WestEd

POLICY BRIEF

Teaching K–8 Science Through Distance Learning: Overall Impacts of the COVID-19 Pandemic

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The COVID-19 pandemic has had a huge impact on education. Science teaching, in particular, has faced specific challenges given the field's emphasis on high-quality instruction that has students "do" science collaboratively rather than just read about it or hear about it in a lecture. This brief provides

- a summary of data collected by WestEd relating to how the pandemic has affected science education in NGSS Early Implementer districts and other locations around the country;
- findings regarding student-centered science instruction and equity during the pandemic;
- descriptions of how some teachers innovated to provide engaging, high-quality science instruction to their students despite the challenges; and
- lessons learned and recommendations for ensuring high-quality NGSS-aligned science instruction and learning moving forward.

Prior to the pandemic, California was leading the way in the implementation of Next Generation Science Standards (NGSS),[1] and many well-prepared teachers in the state were engaging students in NGSS-aligned science instruction. This was especially true in the districts that participated in the NGSS Early Implementers (EI) Initiative. The Initiative provided intensive support for districtwide implementation of the NGSS in grades K–8 through substantial teacher and administrator professional development and a leadership component that built capacity and helped develop school and district systems to support implementation.[2] With the resulting deep knowledge, networks, and systems in place to support NGSS implementation, these districts were particularly well positioned to be able to sustain important aspects of NGSS-aligned instruction during the pandemic.

However, most teachers in these districts, as well as many others around the state and nation, have reported drastic reductions in high-quality science in their classrooms and districts as a result of the pandemic. It seems that everyone involved in science education, and education at large, has anecdotal evidence of this decline. In contrast, the study described in this brief represents a rare instance of being able to provide substantial, systematic data on the scope and scale of the recent instructional turmoil. In addition, it highlights what we can learn from science teachers who forged solutions to some of the problems.

1 NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. National Academies Press.

2 The NGSS Early Implementers Initiative was funded by the S. D. Bechtel, Jr. Foundation and by district resources and contributions. Lasting a remarkable 6 full years (2014 to 2020), the Initiative involved eight public school districts and two charter management organizations that represented diverse communities throughout California. See this WestEd site regarding the EI Initiative, including links to the 14 reports written about this work. (To see the reports, scroll down the page to Related Resources and click on the View More tab.)

A Nationwide Survey

At the start of the pandemic in spring 2020, WestEd developed and disseminated a nationwide survey to capture and document the immediate impact of the pandemic on science education. Respondents were K–8 teachers who reported that they taught science prior to the implementation of distance learning in their classrooms. Survey questions asked about teaching contexts (e.g., school district information and demographics, teaching responsibilities before and *during* the pandemic), levels of student learning and engagement *before* and during the pandemic, alignment of remote instruction with the NGSS, and support from outside sources (e.g., district- or school-level support).

After seeing the continued impact of the pandemic over the course of the 2020/21 school year, WestEd readministered the survey in spring 2021. A total of 342 K–8 teachers from 31 states in 2020 and 352 teachers from 15 states in 2021 responded. In both years California teachers represented the largest proportion of responses (making up 42% and 75% of the total responses, respectively), and EI teachers comprised about one third of these California respondents in 2020 and about one half in 2021.

A value-added feature of this study is that for a subsample of middle school teachers, we were able to compare what they reported about their science teaching during the pandemic to what they reported about it before the pandemic. (If interested in how this was done, see the next paragraph.) Other teachers in the study were asked to remember and describe their teaching before the pandemic.

Method of comparing teaching during and before the pandemic. California middle school teachers were selected as a subsample in order to be able to compare data we had from an existing project that investigated NGSS implementation in this population. The existing project was a multiyear, National Science Foundation–funded study with over 120 grades 6–8 public school teacher participants across California. This California study investigated the ways in which teachers implemented the NGSS in their classrooms and the factors that may impact their NGSS instruction. Many of the survey items that this project used to characterize NGSS instruction from 2017 through 2020 were also used in the national survey described in this brief. Of the 89 California middle school teachers who responded to the national survey in spring 2020, approximately half (46) were teachers who had also responded to at least one prior survey as a part of the California project. Thus, we were able to compare the responses of this population over time, tracing the trajectory of their responses from 2017 through 2021 to assess the magnitude of the pandemic's impacts on NGSS instruction. In this brief we refer to this subsample as "California middle school teachers." Any other mention of teachers refers to the full national sample.

Findings

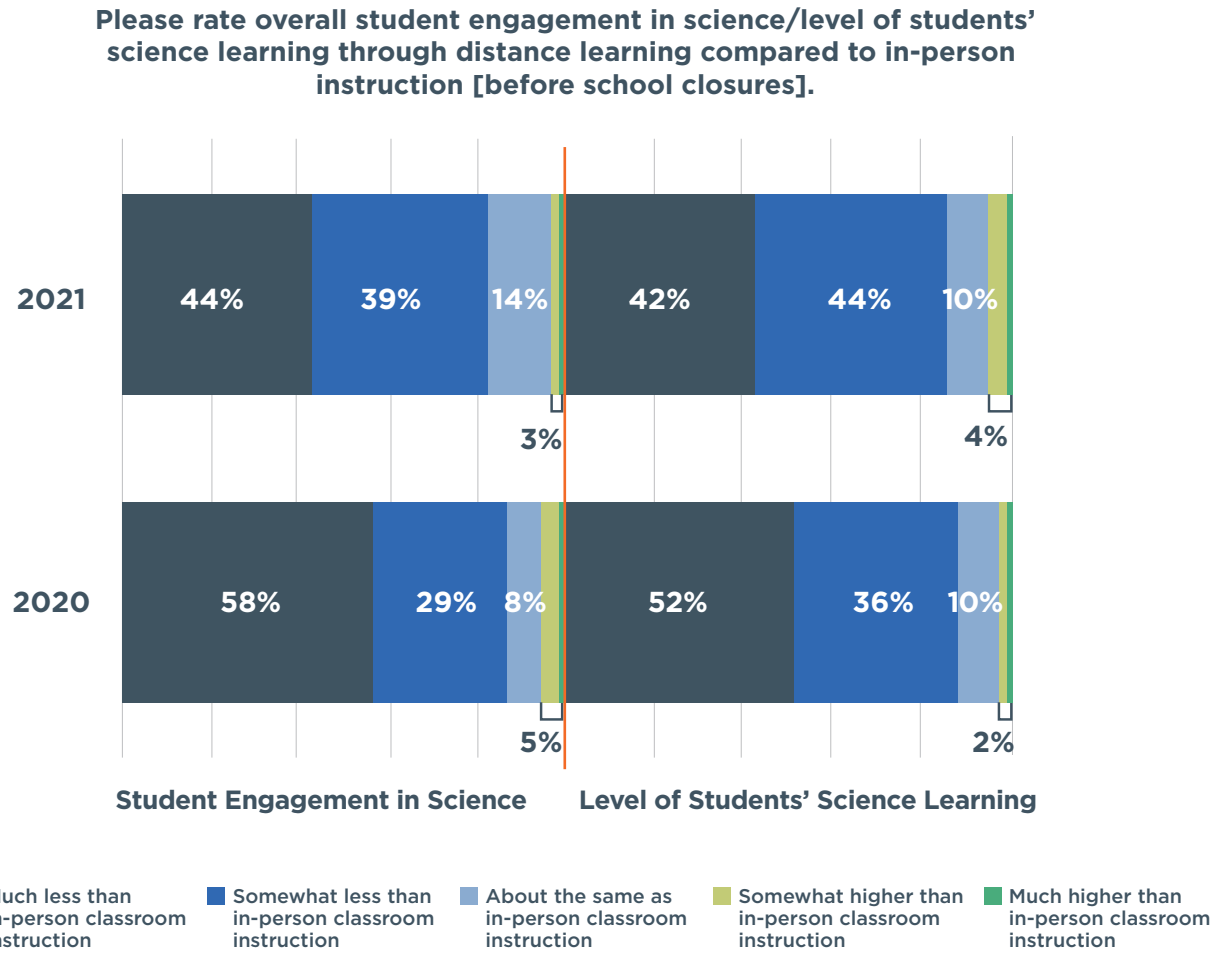
When schools closed in spring 2020 because of the pandemic and instruction shifted from in person to remote, science instruction took a back seat to mathematics and reading and writing (English language arts, or ELA) instruction. In the new, limited learning environment, math and ELA were given priority as being essential for elementary students. As a result, many districts and individual teachers made the decision to either cut science from their instruction entirely or dramatically reduce the time spent on it. Most teachers we surveyed in 2020 and 2021 reported significant reductions and changes to science instruction. However, the survey data collected in spring 2021 indicates that throughout the 2020/21 school year, some teachers learned how to incorporate important features of high-quality science teaching into their remote instruction. Our findings highlight the impact of pandemic closures on key aspects of high-quality science instruction:

- student learning and engagement,
- time spent on science,
- NGSS three-dimensional instruction, and
- scientific discourse.

Students were less engaged in science learning and learned less science during distance learning

Teachers were asked to compare student engagement in science learning during the 2020 and 2021 school closures with student engagement in science learning during in-person instruction before school closures. As shown in Figure 1, more than half (58%) of respondents in 2020 reported that students were engaged "much less" in science learning during distance learning. The 2021 data show a subtle improvement, with slightly fewer teachers (44%) reporting that students were engaged "much less" in science learning during distance learning. Furthermore, a majority of teachers (52%) in 2020 reported that students were also learning less science during distance learning than they had before school closures. But by spring 2021, fewer teachers (42%) reported that students were learning less science during distance learning.

Figure 1. Student engagement and learning in science during distance learning compared with student engagement and learning in science before school closures



Note. See Appendix B for sample sizes.

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

The factors that likely contributed to why teachers felt students were less engaged in and learning less science could apply to any school subject. The pandemic was traumatic and increased challenges and responsibilities for many. Teachers, students, and parents felt burned out and overwhelmed, and they could not exert the effort needed to engage deeply or meaningfully in school.[3] Teachers were distracted by having to learn and transition to completely new teaching methods and tools, and students tended to be more difficult to engage while at home. However, researchers have found that the subject of science, in particular, was the most difficult to teach virtually[4] and that many elementary teachers tended to focus on math and ELA, thus giving students little opportunity to engage in science during school closures.[5]

The difference between the 2020 and 2021 responses may indicate that teachers were beginning to adapt to new modes (e.g., online class meetings) and methods of instruction. But most teachers still reported that science learning and engagement remained much lower throughout school closures than it had been before school closures.

One teacher we interviewed noted that a major challenge to teaching during the pandemic was "getting students to care to learn and try. They would just sit with blank faces and not want to participate when being asked questions." Another teacher explained a possible reason for lower student engagement:

> *Science is a very hands-on subject. Watching videos and demonstrations is not as fun for the students, and they do not buy into the learning of the subject as much.*

However, some teachers reported being able to keep student participation up during distance learning. Comparing differences in student engagement in 2021 between EI and non-EI teachers, we found that EI teachers reported encouraging participation of all students more often than non-EI teachers did. We attribute this to the EI professional learning they received and the district-level supports that were established during the Initiative. As a result, EI teachers felt better prepared and able to tackle the challenges of science teaching during the pandemic.

Substantially less time was spent on science during distance learning

Another challenge of online teaching was that teachers simply had much less time with students—it was unrealistic to expect students to spend hour after hour on Zoom. When teachers were asked at the beginning of the pandemic how much time they intended their students to spend on science altogether in 2020, including all class and homework time, the vast majority (75%) said less than two hours per week. A small minority of teachers (24%) said they intended for their students to spend two or more hours per week on science. However, when surveyed again in spring 2021, nearly half of teachers (49%) said they intended their students to engage in a *minimum* of two hours per week of science during the 2020/21 school year, a marked increase from the prior year.

Although teachers intended to engage students in science during distance learning, the reality was that students may not have spent much time actually doing science. As one teacher noted, "We were required to do ELA and math only. Science was optional." Furthermore, even when teachers wanted to teach science, one teacher explained, "Some students [chose] to opt out of distance learning

3 Holquist, S. E., Cetz, J., O'Neil, S. D., Smiley, D., Taylor, L. M., & Crowder, M. K. (2020). *The "silent epidemic" finds its voice: Demystifying how students view engagement in their learning*. McREL International.

4 Kurtz, H. (2020, April 10). National survey tracks impact of coronavirus on schools: 10 key findings. *Education Week*.

5 Pesnell, B. (2020). *Elementary teachers' experiences with remote learning and its impact on science instruction: Multiple cases from the early response to the COVID-19 pandemic* [Doctoral dissertation, University of Arkansas, Fayetteville]. Theses and Dissertations, ScholarWorks@UARK. https://scholarworks.uark.edu/etd/3893

instruction." So, even when participation in science learning was encouraged, students could choose to opt out entirely. The teachers who responded to our survey *were* teaching at least some science during school closures. However, we are aware that many more elementary teachers in California who are not represented in the data were directed to not teach science, elected not to, or were not able to due to limitations of time, materials, or resources.

Teachers struggled to implement NGSS three-dimensional instruction during distance learning

The NGSS envision science learning as three-dimensional (3D), incorporating science and engineering practices (SEPs), crosscutting concepts (CCCs), and disciplinary core ideas (DCIs) to elicit student interest and to foster learning in science. This 3D framework is a key feature of the innovative science instruction the NGSS promotes. When teachers were engaging students in science during the pandemic, it would have been ideal that they were engaging students in NGSS-aligned science.

However, teachers struggled to implement many of the key elements of NGSS into their instruction during distance learning. They reported having trouble delivering 3D lessons, including implementing the SEP and CCC features of the NGSS. When asked how difficult it was to implement the SEPs, over half (60%) reported that it was "much more" difficult to implement them in 2020 than it had been prior to school closures. When asked the same question in 2021, they reported that it was slightly less difficult than it had been in spring 2020 but still "somewhat more" difficult than it had been before school closures. These findings hold for CCCs as well.

The decreased implementation of SEPs and CCCs was the result of the distance learning format. One teacher explained:

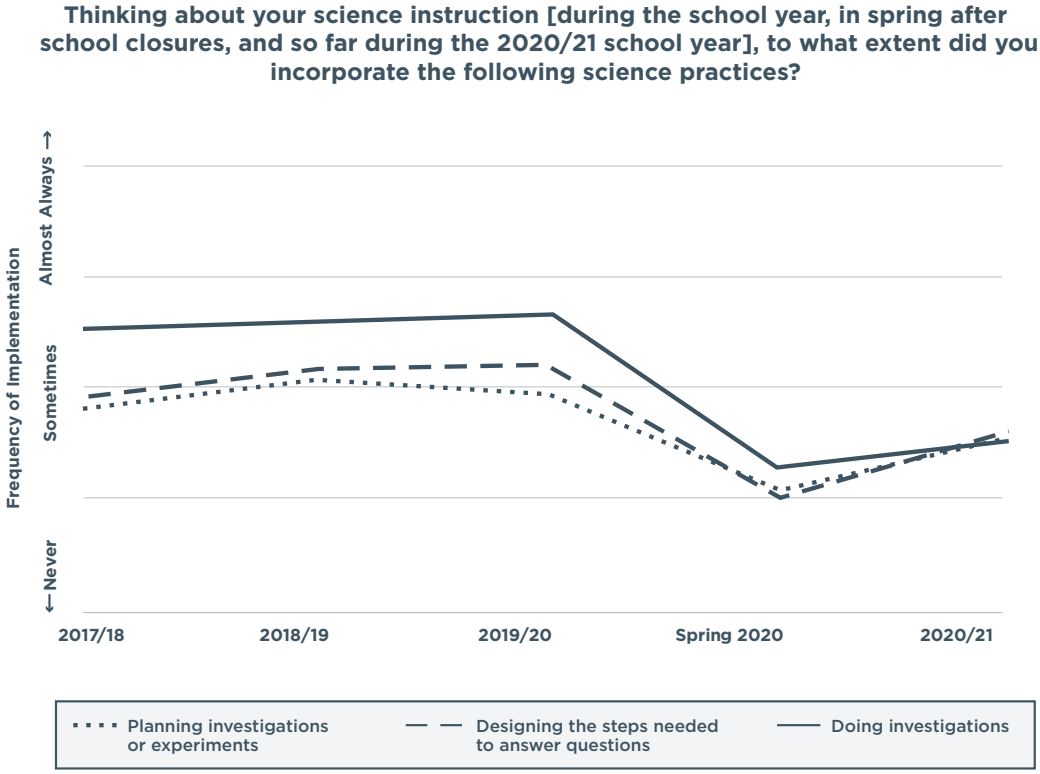
> *The challenges I am confronting are not being able to do hands-on investigations, experiments, and design activities, which serve as an anchor for many of the other activities we do in the science classroom.*

Teachers often noted that they preferred hands-on learning, but they pointed out that it was nearly impossible to accomplish during distance learning.

Despite having to surmount these barriers, a greater number of teachers reported incorporating SEPs and CCCs in 2021 than did in 2020 (Appendix, Table A1). This increase is statistically significant and is attributable to teachers' resiliency and dedication to teaching NGSS-aligned science. Although this increase is a step in the right direction, the status of the implementation of SEPs and CCCs at the end of the 2020/21 school year reflects the magnitude of the impact of school closures on science instruction.

Longitudinal data from our sample of California middle school science teachers reveal a much more dramatic decrease in the implementation of key features of the NGSS, including SEPs, as a result of pandemic closures. Figure 2 shows a decrease in the reported implementation of various SEPs in spring 2020 compared with implementation in previous years and then a significant increase in 2021. However, even in 2021 the reported frequency of implementation of the SEPs is still far lower than it was before the pandemic.

Figure 2. Average teacher implementation of NGSS 3D investigation-related science practices



Note. See Appendix B for sample sizes.

Source. WestEd. (2020); WestEd. (2020–2021).

As shown, California middle school science teachers reported decreased frequency of engaging students in investigations, labs, or experiments throughout the pandemic. Despite investigations being a fundamental component of the NGSS — and science more generally — teachers were slow to implement them in their remote instruction. In fact, 15 percent of California middle school teachers reported not being able to incorporate them into their remote instruction *at all* during the 2020/21 school year. Teachers explicitly connected this lack of investigations to a loss of student engagement, with one teacher saying:

> *Students were more engaged and learning more when they were in the classroom because they were able to do the experiments with the materials that were provided.*

Without the ability to distribute materials to students, teachers were unable to teach science by using investigations and labs. Furthermore, during distance learning many teachers said they felt constrained when trying to incorporate investigations or experiments into their classrooms because students could not work in groups and collaborate in meaningful ways to "figure out" science together as they had been able to do before the pandemic. The lack of materials for investigations meant that students participated far less in one of the most crucial and foundational components of the NGSS than they had before distance learning.

Although many teachers struggled to implement key NGSS features during distance learning, our analysis found that California EI teachers reported more NGSS enactment during remote instruction than did teachers who did not participate in the

Initiative. On average, EI teachers reported implementing SEPs and CCCs significantly more often in 2021 than did non-EI teachers (Appendix, Table A2). The differences in implementation between the two groups were statistically significant. This finding illustrates the effectiveness of strong, longitudinal professional learning for teachers like that provided by the Initiative. EI teachers were able to implement SEPs and CCCs more often because they developed their own instructional materials that were aligned with the NGSS and they had more district supports.

Students were less likely to engage in scientific discourse during distance learning

While not an explicit feature of the NGSS, discourse is considered an important, high-impact practice for deep science learning. NGSS science is all about students "figuring things out," and discourse is essential in that process.[6] Teachers in the California middle school science teacher sample reported significant decreases in their facilitation of scientific discourse to elicit student ideas in 2020 compared with their facilitation efforts in previous years, followed by modest increases in 2021.

Teachers of young students, especially, struggled with facilitating scientific discourse online. One teacher explained:

> *These were kindergarteners and first graders, and not being able to see their reactions and ask them questions based on their reactions was tough. The communicative part of science was pretty much lost. I think kids were less likely to ask questions in a distance format.*

Thus, students in both 2020 and 2021 experienced a substantial lack of opportunity to practice and engage in scientific discourse.

The survey data show that EI teachers were able to facilitate more oral and written discussions and discussions about results from investigations than were non-EI teachers. Again, we attribute this finding to the intensive professional learning they received as part of the Initiative. Most of the EI districts had developed and disseminated grade-specific units to all teachers prior to the pandemic. After schools closed, many teachers established networks with others who were trained in NGSS teaching in order to share resources and strategies. This exposure to professional learning and networking resulted in modest benefits for teachers during the pandemic.

Student-Centered Instruction and Equity

The pandemic both exacerbated and raised awareness of equity issues in the U.S. education system. The issue of inequitable access to quality science education for all students, especially students of color, is not new.[7] Early in the pandemic, we found that equity issues were especially pronounced in terms of lack of access to reliable Internet and to materials necessary for distance learning.[8] But when instruction pivoted to distance learning because of school closures, teachers were faced with the challenge of engaging students from a distance who were scared, sad, separated from friends and family, and confined to their homes. Teachers soon discovered the importance of developing a personal relationship with each child — and often also with their families. This experience has provided a key lesson about teaching all students. Educators have an obligation to provide access to instruction that

6 Stroupe, D., Caballero, M. D., & White, P. (2018). Fostering students' epistemic agency through the co-configuration of moth research. *Science Education, 102*(6), 1176–1200.

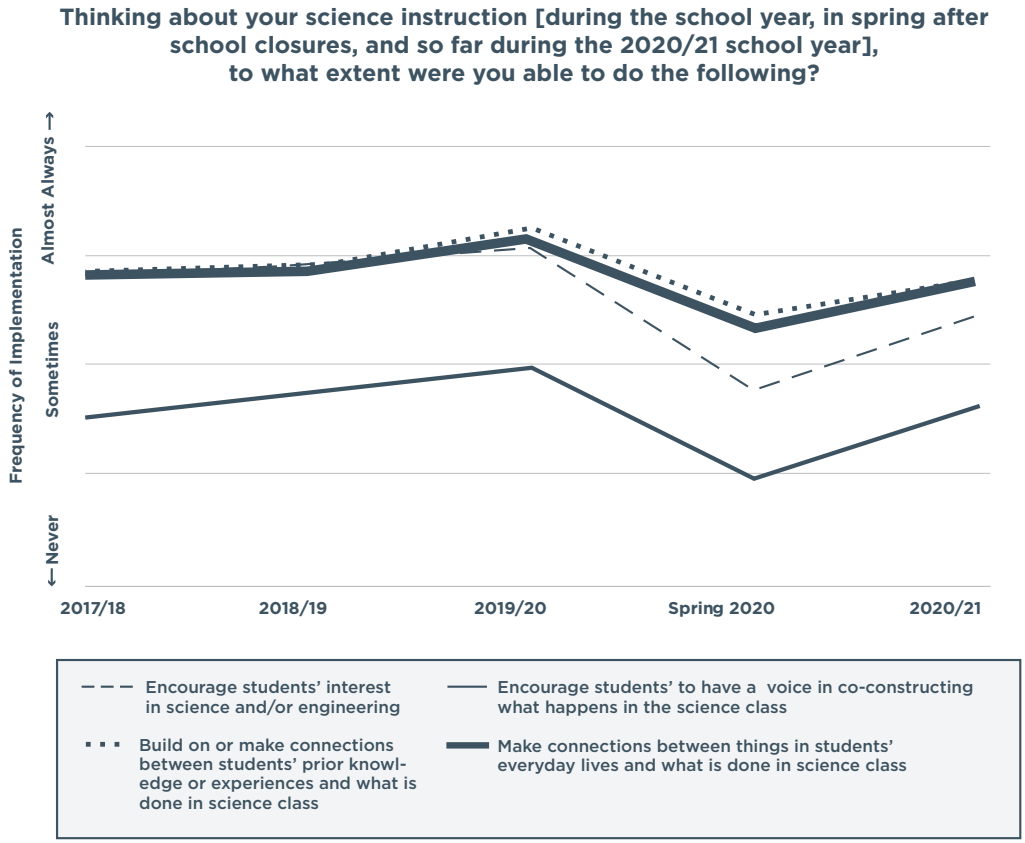
7 National Academies of Sciences, Engineering, and Medicine. (2021). *Science and engineering in preschool through elementary grades: The brilliance of children and the strengths of educators*. The National Academies Press. https://doi.org/10.17226/26215

8 Iveland, A., Rego, M., Macias, M., Salcido White, M., & Arnett, E. (2020, 2021). *Impacts of COVID-19 on science instruction and enactment of the Next Generation Science Standards* [Conference presentation]. National Association for Research in Science Teaching 2020 and 2021 Annual International Conferences, virtual; United Nations. (2020, August). *Policy brief: Education during COVID-19 and beyond*. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

has meaning and relevance to students, and doing so requires knowing who they are.

Our findings indicate that there were statistically significant increases in some key features of NGSS-aligned instruction. For example, there were significant increases in SEP and CCC implementation in 2021 when compared with their implementation in 2020. Similarly, we found that there were also increases in how often teachers were able to encourage student interest and agency in science and in how often they connected science instruction to students' everyday lives, prior knowledge, or experiences (Figure 3). This is good news, as these practices are highly recommended by the NGSS and science education experts in the field to engage *all* students and engage them in more deep science learning.[9]

Figure 3. Frequency of teacher use of strategies to encourage student interest and agency in science



Note. See Appendix B for sample sizes.

Source. WestEd. (2020); WestEd. (2020–2021).

When we disaggregated our data by student demographics (i.e., classes with greater than 50% Latino students, classes with greater than 50% White students, or classes with a mix of student ethnicities), we found that teachers were stepping up to serve and provide high-quality NGSS instruction to all their students. There were no statistically significant differences in reported SEP implementation

9 National Academies of Sciences, Engineering, and Medicine. (2021).

in 2020 and 2021 between teachers who taught a classroom majority of Latino students and teachers who taught a classroom majority of White students. However, teachers with a classroom majority of Latino students or other students of color reported drawing on students' cultural backgrounds for science instruction and encouraging student voices in the classroom more often than teachers who taught a classroom majority of White students, and these differences were statistically significant. In other words, the teachers we surveyed were attentive to student needs and issues of equity throughout the tumultuous 2020/21 school year.

Although there were no differences in the *types* of instruction students received by student demographics, there were differences in the *materials* teachers used and through which instruction was delivered. Teachers of a classroom majority of Latino students were more likely to use commercially published textbooks and online units or courses that students work through at their own pace (e.g., i-Ready, Edgenuity) and were less likely to use lessons or materials that they created themselves than were teachers with students who were of other ethnicities, including a classroom majority of White students.

This has important implications for students' access to equitable, high-quality science instruction. Previous work has shown that a majority of teachers are working without materials aligned with the NGSS despite the NGSS or similar standards being fully adopted in many U.S. states.[10] When teachers rely more heavily on textbooks or other materials that may not be aligned with the NGSS, their students are put at a disadvantage. In addition, teaching with materials that are not aligned with the NGSS might result in more work for teachers if they need to supplement or modify these materials in order to accomplish the goals of the NGSS. There has been, and continues to be, a pressing need to provide teachers with curriculum, textbooks, and other materials that are aligned with the NGSS so that they can implement the vision for high-quality science education to *all* students regardless of background or ethnicity.

What We Can Learn From Some Innovative Teachers

In contrast to the majority of our survey respondents, a small group of teachers reported *increased* student engagement and learning during distance learning. The teachers who felt their students were more engaged in science during distance learning when compared with in-person instruction cited the following reasons for this change:

- capitalizing on flexible schedules;
- using familiar low-cost or no-cost materials to engage students in science; and
- encouraging student ownership of their new learning environments.

We interviewed these teachers and asked them to explain why they thought their students were more engaged and how they supported this engagement. Several teachers offered that the more relaxed schedule and the removal of hard deadlines allowed students to spend more time reading, watching, learning, writing, and responding to science phenomena in their classrooms. In addition, some teachers reported feeling that they had more time to teach science because state tests were suspended during the pandemic and so there was less pressure to focus on ELA and math for testing purposes.

Several teachers also explained that asking students to use resources and materials readily available in their homes seemed to make the science more relatable and accessible to them. One teacher described it this way:

10 Grace, J., Oberholzer-Vandergon, V., Woodruff, R., Harris, E. M., A'Hearn, P., King, C., Poland, R., Sikorski, T., Tupper, D., & Wygant, H. A. (2021). *Report findings: Status of science implementation in California 2019–2020*. California Association of Science Educators. https://cascience.org/application/files/3816/3857/8886/FINAL_CASE_NGSS-SurveyReport.pdf

The different home environments meant there was more freedom to fail and a certain sense of "comfort/reassurance" using recycled materials or even "trash." . . . You can't mess it up. Also, when science concepts are connected to familiar materials and easy-to-source supplies . . . I believe there is a higher degree of interest.

In general, many of these teachers reported that basing science activities on materials commonly found at home or encouraging students to do observations in their own backyards or local communities kept students engaged in science throughout distance learning. Another teacher described such an activity:

One activity that had particular success was assigning students to build a paper rocket that could fly without being touched. Students were able to use tape, paper, and a straw. After students had time to work on their project at home, with parents if possible, we were able to meet back up on Zoom and extend the lesson with math and graphs and writing. One student was even so taken with the activity that she went on to build different types of DIY-at-home rockets.

Importantly, we found that teachers who participated in the Initiative largely reported success with being able to continue instruction aligned with the NGSS (e.g., focusing on investigations, anchoring instruction in phenomena, facilitating scientific discourse). One grade 6 teacher in particular, pseudonym Kelly, explicitly named the Initiative as the reason for her continued use of phenomena. She explained, "After the Early Implementers [Initiative], I can't teach without some big idea or some essential question like, what's driving this learning right now?" Kelly felt that because of what she learned during the Initiative, she was able to continue to use phenomena and essential questions to guide her science instruction, even during distance learning.

Kelly went on to name the Seek app,[11] a resource she learned about through the Initiative, as an important tool she used to enable students to continue investigations during distance learning. For one assignment, Kelly explained that initially she planned to ask students to complete a worksheet on pollinators and the reproductive parts of flowers. However, she chose instead to engage students in an online investigation. As a result, Kelly found that her students were more engaged in the assignment and that they returned to class enthusiastic to share information about local flowers. Kelly said:

[This investigation] led to this little girl, she was like, "I found so many different flowers over the weekend. Look at these flowers I found, and they all have different male and female parts!" I'm like, "Oh my gosh, that's so cool!" Then I showed her the Seek app that I learned [about in] our Early Implementers [Initiative]. . . . [In] class we identified one of the flowers that she was looking for. I don't know — it led to real-life kinds of things.

This example is striking for two reasons:

- The Initiative provided tangible resources for EI teachers to leverage in order to continue to engage students in high-quality, NGSS-aligned instruction during distance learning despite also facing the same challenges non-EI teachers faced.
- Technology during distance learning afforded students opportunities to get outside and into their local communities and to engage in the science around them.

We acknowledge that students more readily, if not necessarily, exploring their home environment is a unique advantage of distance learning as a result of school closures.

11 The Seek app is a citizen science app that enables students to use their mobile devices to identify plants and animals. The Seek app was developed by iNaturalist, a joint initiative of the California Academy of Sciences and the National Geographic Society.

Lessons and Recommendations for Administrators

The COVID-19 pandemic hit just when many districts were beginning to implement the NGSS, sharply reducing the amount and quality of science taught. After schools closed, many teachers struggled to engage students in high-quality science lessons, and they reported less science learning during the 2020/21 school year. Nonetheless, there are a number of success stories to learn from. These stories inform our recommendations. Furthermore, although hybrid learning is a potential solution in many areas of the United States that continue to battle the pandemic, it will likely present challenges similar to those distance learning has. This makes these recommendations even more relevant as we all continue to navigate the pandemic.

Lessons

- The lack of access to high-quality science instruction and learning that existed before the pandemic has deepened and widened.
- Distance learning presented challenges specific to science; key activities central to learning science were especially difficult to complete remotely.
- Hands-on investigations were the most difficult NGSS activity to implement through remote instruction.
- Teachers improved at implementing the NGSS online as they discovered and mastered new tools and methods, but many were left to their own devices regarding science instruction because districts prioritized math and ELA.
- By the end of the 2020/21 school year, teachers reported a slight rebound in implementing the NGSS, with a long way to go to reach pre-pandemic levels.
- Teachers in EI districts, with supports established during the Initiative, reported a more robust rebound in student participation and in implementing the NGSS in 2021 than did non-EI teachers.
- Teachers got to know students and their families in a deeper way than they had before the pandemic. Many realized the importance of these relationships in being able to engage and have a positive impact on their students' learning.
- Distance learning provided a more natural opportunity to capitalize on student interest in and investigation of science phenomena in their homes or local communities.

Recommendations

- Access to high-quality science is a matter of equity.
  - **Ensure that high-quality science is actually taught, especially in grades K–5. This entails communicating that science is a core subject, on par with ELA and math.**
  - **Ensure that all students, including students who are historically underserved, have access to high-quality science. Encourage teachers to learn how to incorporate the cultural backgrounds of students into activities in order to make lessons relevant and engaging for all students.**
- Support teachers in providing high-quality science.
  - **Make NGSS-aligned instructional materials available and provide professional development for teachers to learn how to use them.**
  - **Make ongoing professional learning available to teachers in order to support and sustain their transition to high-quality NGSS science.**
  - **Provide opportunities and continued support for teachers to develop and share engaging science lessons that incorporate resources available at students' homes.**
- During stressful times, such as during a transition to remote instruction, allow teachers the flexibility to allocate time so that they can tailor classwork to their students' needs and interests.

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Appendix A. Statistically Significant Means for Survey Questions About Incorporating NGSS Into Remote Instruction

Table A1. Teachers Reported Incorporation of SEPs and CCCs in 2020 and 2021

To what extent did you incorporate . . .	Mean for 2020	Mean for 2021
Asking questions	2.46	2.99
Planning investigations or experiments	1.39	1.62
Doing investigations	1.46	1.74
Coming up with explanations	2.19	2.59
Developing and using models	2.19	2.59
Using evidence to support a claim	2.07	2.61
Recording observations	1.87	2.29
Evaluating information	2.07	2.36
Graphing data	0.91	1.41
Analyzing and interpreting data	1.72	2.05
Looking for patterns in data	1.50	2.08
Designing the steps needed to answer questions	1.15	1.56
Defining engineering problems	0.92	1.33
Defining criteria and constraints of a design problem	0.86	1.19
Developing possible solutions	1.19	1.42
Evaluating competing design solutions systematically	0.68	1.04
Developing a model to generate data for iterative testing	0.76	1.07
Analyzing data from tests to determine the best characteristics	0.74	1.01
Optimizing a design solution	0.70	0.93
Identifying successful design characteristics to develop a better solution	0.74	1.05
Breaking down complex problems into smaller pieces	1.04	1.36
Cause and effect	0.90	1.14

To what extent did you incorporate . . .	Mean for 2020	Mean for 2021
Patterns	1.96	2.39
Scale, proportion, and quantity	1.98	2.35
Systems and system models	1.59	2.09
Energy and matter	1.63	2.10
Structure and function	1.50	1.76
Stability and change	1.86	2.06

Note: Scale is 0 = not at all, 2 = somewhat, 4 = to a great extent.

Table A2. EI and non-EI Teachers Reported Incorporation of SEPs and CCCs

To what extent did you incorporate . . .	Mean for EI teachers	Mean for non-EI teachers
Doing investigations	2.04	1.57
Recording observations	2.74	2.15
Talking about results from investigations	2.51	2.09
Developing a model to generate data for iterative testing	1.51	0.89
Discussing structure and function	2.43	1.95
Making connections between science and engineering	2.29	1.77

Note: Scale is 0 = not at all, 2 = somewhat, 4 = to a great extent.

Appendix B. Survey Sample Sizes for Figures 1–3

Table B1. Survey Sample Sizes for Figure 1

Survey Question	Sample Size (2020)	Sample Size (2020–2021)
Please rate overall student engagement in science through distance learning compared to in-person instruction [before school closures].	452	193
Please rate overall level of students' science learning through distance learning compared to in-person instruction [before school closures].	452	193

Source. WestEd. (2020); WestEd. (2020–2021).

Table B2. Survey Sample Sizes for Figure 2

Survey Question/ Survey Year	Thinking about your science instruction, to what extent did you incorporate the following science practice: planning investigations or experiments?	Thinking about your science instruction, to what extent did you incorporate the following science practice: designing the steps needed to answer questions?	Thinking about your science instruction, to what extent did you incorporate the following science practice: doing investigations?
2017/18	127	127	127
2018/19	119	119	119
2019/20	109	109	109
Spring 2020	246	246	246
2020/21	190	190	190

Source. WestEd.

Table B3. Survey Sample Sizes for Figure 3

Survey Question/ Survey Year	Thinking about your science instruction, to what extent were you able to do the following: encourage students' interest in science and/or engineering?	Thinking about your science instruction, to what extent were you able to do the following: encourage students' to have a voice in co-constructing what happens in the science class?	Thinking about your science instruction, to what extent were you able to do the following: build on or make connections between students' prior knowledge or experiences and what is done in science class?	Thinking about your science instruction, to what extent were you able to do the following: make connections between things in students' everyday lives and what is done in science class?
2017/18	127	127	127	127
2018/19	119	119	119	119
2019/20	109	109	109	109
Spring 2020	246	246	246	246
2020/21	181	184	184	182

Source. WestEd.

Appendix C: Descriptions of Figures 1–3

Figure 1. Student engagement and learning in science during distance learning compared with student engagement and learning in science before school closures

Overview and presentation

Two horizontal bar graphs show the percentages of teachers who responded to the survey prompt "Please rate overall student engagement in science and level of students' science learning through distance learning compared with that during in-person classroom instruction before school closures" using the following scale: much less than in-person classroom instruction, somewhat less than in-person classroom instruction, about the same as in-person classroom instruction, somewhat higher than in-person classroom instruction, and much higher than in-person classroom instruction. The first graph shows the responses to the survey disseminated in spring 2021, when the sample size was 193. The second graph shows the responses to the survey disseminated in spring 2021, when the sample size was 452.

Numerical values presented in the image (2021)

Survey prompt	Much less	Somewhat less	About the same	Somewhat/ much higher
Please rate overall student engagement in science through distance learning compared with that during in-person classroom instruction before school closures.	44%	39%	14%	3%
Please rate level of students' science learning through distance learning compared with that during in-person classroom instruction before school closures.	42%	44%	10%	4%

Numerical values presented in the image (2020)

Survey prompt	Much less	Somewhat less	About the same	Somewhat/ much higher
Please rate overall student engagement in science through distance learning compared with that during in-person classroom instruction before school closures.	58%	29%	8%	5%
Please rate level of students' science learning through distance learning compared with that during in-person classroom instruction before school closures.	52%	36%	10%	2%

Figure 2. Student engagement and learning in science during distance learning compared with student engagement and learning in science before school closures

Overview and presentation

Line graph that illustrates the magnitude of the impact of school closures during the COVID-19 pandemic on science instruction. The graph charts teachers' responses to the survey question "Thinking about your science instruction, to what extent did you implement the following science practices?" using the scale never, sometimes, almost always. The science practices the question refers to are planning investigations or experiments, designing the steps needed to answer questions, and doing investigations. The *x*-axis shows the school years in which survey responses were collected (2017/18 through 2020/21), and the *y*-axis shows the frequency of implementation. The graph illustrates that from the 2017/18 school year until spring 2020, teachers consistently reported that they sometimes implemented the science practices, particularly the practice of doing investigations. However, implementation dropped sharply after schools transitioned to distance learning. And although the reported implementation increased significantly in 2021, the frequency of implementation was still far lower than it had been before the pandemic.

Figure 3. Frequency of teacher use of strategies to encourage student interest and agency in science

Overview and presentation

The graph charts teachers' responses to the survey question "Thinking about your science instruction, to what extent were you able to do the following?" using the scale never, sometimes, almost always. The strategies the question refers to are encouraging students' interest in science and/or engineering, encouraging students' to have a voice in co-constructing what happens in the science class, building on or making connections between students' prior knowledge or experiences and what is done in science class, and making connections between things in students' everyday lives and what is done in science class. The *x*-axis shows the school years in which survey responses were collected (2017/18 through 2020/21), and the *y*-axis shows the frequency of implementation. The graph illustrates that from the 2017/18 school year until spring 2020, teachers consistently reported that they often implemented all but one strategy, making connections between students' everyday lives and what is done in science class. This strategy was implemented only sometimes but was on the rise. However, implementation of all strategies dropped sharply after schools transitioned to distance learning. By the end of the 2020/21 school year, the frequency of implementation of all strategies was almost at the level it had been before the pandemic.

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