in discussion:

It’s been a wrestling match trying to get students to engage in discourse. It’s been the contagious norm to not turn on your camera unless you’re forced to. If they can get away with doing my [assignment] without opening [their mouths], that’s what they’re gonna do. If you allow it, you’ll hear the same voices every day. You’ve gotta get creative [in making] discussion prompts accessible so the kids are willing to engage [with] them. And incentives—giving them tools to document their conversations, assigning roles. You’ve gotta be diligent If you [aren’t] and you just say, “Go to these breakout rooms and discuss the following,” you either get nobody’s talking or we’re done. . . . There’s gotta be some accountability mechanism. And I worry about development because I know how important student-to-student interaction is to learn, and [with distance learning] it’s not happening as frequently.

Figure 1. Percentage of Teachers Who Used Core NGSS Teaching Strategies Versus General Teaching Strategies Often or Very Often During the 2020/21 School Year



Note. Each value shown is the percentage of teachers who chose a survey value of 4 or 5, where 5 indicated that they used the teaching method “very often” (n = 193).

Source: WestEd. (2020–2021). *Impacts of COVID-19 on K–8 science instruction: 2020–2021 survey* [Unpublished raw data].

It is very likely that because teachers did not have distance-learning lessons that strongly met the intent of the NGSS, they gravitated to general, more readily executed methods for teaching science.³ Thus, they asked students to watch videos or simulations (81%), a teacher-led science experiment, lab, or investigation (30%), or a teacher-led analysis of data (21%), or they asked students to read (59%) or write (43%). Teachers more evidently engaged students in NGSS-aligned learning when they had students engage in oral discussions as a class (61%) or in small groups (30%); engage in written discussions as a class (25%) or in small groups (11%); analyze data or use mathematics (24%); conduct an experiment, a lab, or an

investigation (21%); collaborate on group work (16%); or present projects or other work products (16%).

For example, most teachers reported that having students conduct investigations on their own through distance learning was challenging (Table 1). Consequently, many teachers reported that they pivoted to conducting investigations themselves “often” or “very often” rather than asking students to conduct investigations.

However, some teachers reported successfully implementing NGSS-aligned strategies despite challenges and barriers. In their interviews, they talked about committing to using whatever NGSS-aligned

³ Caveats: (a) NGSS-aligned instruction *can* occur through these methods, but the likelihood of teaching that strongly meets the intent of the NGSS is more self-evident with NGSS-aligned methods, and (b) we designate some methods as NGSS-aligned and others as general methods based on common interpretations in the science education field (Berland et al., 2016; Krist et al., 2019; Reiser et al., 2017).

teaching strategies they could within the constraints of distance learning, whereas some of their peers reported feeling overwhelmed and simply “unable to do NGSS now.” Indeed, as this brief and its companion brief describe, distance learning was a formidable challenge to designing and carrying out a full-fledged NGSS ideal of cohesive, phenomena-based units that integrate all three NGSS dimensions: disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs).

Interviewees who were able to implement NGSS-aligned teaching strategies were innovative in what they could do and did not let what they could not do keep them from doing anything at all. For example, if they felt they could not structure overarching phenomena to drive instruction of a unit, they still could conduct more discrete investigations that were fueled by student inquiry. Even further, if they felt challenged to engage students in conducting investigations (i.e., the NGSS SEP of designing and conducting investigations), there were the seven other NGSS SEPs that students could still experience—even in an adapted form—such as communicating information, developing models based on a video or teacher demonstration, or analyzing and interpreting data provided by the teacher rather than data they had collected during an investigation.

Issues with technology

More than half of the teachers surveyed reported that technology presented a major challenge during distance learning (Table 1). Although few teachers received professional learning about remote instruction, those who did reported receiving guidance related to the access and use of technology and to supporting students’ use of technology. Some districts went to great effort to ramp up initiatives to provide students with computers and internet access. However, the following teacher’s comment notes that although this major step in remote teaching and learning is necessary, there still were significant challenges to using the internet:

So I think, in general, there are massive equity issues around access because we can’t see what’s happening. All we can see is what’s getting turned in, right? I would say probably 30 percent of my kids have their cameras on, maybe less. And when I ask them, oftentimes they are AFK [away from keyboard]. Or they will unmute themselves and talk, and it’s like a cacophony. You don’t realize there’s another kid on Zoom in the room, and the TV’s on, and the dog’s barking, and there’s a baby crying, and there’s, you know—there’s a lot happening in their lives. So I think the distance learning itself is a huge equity issue. And even the hybrid [model, in which] kids are expected to do things on their own is really tough. My English Learners—I mean, it breaks my heart. I don’t know how to, or I haven’t found a way to, be as supportive as I would like—even when they’re in front of me. Because we have kids spread out, [and] kids have masks on.

Thus, even when students had internet access, teachers still found it difficult to deliver remote lessons. However, teachers learned over time how to use technology more effectively to engage students in deep learning and discourse. Teachers learned how to better utilize the features of their video conferencing software, such as Zoom’s chat and breakout rooms, and to create accountability measures for student participation (e.g., having students take notes on a shared virtual document or having assigned roles for sharing out during class discussions).

One teacher said, “We have learned loads of new strategies for creating and sharing virtual lessons and have lots of ideas on how to apply this to a regular school year.” Examples of these strategies and tools include having students work at their own pace with a variety of materials to choose from in order to better accommodate differing needs; using different platforms that are helpful for disseminating information and allowing each student to share their work; and having students create online student portfolios, work with digital notebooks, or complete group work on online documents.

Low student participation, motivation, and engagement in online formats

Distance learning made the importance of student engagement all the more apparent. More than half of teachers were plagued by low student participation, motivation, and engagement (Table 1). While engaging students in distance learning was challenging, some interviewees noted that science often engaged students more readily during distance learning than other subjects did. This is illustrated by this teacher's comment: "I feel the teachers in our school appreciate what science offers. It's [enjoyable] to see your kids being so interested and engaged in the things that have to do with science." Indeed, other teachers reported that science was a catalyst for increased student engagement and participation during distance learning:

Kids were just like, "Finally it's Friday. We get to do some science." . . . And those kids that wouldn't really participate during the day for other content, they would definitely be participating during science.

Lack of science materials and supplies for students

We heard from interviewees that schools in most districts were providing "drive-by packets," or packets of instructional supplies that families could pick up via scheduled drive-throughs at their child's school. Unfortunately, materials for student science activities often were not included. However, again, there were some success stories in regard to getting materials for science activities into students' hands.

The following teacher's comment describes including science materials in drive-by packets: "We need to be prepared with materials and what we want [students] to have in front of them so that they can have these materials [in their packets]." Some teachers found the bandwidth to go the extra mile when they realized that including science materials in drive-by packets was not a sufficient solution for all students:

But for some kids I'd need to say, "I'm sorry, you didn't get your stuff. Do you have foil at your house? Do you have a paper plate? Do you have an ice cube?" We just have become resourceful, and they have to just make do with what they have. I can't think, "It doesn't work for me." I'll find a way, and if they don't do it, then they don't. But I'll give it a try.

A science teacher leader in another district identified some materials that her district provided students with:

We started to send materials to [students], starting with one of our second grade projects. We sent pancake mix and cornstarch for our mix-it-up cooking project so all second grade students would be able to make pancakes. And our first grade just received their seed assortment kit so they can start growing plants at home. And we're in the process of getting flashlights to send them for our light investigation.

District Support to Provide Science for All Students

When teachers were asked about the help they had received from their districts that was related to different aspects of science instruction, they reported receiving the least help with

- » integrating engineering, math, and computer science;
- » monitoring student understanding and differentiating instruction for diverse learners; and
- » incorporating students' backgrounds and real-world issues into science instruction.

All three are critically important for equitable implementation of the NGSS. The NGSS CCCs explicitly call for cross-disciplinary coherence between disciplines (e.g., math and computer science). Differentiating instruction is important for diverse learners and students with disabilities. And incorporating students' backgrounds and real-world issues has been shown to increase engagement and learning in diverse

learners. Although it is disheartening to hear that most teachers were not receiving support in these critical areas, we can report some examples of districts that did provide crucial support for equitable access to quality science instruction.

Instructional materials

A huge burden was placed on teachers not only to learn how to teach remotely, but also to become their own curriculum developers. In interviews, teachers often talked about a lack of access to science curriculum materials and lessons that were appropriate for distance-learning or hybrid-learning environments. Further, changes in the frequency and length of teaching sessions during distance learning required them to reconfigure lesson components and pacing when using existing science curriculum materials. One teacher related that it took “hours” to transform one regular in-class lesson into a single 30-minute lesson appropriate for distance learning.

Teachers in districts that had already adopted NGSS-aligned curricula prior to the pandemic reported that they used the materials they had in whatever way they could. However, these teachers reported feeling the need to supplement with other materials because their curricula were not designed for distance learning. Many teachers indicated that they needed to draw from multiple resources to have materials that worked for remote instruction. With materials and lessons coming from varied sources, lessons and units are unlikely to be as coherent, and such incoherence can dampen student learning and engagement. One teacher explained:

My sense is that a lot of teachers have defaulted to worksheet-kinds of very traditional things because that's what students expect, that's what students can do, that's what parents are used to and parents expect. So it's become kind of a packet mentality. And I think where it impacts me directly is [regarding] the pedagogy of NGSS and that we're trying to help kids be able to make sense of things and figure out and come to describe and explain phenomena. If all

their other classes are related to just [getting] the thing done, it's harder for them to think on their own [and] to really do that deep thinking.

Although many districts and schools left teachers to be their own curriculum developers, we learned of one district that deployed some resources to help as soon as schools were closed in spring 2020. A former Early Implementers (EI) Initiative teacher leader was supported in adapting and creating lessons and units appropriate to distance learning for circulation as a resource to all district science teachers:

[The lessons] were just stuff [students] could do at home. Like kindergartners observing the colors of the sky at sunrise, sunset. Just simple things that were short, sweet, and doable. And there were a lot of options like, “Well, if you don't have this, do this. If you can journal, journal. If you don't have journaling, then do this.” They're not prescriptive; they're a lot of “This is kind of the intent, and here are some ways you could do it. But feel free to do what you want.” I really just wanted [to provide] NGSS, three-dimensional, phenomenon-based units or sequences.

This teacher's district also provided not only funding for teachers to develop units for distance learning that were NGSS-aligned and engaging for students, but also time for teachers to share these online units with grade-level peers across the district through webinars and shared workspaces.

Prioritizing science

A strong indicator of a district prioritizing science is the district's willingness to provide professional learning. We learned of two districts that provided professional learning about NGSS teaching specifically for their administrators during the pandemic. This represents a high level of support for science, as the evaluation of the NGSS EI Initiative found. Data from the eight participating districts showed that support from administrators is crucial for teachers endeavoring to implement NGSS instruction.⁴

⁴ See Estrella, D., Tyler, B., Britton, T., Iveland, A., Nguyen, K., & Arnett, E. (2019). *Administrators matter in NGSS implementation (2019): Updated findings on how school and district leaders are making science happen*. WestEd. <https://www.wested.org/resources/administrators-matter-in-ngss-implementation-2019/>

In the first of the two districts that provided professional learning for administrators, two principals were empowered to establish a career STEM Pathways initiative with financial support to pay teachers and administrators to attend meetings, develop deliverables, and implement lessons with students. They devised a pathways structure of three strands (computer science, NGSS, and climate science) and found that their ideas were met with a lot of enthusiasm by teachers who had been working in isolation for months.

In the second district, during three of its monthly districtwide meetings for administrators, 1 to 2 hours were allocated to professional learning about how to implement teaching consistent with NGSS. This was in addition to encouraging elementary grades to include strong attention to science during their online professional learning meetings. Throughout the pandemic, this district maintained its prepandemic stance that science is a core school subject on par with English language arts (ELA) and mathematics.

Another district made science a core subject in grades preK–5 by delivering ELA through STEM units. The instructional framework was to use overarching design challenges that required ELA instruction throughout STEM investigations. In the middle grades, teachers evolved their instruction to better integrate mathematics and science.

Another strong indicator of a district making science a core subject is the district's efforts to establish or maintain science leaders. During the NGSS EI Initiative, which ended just as the pandemic began, all eight districts had budgeted for a science position (or an extra science position) at the district level, funded through grant funds. After school closures, five of the districts made budgetary decisions to maintain those positions. These districts' commitment to making science a priority paved the way for teachers to continue to implement equitable, NGSS-aligned science education.

Survey data showed that this level of attention to science during the pandemic was far from the case in

most districts. Indeed, during a webinar convening of superintendents from across California,⁵ many participants mentioned that they had actually just forgotten about science during school closures!

Recommendations

Promote and expect NGSS-aligned instruction to be taught in order to overcome student distance-learning fatigue

In a world that must now cope with COVID-19, learning science is even more indispensable for life and citizenship. That aside, it is in administrators' interest to encourage science instruction rather than discouraging or limiting it in favor of other school subjects. Because students are innately curious and interested in learning about the world around them, instruction in science, more than in other subjects, can help teachers overcome the formidable challenge of lack of student engagement during distance learning. Therefore,

- » make science a core school subject on par with English language arts and mathematics;
- » fund central-office science specialists and coaches; and
- » support teachers who opt to make science the carrier and driver of instruction, and integrate delivery of other school subjects into science instruction.

Encourage teachers to pursue what they can of NGSS-aligned instruction rather than being daunted by it and setting it aside wholly

NGSS-aligned science instruction is even more motivating to students than regular science instruction and, further, promotes higher student learning. It is challenging during distance learning to carry out instructional methods that address the full spectrum of NGSS expectations. However, encourage teachers to do what they can rather than not doing anything at all:

⁵ The webinar, *A Conversation With California Superintendents Who Have Opened Schools for In-Person Instruction*, was held on February 12, 2021, and was sponsored by the California Partnership for Math and Science Education.

- » It is better to use teaching methods consistent with any part of the NGSS expectations rather than to use none at all.
- » For example, although some SEPs take a lot of planning and innovation to address, some can be incorporated during distance learning fairly easily.

Support teachers in creating and adapting lessons appropriate for distance learning

All existing curricula—whether commercial or developed by districts, schools, or teachers—need to be substantially adapted for distance learning. Therefore,

- » recognize that teachers have this additional burden and afford them whatever time and flexibility you can for their work, and
- » support some teachers in individually or collaboratively creating or adapting distance-learning science lessons for use by other teachers in the school or district.

Help teachers acquire and provide students with materials for doing science investigations and activities at home

There is tremendous value in having students do activities and investigations that draw on available items in their households. However, teachers often still want or need to have students do activities with materials that are supplied to them. Districts and schools should be sure that

- » drive-through packets picked up by students' families include supplies for hands-on science and
- » science teachers receive help acquiring and paying for these materials.

Continue or start professional learning about NGSS-aligned teaching for administrators as well as teachers

Shifting science instruction to incorporate NGSS-aligned methods required support even before the pandemic. Having to start or maintain this progression during distance learning makes the need for professional learning about NGSS even greater. For teachers, administrators can, at a bare minimum, take advantage of standing teacher professional learning and grade-level meetings to talk about science instruction. Districts also should have professional learning specifically for administrators:

- » Spend some time at regular districtwide meetings for administrators on professional learning about NGSS and on how to support the district's teachers in moving toward the standards.
- » During professional learning about NGSS for teachers, also conduct sessions for administrators.

Provide deeper professional learning about using technology in distance learning

Go beyond the necessary but, unfortunately, insufficient strategy of widely and equitably providing students with access to computers and the internet:

- » Provide professional learning that helps teachers use technology to facilitate teaching pedagogies that promote higher student learning, such as technology that enables online student collaboration and discourse.
- » Provide an opportunity for teachers to share discoveries and ideas related to using technology to support high-quality science instruction.

Appendix: Description of Figure 1

Percentage of Teachers Who Used Core NGSS Teaching Strategies Versus General Teaching Strategies

Overview and presentation

Two vertical stacked bar graphs show the percentages of teachers who answered the survey question “To what extent have you been using the following kinds of instruction to teach science so far this school year?” The two kinds of instruction the question refers to were core NGSS teaching strategies versus general teaching strategies. The values shown in each graph are the percentages of teachers who had used the teaching method often or very often. The sample size was 193.

Numerical values presented in the image

Core NGSS Teaching Strategies	Percentage of teachers who had used this strategy often or very often
Oral discussions (whole class)	61%
Oral discussions (small group)	30%
Written discussions (whole class)	25%
Students analyzing data or using mathematics	24%
Students doing an experiment, lab, or investigation	21%
Group work (e.g., collaborating on a project or assignment)	16%
Presenting student projects or other work projects	16%
Written discussions (small group)	11%

General teaching strategies	Percentage of teachers who had used this strategy often or very often
Online class meetings	82%
Watching videos or simulations from online sources	81%
Reading material online or in print	59%
Any writing (e.g., essays, completing worksheets) online or in print	43%
Teacher-led experiment, lab, or investigation	30%
Teacher-led analysis of data or using mathematics	21%

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