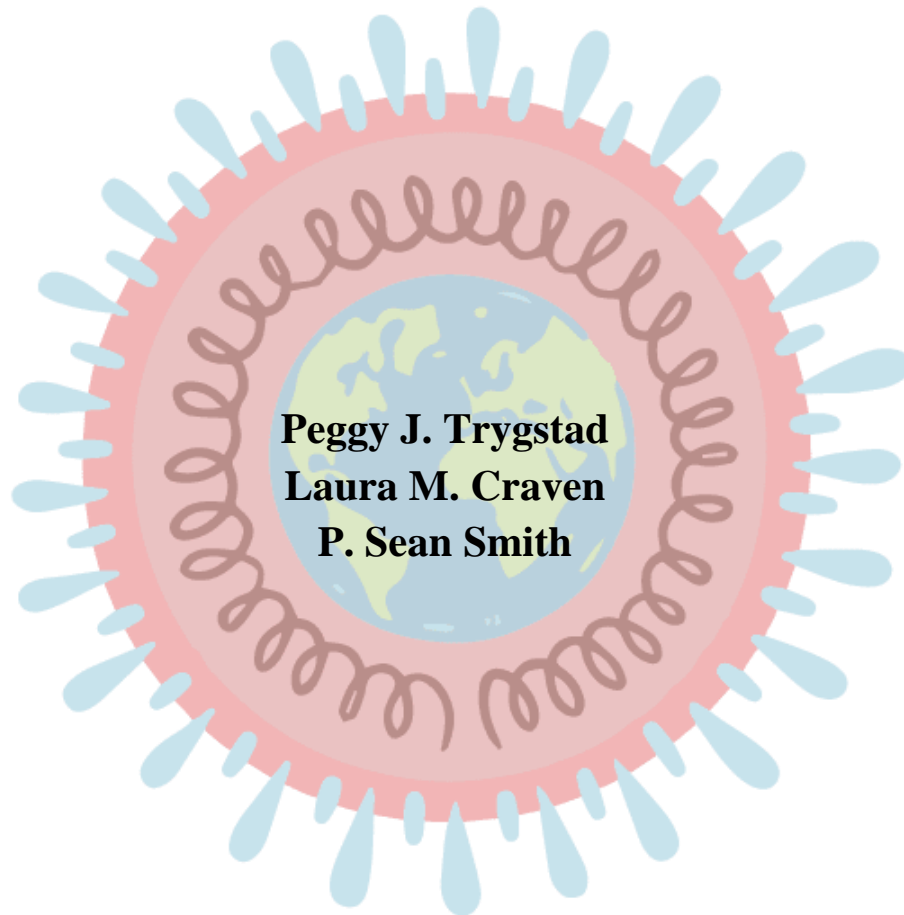


Science Teachers as Public Health Educators: How the COVID Pandemic Reshaped the Roles and Experiences of K–12 Science Teachers



**With:
Anna D. Bruce
Lauren A. Harper
Sarah E. Safley**

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INTRODUCTION

In the spring of 2020, Horizon Research, Inc. (HRI) was awarded a grant from the National Science Foundation (NSF Award DRL–2027397) to study how K–12 science teachers react when urgent science-related issues such as COVID¹ emerge. Encouragingly, the study revealed that science teachers across the nation played a critical part of the nation’s response to the pandemic by (1) providing students with accurate scientific information about COVID, (2) helping students evaluate sources of information about COVID, and (3) increasing student understanding of the nature of science (NOS, e.g., how science generates and refines knowledge). Additionally, science teachers took it upon themselves to support student mental health, doing their best to calm student fears, answer students’ urgent questions, and address widespread misconceptions. In these ways, science teachers assumed the role of public health educators.

In early 2022, HRI received support from NSF (Award DRL–2204901) to build on and expand knowledge generated by our original study. This follow-up study delved into how the pandemic reshaped K–12 science teachers’ roles, including how long and how often they continued to address COVID in their instruction, how their teaching about COVID changed over time, and factors that exerted the greatest influence on their teaching about COVID. Additionally, the study provided an opportunity to gather important information about the impacts of COVID on science teachers themselves, including the manageability of workload, opportunities for professional growth/development, physical/mental wellness, and job satisfaction. The study addressed the following research questions:

1. How does the pandemic continue to influence teachers’ science instruction (e.g., instructional time, instructional strategies), and how has that influence shifted?
2. How has teaching about COVID evolved? What new topics (e.g., vaccines) have they taken up in the context of COVID?
3. What factors now exert the greatest influence on science teachers’ teaching about COVID, and how do those differ from the factors at play in the spring of 2020?
4. What are the impacts of the pandemic on science teachers themselves, including manageability of workload, opportunities for professional growth/development, physical/mental wellness, and job satisfaction?

¹ Throughout the remainder of this report, we will use the term “COVID” to refer to both the virus and the disease. However, we will use the individual terms if we are specifically referring to one or the other.

COVID is likely not the last urgent global health concern our nation will face. As such, this study is important for helping the field better understand the role that science teachers can play in a national response, both now and during the next such crisis. The study is also important for understanding the factors that impacted science teachers' COVID-related instruction so that we can better support them in fulfilling a critical public health function. Further, it is important to draw attention to the far-reaching impacts of the COVID pandemic on science teachers themselves, as these individuals are uniquely and precariously situated at the intersection of knowledge dissemination and contentious public policy measures.

METHODOLOGY

The methodology for this study involved developing a teacher survey and interview protocol, recruiting participants, collecting data, and analyzing data. This section provides a description of each of these components of the methodology, as well as important information for interpreting the findings of the study while reading the report.

Instrument Development

Survey

The survey, which included a mix of items that had been used in the previous study and new items, covered a broad range of topics, including how teachers addressed COVID in their instruction, how their teaching about COVID changed over time, and factors that exerted the greatest influence on their teaching about COVID. Additionally, the survey gathered information about the impacts of COVID on science teachers themselves, including the manageability of workload, physical/mental wellness, and job satisfaction. For former teachers (i.e., those who left the profession after the 2019–20 school year), a subset of survey items focused on the ways in which COVID impacted their decision to leave the profession.

Once survey items had been drafted, an abridged version was piloted with a sample of 30 teachers, 10 from each grade band (elementary, middle, high). Pilot survey responses informed the revision of existing survey items and addition of new items. The final version of the survey was programmed into an online administration platform and tested to ensure it functioned according to design specifications, including different pathways for current and former teachers and other skip logic. The final version of the survey is included in Appendix A.

Interview Protocol

The teacher interview protocol focused on many of the same topics as the teacher survey and was intended to elicit additional information about the varied contexts in which teachers worked. The interview protocol was piloted with a small number of teachers prior to broader use to ensure that the questions were clear and interpreted as intended.

Study Recruitment

HRI recruited teachers for the study from two sources. First, we sent emails to all teachers who participated in the previous COVID study, as well as science teachers subscribed to a mailing list maintained by HRI. We also enlisted the help of the National Science Teaching Association (NSTA), which has a membership of over 55,000 teachers and a mailing list of over 200,000. NSTA sent a description of the study and link to the study registration form to a substantial portion of their members. Between the two recruiting strategies, we registered just under 2,000 current and former K–12 science teachers for the study.

Data Collection

Survey

Administering the survey to teachers before the end of the 2021–22 school year was important for achieving an adequate response rate. The survey was launched in May 2022 and closed at the end of August 2022 with a response rate of 56 percent.²

The study timeline and budget precluded drawing a nationally representative sample for the teacher survey. Instead, HRI attempted to register and survey enough teachers so that a representative group could be constructed from respondents for analysis purposes. We received completed surveys from 1,081 current and former teachers, which was not a large enough sample to exclude any without risking large standard errors. However, the teachers in our sample are quite similar on most demographic factors to the greater population of teachers, according to demographic data from the 2018 National Survey of Science and Mathematics Education.³ These comparisons are included in Appendix B.

HRI segmented the sample of current teachers into elementary, middle, and high school grade bands. A small number of former teachers also completed the survey. The number of teachers in each category is shown in Table 1.

² Teachers who registered for the study received an initial email with instructions for accessing and completing the survey. Several email reminders were sent, both during the school year and over the summer, to those who had not yet completed the survey.

³ Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). Report of the 2018 NSSME+. Horizon Research, Inc.

Table 1
Sample Size

	Number of Teachers
Total	1081
Elementary	180
Middle	323
High	523
Former teachers [†]	55

[†] Includes teachers from all three grade bands.

Interviews

Teachers who completed the survey were asked if they were willing to participate in a follow-up interview. HRI drew a purposive sample from those who agreed to participate, with the goal of balancing the sample in terms of grade band, life science/non-life science teaching assignment (at the middle and high school levels), and region of the country. Within these strata, teachers were randomly selected and contacted on a rolling basis throughout the data collection period. When a selected teacher declined or did not respond, a similar backup was contacted as a replacement. Using this approach, 40 of the 80 teachers contacted were interviewed.

Data Analysis

Survey

To facilitate the reporting of large amounts of survey data, and because individual survey items are potentially unreliable, HRI used factor analysis to identify survey items that could be combined into “composites.” Each composite represents an important construct related to COVID in science education and is reported on a scale from 0 to 100. A detailed description of the composite creation and composite definitions are included in Appendix C.

Although not designed primarily as an equity study, the survey also provides some data about the extent to which students across the nation had equitable opportunities to learn about COVID. Data were analyzed by four factors⁴ historically associated with differences in educational opportunities:

- **Percentage of students in the school eligible for free/reduced-price lunch (FRL)**
 Teachers were grouped into 1 of 4 categories based on the percentage of students in the school eligible for FRL. The categories were defined as quartiles within groups of schools serving the same grades (e.g., schools with grades K–5, schools with grades 6–8). Cut points for these quartiles are included in Appendix C.

⁴ Three factors—percentage of students eligible for FRL, percentage of students from URM groups, and community type—are school-level factors. The fourth—political leaning—is a county-level factor. For analysis purposes, all factors were assigned to individual teachers’ responses.

- **Percentage of students in the school from historically underrepresented minority (URM) groups**

Teachers were grouped into 1 of 4 quartiles based on the percentage of students in the school from race/ethnicity groups historically underrepresented in STEM (i.e., American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, multi-racial). Cut points for these quartiles are included in Appendix C.

- **Community type**

Teachers were coded into 1 of 3 types of communities:

- Urban: central city;
- Suburban: area surrounding a central city, but still located within the counties constituting a Metropolitan Statistical Area (MSA); or
- Rural: area outside any MSA.

- **Political leaning**

Teachers were coded into 1 of 2 categories based on whether the majority of voters in their school's county voted for the Democratic presidential candidate or Republican presidential candidate in the 2020 election.

Equity analyses of selected survey items and composites include all current teachers (grades K–12) with available equity data.

Teachers were presented with several open-ended items throughout the survey. Responses to these items were analyzed using an emergent coding scheme, where responses were classified into one or more different categories. Responses were then analyzed by frequency within grade bands.

Interviews

Interview data were used to write a vignette report,⁵ which provide illustrative examples of the interplay among numerous factors that influenced teachers' response to COVID. Teacher quotes from the interviews are also interspersed throughout this report to supplement the survey findings.

⁵ Trygstad, P. J., Harper, L. A., Bruce, A. D., Safley, S. E., & Smith, P. S. (2023). *Teaching Science During the COVID Pandemic: K-12 Teachers Tell Their Stories*. Horizon Research, Inc.

Organization of This Report

The results of the study, like those from any survey based on a sample of a population (rather than on the entire population), are subject to sampling variability. The sampling error (or standard error) provides a measure of the range within which a sample estimate can be expected to fall a certain proportion of the time. For example, survey findings may indicate that 15 percent of elementary teachers gave a lecture when they addressed COVID with their students. If the sampling error for this estimate was 3 percent, then, according to the Central Limit Theorem, 95 percent of all possible samples of that same size selected in the same way would yield estimates between 9 percent and 21 percent (that is, 15 percent \pm 2 standard error units). The standard errors for the estimates presented in this report are included in parentheses in the tables (see Figure 1).

Percent of Teachers			
All (N=359)	Focus of Class		
	Life Science (N=142)	Non-Life Science (N=217)	
65 (2.3)	76 (3.7)	61 (2.9)	Number of survey respondents in category
47 (2.4)	48 (4.4)	47 (2.2)	Percentage of survey respondents
48 (2.4)	53 (4.4)	46 (2.9)	
47 (2.4)	48 (4.4)	46 (2.9)	
40 (2.4)	46 (4.4)	37 (2.8)	Standard error
18 (1.9)	15 (3.2)	19 (2.3)	
17 (1.8)	22 (3.6)	14 (2.1)	

Figure 1

A summary of each table highlighting or interpreting the results precedes the table. The summary points out only those differences that are substantial as well as statistically significant at the 0.05 level.⁶ When full distributions of responses are shown, differences among grade bands or timepoints were tested using the Chi-square test of independence. Post-hoc tests to determine which response option(s) are different were not conducted, but likely reasons for any observed difference are mentioned in the text.

Comparisons were made between groups within each equity factor. For FRL and URM, comparisons were made between the highest and lowest quartiles. For community type, comparisons were made among all three locales (urban vs. suburban, urban vs. rural, and rural

⁶ Given the exploratory nature of this report, all tests of significance were conducted without controlling the Type 1 error rate.

vs. suburban). For political leaning, comparisons were made between Democratic- and Republican-leaning counties.

FINDINGS

Sources of Information About COVID

To find out where teachers accessed information about COVID, the survey asked them what media sources they consulted. Findings regarding which sources of information were used by teachers at each grade band are described in this section of the report.

Large percentages of teachers at each grade band relied on the Centers for Disease Control and Prevention (CDC) website as a source of information about COVID. Secondary teachers also commonly accessed other health information websites, including the National Institutes of Health (NIH) and World Health Organization (WHO).

Table 2 shows which sources teachers relied on to a substantial extent (i.e., those responding 3 or 4 on a four-point scale ranging from 1 “Not at all” to 4 “To a great extent”). About three-quarters of teachers across grade bands reported using the Centers for Disease Control and Prevention (CDC) website to a substantial extent. The rest of the sources were used by about half or less of all teachers. Interestingly, the National Institutes of Health (NIH) and World Health Organization (WHO) websites were used substantially by about half of secondary teachers, but only a third of elementary teachers. On the other hand, nearly half of elementary teachers used resources provided by their school district, while only a fifth of secondary teachers reported the same.

Table 2
Teachers Indicating That Various Media Served
as a Source of Information About COVID to a Substantial Extent[†]

	Percent of Teachers		
	Elementary (N = 180)	Middle (N = 323)	High (N = 523)
Centers for Disease Control and Prevention (CDC) website	75 (3.3)	78 (2.3)	77 (1.8)
National Institutes of Health (NIH) website	32 (3.5)	46 (2.8)	53 (2.2)
World Health Organization (WHO) website	33 (3.5)	44 (2.7)	49 (2.2)
Conversations with health professionals (e.g., nurses, doctors)	53 (3.7)	50 (2.8)	47 (2.2)
Radio/internet/podcast program (e.g., NPR, TedTalk)	40 (3.6)	45 (2.8)	46 (2.2)
Popular science magazines (e.g., Scientific American, Discover)	28 (3.3)	42 (2.7)	46 (2.2)
Johns Hopkins Coronavirus Resource Center website	34 (3.5)	36 (2.7)	43 (2.2)
Local news station (e.g., NBC4), via radio, TV, or Internet	52 (3.7)	50 (2.8)	41 (2.1)
Newspapers, whether print or online (e.g., NY Times, Boston Globe)	31 (3.4)	37 (2.7)	41 (2.1)
Conversations with other teachers	41 (3.7)	32 (2.6)	36 (2.1)
National broadcast TV news program (e.g., NBC Nightly News, CBS Nightly News)	45 (3.7)	42 (2.7)	35 (2.1)
Websites from other health organizations (besides CDC, Johns Hopkins, NIH, and WHO)	28 (3.3)	33 (2.6)	35 (2.1)
Websites from teacher professional organizations (e.g., National Science Teachers Association, National Association of Biology Teachers)	31 (3.4)	32 (2.6)	29 (2.0)
Online-only sources (e.g., Huffington Post, Yahoo News, AOL)	27 (3.3)	25 (2.4)	29 (2.0)
24-hour TV news (e.g., CNN, MSNBC, FOX, BBC)	36 (3.6)	25 (2.4)	24 (1.9)
Resources provided by your school district	48 (3.7)	23 (2.3)	20 (1.8)
Conversations with others (i.e., not health professionals or teachers)	33 (3.5)	21 (2.2)	20 (1.7)
Other magazines, whether print or online (e.g., Time, New Yorker)	18 (2.8)	13 (1.8)	19 (1.7)
Social media (e.g., Facebook, Instagram, LinkedIn, Twitter)	23 (3.1)	12 (1.8)	14 (1.5)
TV talk show (e.g., the View, Today Show, Daily Show)	10 (2.2)	5 (1.2)	5 (0.9)

[†] Includes teachers indicating 3 or 4 on a four-point scale ranging from 1 “Not at all” to 4 “To a great extent.”

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.
(Elementary School Teacher - Interview Response)

I did a lesson on where to find credible sources. We went to the CDC, Hughes Health, Mayo Clinic, WebMD, Johns Hopkins, and pulled up 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.”
(High School Teacher - Interview Response)

That information was all coming down from the CDC, and I used all the information I could get from that site. I kept on reading to make sure that I knew for the kids. . . . That I was giving them all the current information.
(High School Teacher – Interview Response)

Elementary teachers were more likely than secondary teachers to turn to local/national news and personal conversations/social media for information about COVID. Secondary teachers used health/science organization websites more often.

Subsets of items shown in Table 2 were combined into three composite variables: (1) local/national television news stations, (2) health/science organization websites, and (3) personal conversations/social media. As can be seen in Table 3, the composite means suggest that teachers across grade bands used each of these types of sources for information about COVID to minimally to moderately. However, there were some differences by grade band. Elementary teachers were more likely to consult local/national television news than high school teachers (mean scores of 44 vs. 37). Elementary teachers were also more likely to use personal conversations and social media than their middle and high school counterparts (mean scores of 38, 29, and 31, respectively). On the other hand, middle and high school teachers were more likely than elementary teachers to use health/science organization websites (mean scores of 46, 47, and 40, respectively).

Table 3
Extent to Which Teachers Indicated That Various Media Served as a Source of Information About COVID Composites

	Mean Score		
	Local/National Television News Stations	Health/Science Organization Websites	Personal Conversations/Social Media
Elementary (N = 180)	44 (2.0)	40 (1.8)	38 (1.7)
Middle (N = 323)	40 (1.3)	46 (1.3)	29 (1.1)
High (N = 523)	37 (1.1)	47 (1.0)	31 (0.9)

Equity analyses revealed some differences in the extent to which teachers consulted various forms of media for information about COVID.

The three composite variables related to teachers’ sources of information about COVID (shown in Table 2) were examined by equity factors. As can be seen in Table 4, there were few

differences across equity factors for each composite. One notable difference, however, is that teachers in high-poverty schools were more likely to consult health/science organization websites than teachers in low-poverty schools (48 vs. 42). In addition, teachers in urban schools were more likely than those in suburban or rural areas to use personal conversations and/or social media as a source of information (mean scores of 34, 30, and 30, respectively).

Table 4
Equity Analysis of the Extent to Which Teachers Indicated That
Various Media Served as a Source of Information About COVID Composites

	Mean Score		
	Local/National Television News Stations	Health/Science Organization Websites	Personal Conversations/Social Media
FRL (N = 802)			
Lowest Quartile	38 (1.7)	42 (1.6)	32 (1.5)
Second Quartile	40 (1.7)	45 (1.5)	31 (1.5)
Third Quartile	40 (1.6)	46 (1.8)	31 (1.6)
Highest Quartile	42 (1.8)	48 (1.7)	33 (1.4)
URM (N = 988)			
Lowest Quartile	38 (1.6)	45 (1.5)	31 (1.3)
Second Quartile	38 (1.6)	45 (1.5)	30 (1.3)
Third Quartile	41 (1.6)	45 (1.6)	32 (1.4)
Highest Quartile	42 (1.6)	47 (1.5)	33 (1.3)
Community Type (N = 1026)			
Urban	41 (1.5)	47 (1.3)	34 (1.1)
Suburban	39 (1.1)	45 (1.1)	30 (0.9)
Rural	37 (1.7)	43 (1.7)	30 (1.4)
Political Leaning (N = 1026)			
Democratic Presidential Candidate	40 (1.0)	46 (0.9)	32 (0.8)
Republican Presidential Candidate	38 (1.2)	44 (1.2)	30 (1.0)

Teaching About COVID

The survey asked teachers if they addressed COVID in their science instruction during the 2021–22 school year. Examples of addressing COVID might include class discussions, formal lessons, student presentations, or current event coverage. Teachers who addressed COVID were also asked how much class time they devoted compared to the previous school year, what specific topics of the virus/disease were addressed, and what instructional materials were used. These data are discussed in this section of the report.

Large proportions of teachers at each grade band devoted class time to COVID.

As can be seen in Table 5, over 70 percent of teachers at each grade band reported addressing COVID in their classes. However, middle and high school teachers reported covering the topic more than elementary teachers (82, 82, and 71 percent, respectively).

Table 5
Teachers Who Addressed COVID in Their Science Instruction

	Percent of Teachers
Elementary (N = 180)	71 (3.4)
Middle (N = 323)	82 (2.1)
High (N = 523)	82 (1.7)

While a majority of all teachers addressed COVID, those in high-poverty schools did so more than their low-poverty counterparts.

Table 6 shows percentages of teachers who addressed COVID by equity factors. Large percentages of teachers addressed COVID across equity factors, with the only significant difference being that teachers in high-poverty schools addressed COVID more than those in low-poverty schools (83 vs. 70 percent).

Table 6
Equity Analysis of Teachers Who Addressed COVID

	Percent of Teachers
FRL (N = 802)	
Lowest Quartile	70 (3.3)
Second Quartile	80 (2.8)
Third Quartile	86 (2.5)
Highest Quartile	83 (2.6)
URM (N = 988)	
Lowest Quartile	77 (2.7)
Second Quartile	79 (2.6)
Third Quartile	80 (2.5)
Highest Quartile	83 (2.4)
Community Type (N = 1026)	
Urban	81 (2.2)
Suburban	78 (1.8)
Rural	81 (2.8)
Political Leaning (N = 1026)	
Democratic Presidential Candidate	81 (1.6)
Republican Presidential Candidate	78 (2.1)

Teachers spent less time addressing COVID during the 2021–22 school year than they did in the 2020–21 school year.

Teachers who addressed COVID were asked to compare the time they spent on the subject in the 2020–21 and 2021–22 school years. As can be seen in Table 7, the majority of teachers at each grade band spent less time addressing COVID in the 2021–22 school year than they did in the 2020–21 school year (when COVID was much more prevalent and surrounded by a lot of uncertainty). There are significant differences between the distributions of responses for each grade band, likely due to smaller percentages of high school teachers spending much less time covering the topic.

Table 7
Teachers Indicating How Much Time They Spent Addressing COVID

	Percent of Teachers		
	Elementary (N = 127)	Middle (N = 264)	High (N = 428)
Much less time in the 2021–22 school year than in the 2020–21 school year	43 (3.4)	46 (2.7)	33 (1.9)
Slightly less time in the 2021–22 school year than in the 2020–21 school year	27 (2.9)	24 (2.2)	29 (1.8)
About the same amount of time in the 2021–22 school year in the 2020–21 school year	18 (2.5)	20 (2.0)	26 (1.8)
Slightly more time in the 2021–22 school year than in the 2020–21 school year	7 (1.6)	9 (1.4)	11 (1.2)
Much more time in the 2021–22 school year than in the 2020–21 school year	6 (1.4)	2 (0.7)	3 (0.6)

† Only those who indicated devoting instructional time to COVID are included in this table.

Large percentages of teachers addressed COVID as part of their curriculum, increasingly so as grade level increases. Elementary teachers were more likely to address COVID as a standalone topic than their secondary counterparts.

Teachers who addressed COVID were also asked whether they addressed the topic as part of their curriculum or as a standalone topic. As can be seen in Table 8, the majority of teachers at each grade band addressed COVID as part of their curriculum. However, high school and middle school teachers were more likely to address COVID as part of their curriculum than elementary teachers (82, 73, and 60 percent, respectively). In contrast, elementary teachers were just as likely to address COVID as part of their curriculum as they were to address it as a standalone topic.

Table 8
How Teachers Addressed COVID in Relation to Their Curriculum†

	Percent of Teachers	
	Addressed as part of curriculum	Addressed as a standalone topic
Elementary (N = 127)	60 (4.3)	61 (4.3)
Middle (N = 264)	73 (2.7)	45 (3.1)
High (N = 428)	82 (1.8)	42 (2.4)

† Only those who indicated devoting instructional time to COVID are included in this table.

Regardless of grade range, nearly 4 in 5 teachers indicated that their students asked questions about COVID.

When students had questions about COVID, they turned to their teachers for answers. In fact, over three-quarters of teachers at each grade band indicated that their students asked questions about COVID (see Table 9).

Table 9
Teachers Indicating Students Asked About COVID

	Percent of Teachers
Elementary (N = 127)	77 (3.7)
Middle (N = 264)	83 (2.3)
High (N = 428)	84 (1.8)

† Only those who indicated devoting instructional time to COVID are included in this table.

Kids always have questions about anything, and we kind of worked through some of that. At the very beginning, there wasn't a 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 it's 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 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. . . . And that's hard for them to hear, I think. Sometimes it was like "What do you mean? How does nobody know this?"

(Middle School Teacher – Interview Response)

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.

(High School Teacher – Interview Response)

There was a great deal of variation in the types of questions students asked about COVID.

The teachers who indicated that their students asked questions about COVID were asked about the nature of those questions. As can be seen in Table 10, student questions were most often centered around three topics; vaccines/boosters, personal concerns (e.g., “How do I/my family not get sick?” and “Why should we care?”), and actions to prevent transmission. As might be expected, questions around vaccines/boosters were increasingly more common with increasing

grade band, while questions about personal concerns and actions to prevent transmission were more prevalent among younger students. Although students also asked questions about a variety of other topics, no other topic represented more than 10 percent of total student questions.

Table 10
Topics of Most Common Student Questions About COVID[†]

	Percent of Questions		
	Elementary (N = 311)	Middle (N = 736)	High (N = 1242)
Vaccines/Boosters	10 (1.7)	19 (1.5)	26 (1.2)
Personal concerns	36 (2.7)	26 (1.6)	22 (1.2)
Actions to prevent transmission	23 (2.4)	18 (1.4)	12 (0.9)
Characteristics of viruses	5 (1.3)	8 (1.0)	9 (0.8)
Outbreak duration	8 (1.5)	8 (1.0)	7 (0.7)
Teacher’s own opinions or experience	4 (1.0)	4 (0.7)	6 (0.7)
How long is it necessary to take actions to prevent	7 (1.4)	6 (0.9)	5 (0.6)
Risk for infection	9 (1.6)	7 (1.0)	4 (0.6)
Severity of illness	1 (0.6)	4 (0.7)	4 (0.5)
Origins	4 (1.1)	3 (0.6)	4 (0.5)
What sources of information to trust	3 (1.0)	3 (0.6)	4 (0.5)
Immunity/Antibodies	1 (0.6)	3 (0.6)	4 (0.6)
Transmission	6 (1.4)	6 (0.9)	3 (0.5)
Symptoms/Long-term effects	5 (1.2)	3 (0.6)	3 (0.5)
School changes	2 (0.8)	2 (0.5)	3 (0.4)
Testing/Treatment	1 (0.6)	1 (0.4)	3 (0.5)
Mortality	6 (1.4)	2 (0.6)	2 (0.4)
Infection rates/Contagiousness	2 (0.8)	2 (0.5)	2 (0.4)
Conspiracies	1 (0.5)	1 (0.3)	2 (0.4)

[†] Only those who indicated their students asked questions about COVID are included in this table.

Across grade bands, the most commonly addressed topics included ways to prevent coronavirus transmission, how coronavirus is transmitted, and what coronavirus/COVID-19 is.

Table 11 displays the various COVID-related topics that teachers indicated they addressed in their instruction. Across grade bands, over three-quarters of teachers addressed ways to prevent transmission, and over half addressed what COVID is, how coronavirus is transmitted among humans, COVID policies and procedures, and symptoms of COVID. However, there were some differences by grade band. While 74 percent of middle school teachers and 73 percent of high school teachers addressed how the virus has changed/mutated over time, only 43 percent of elementary teachers indicated that this was a topic they covered with their students. Similarly, more than two-thirds of secondary teachers addressed common misconceptions about COVID, in contrast to about half of elementary teachers.

Table 11
Topics Addressed by Teachers During COVID Instruction[†]

	Percent of Teachers		
	Elementary (N = 127)	Middle (N = 264)	High (N = 428)
What COVID is/Transmission			
Ways to prevent coronavirus transmission (e.g., masking, hand washing)	89 (2.8)	87 (2.1)	75 (2.1)
How the virus has changed/mutated over time	43 (4.4)	74 (2.7)	73 (2.2)
What COVID is (e.g., the difference between the virus and the disease)	61 (4.3)	69 (2.8)	69 (2.2)
How coronavirus is transmitted among humans	70 (4.1)	73 (2.7)	64 (2.3)
Local/national COVID policies and procedures (e.g., mask mandates, quarantining, contact tracing)	52 (4.4)	57 (3.0)	52 (2.4)
Symptoms of COVID	55 (4.4)	56 (3.1)	51 (2.4)
Factors that place people at risk for contracting coronavirus (e.g., age, immunocompromised)	31 (4.1)	51 (3.1)	50 (2.4)
Differences among strains of COVID (e.g., Delta, Omicron)	24 (3.8)	44 (3.1)	50 (2.4)
Evaluating Information About COVID			
Common misconceptions about COVID	48 (4.4)	70 (2.8)	67 (2.3)
How to evaluate sources of information about COVID	19 (3.5)	38 (3.0)	49 (2.4)
Advanced COVID Topics			
How COVID compares to other pandemics (e.g., influenza 1918)	30 (4.1)	39 (3.0)	48 (2.4)
Broader impacts of COVID (e.g., impacts on the economy, education)	39 (4.3)	32 (2.9)	44 (2.4)
Differences between outbreaks, epidemics, pandemics, and endemics	19 (3.5)	34 (2.9)	41 (2.4)
Environmental impacts of COVID supplies (e.g., masks, gloves, testing kits)	39 (4.3)	34 (2.9)	31 (2.2)
Social disparities in COVID transmission/treatment/impacts	18 (3.4)	21 (2.5)	30 (2.2)
Vaccines/Immunity			
Types of COVID vaccines (mRNA, viral vector) and how they work	15 (3.2)	39 (3.0)	61 (2.4)
Safety of COVID vaccines	31 (4.1)	48 (3.1)	57 (2.4)
Efficacy of COVID vaccines	17 (3.4)	39 (3.0)	54 (2.4)
COVID vaccine hesitancy	22 (3.7)	33 (2.9)	43 (2.4)
The process/timeline for developing COVID vaccines	14 (3.1)	31 (2.8)	43 (2.4)
Access to COVID vaccines (nationally and/or globally)	30 (4.1)	35 (2.9)	41 (2.4)
COVID immunity	33 (4.2)	36 (3.0)	47 (2.4)
Side effects of COVID vaccines	24 (3.8)	32 (2.9)	35 (2.3)
Testing/Treatment			
Types and accuracy of COVID tests (e.g., antigen/rapid, PCR)	13 (3.0)	23 (2.6)	41 (2.4)
How COVID is diagnosed	21 (3.6)	29 (2.8)	34 (2.3)
How COVID tests work	14 (3.1)	19 (2.4)	33 (2.3)
How COVID is treated	20 (3.6)	27 (2.7)	24 (2.1)

[†] Only those who indicated devoting instructional time to COVID are included in this table.

Teachers relied heavily on units and lessons they created or collected from an online source.

Teachers who devoted instructional time to COVID were also asked which instructional materials they used to do so. The most commonly used instructional materials, across grade bands, were units or lessons that teachers created (see Table 12). However, high school teachers were more likely than middle or elementary teachers to use these self-created materials (69, 55, and 44 percent, respectively). Although used to a minimal extent overall, elementary teachers were more likely than middle or high school teachers to use lessons or resources from websites that have a subscription fee or per lesson cost (36, 25, and 12 percent, respectively).

**Table 12
Instructional Materials Used by Teachers to Address COVID[†]**

	Percent of Teachers		
	Elementary (N = 127)	Middle (N = 264)	High (N = 428)
Units or lessons you created (either by yourself or with others)	44 (4.4)	55 (3.1)	69 (2.2)
Units or lessons you collected from any other source (e.g., conferences, journals, colleagues, university or museum partners)	26 (3.9)	26 (2.7)	39 (2.4)
Lessons or resources from websites that are free (e.g., Khan Academy)	35 (4.2)	36 (2.9)	31 (2.2)
Commercially published materials (printed or electronic)	20 (3.5)	28 (2.8)	30 (2.2)
Lessons or resources from websites that have a subscription fee or per lesson cost (e.g., BrainPop, ShareMyLesson, Teachers Pay Teachers)	36 (4.3)	25 (2.7)	12 (1.6)
State-, county-, or district-developed units or lessons	14 (3.1)	12 (2.0)	10 (1.4)
Commercially published kits/modules (printed or electronic)	3 (1.5)	5 (1.4)	5 (1.0)

[†] Only those who indicated devoting instructional time to COVID are included in this table.

Teachers used a wide range of commercially published resources to address COVID.

Just over half of teachers who addressed COVID used commercially published materials, materials from a website (free or paid), or another outside source (see Table 12). The survey asked those individuals to identify which materials they consulted. As can be seen in Table 13, no single resource was widely used. However, at the elementary level, 52 percent of teachers utilized Mystery Science, and 30 percent utilized Discovery Education. At the middle and high school levels, about one-third of teachers utilized the CDC’s Toolkit for K–12 schools and TedEd.

Table 13
Commercially Published Instructional Resources Used by Teachers to Address COVID[†]

	Percent of Teachers		
	Elementary (N = 88)	Middle (N = 174)	High (N = 286)
CDC’s Toolkit for K–12 Schools	28 (4.8)	32 (3.5)	32 (2.8)
TedEd	10 (3.2)	32 (3.5)	30 (2.7)
COVID-19 Lesson Plans, from NIH	17 (4.0)	24 (3.2)	22 (2.5)
Discovery Education	30 (4.9)	33 (3.6)	16 (2.2)
National Geographic’s Interdisciplinary K-12 Resources	19 (4.2)	20 (3.0)	11 (1.8)
Exploring Infectious Diseases, from EDC	9 (3.1)	9 (2.1)	8 (1.6)
Mystery Science	52 (5.3)	9 (2.1)	5 (1.2)
COVID-19! How Can I Protect Myself and Others? from the Smithsonian Science Education Center	13 (3.5)	15 (2.7)	4 (1.2)
Materials from the Responding to an Emerging Epidemic through Science Education (REESE) project	5 (2.2)	4 (1.5)	4 (1.1)
Responding to a Mystery Illness, from Amgen Biotech Experience	7 (2.7)	3 (1.3)	3 (1.1)

[†] Only those who indicated using commercially published materials, materials from a website (free or paid), or another outside source are included in this table.

Teacher Decision Making

One focus of the survey was identifying factors that impacted teachers’ decisions to either address or not address COVID in their instruction. Teachers were presented with an open-ended question that asked them to state the most important reason why they either did or did not address COVID. Additional items about what might have influenced this decision are also provided in this section of the report.

Across grade bands, about one-quarter of teachers chose to address COVID in their instruction because it was a relevant/current event. The most common reason why elementary and middle school teachers addressed COVID was to promote public health safety.

Teachers who addressed COVID were asked to identify the most important reason behind their decision to do so. Across grade bands, nearly one-quarter of teachers decided to teach about COVID because it was a relevant and current event (see Table 14).

We have been living through the pandemic. As a science teacher, how could I not address, talk about, teach about COVID-19? There has been so much misinformation, lack of reasoning, changing guidelines, and so on; that helping students wade through all the information, thinking and reasoning through source material and making healthy decisions for themselves and their families is a primary duty of any solid science teacher.
(Middle School Teacher – Survey Response)

It's science in action and public health in real life and real time. Instead of addressing illnesses these students haven't seen or that have happened far away, I can use something that we are all experiencing and talk about how science really works while it is happening. It connects with almost all the units I teach – viruses, infectious disease, immunology, and epidemiology.
(High School Teacher – Survey Response)

At the high school level, 21 percent of teachers addressed COVID because it related to their science standards compared to only 10 percent of elementary teachers. Conversely, elementary teachers were more likely than high school teachers to address COVID to promote public health safety (34 vs. 16 percent) and help students address/process their fear/anxiety (14 vs. 6 percent).

I teach young students, so I needed to address proper handwashing, masking, and social distancing.
(Elementary Teacher – Survey Response)

Table 14
Most Common Reasons Why Teachers Addressed COVID[†]

	Percent of Teachers		
	Elementary (N = 127)	Middle (N = 264)	High (N = 428)
Relevant/Current event	20 (3.6)	24 (2.6)	23 (2.0)
Related to science standards	10 (2.7)	15 (2.2)	21 (2.0)
Address misconceptions/misinformation	9 (2.6)	13 (2.1)	18 (1.9)
Promote public health/safety	34 (4.2)	25 (2.7)	16 (1.8)
Student interest	12 (2.9)	18 (2.4)	11 (1.5)
Provide accurate science information	3 (1.5)	8 (1.7)	10 (1.4)
Address evaluating information sources	2 (1.3)	4 (1.2)	7 (1.2)
Address/process negative feelings	14 (3.1)	8 (1.7)	6 (1.2)

[†] Only those who indicated devoting instructional time to COVID are included in this table.

Teachers' reasons for addressing COVID were generally consistent across equity factors.

A subset of items in Table 14 (where the sample size was large enough to detect possible differences) were examined by equity factors, revealing only a few differences in the reasons why teachers addressed COVID (see Table 15). Teachers in high-poverty schools were less likely to address COVID because it related to science standards or to provide accurate science information than teachers in low-poverty schools. Teachers in the highest URM quartile were more likely than teachers in the lowest URM quartile to address COVID as means of protecting students and others' health (30 vs. 18 percent).

Table 15
Equity Analysis of the Most Common Reasons Why Teachers Addressed COVID[†]

	Percent of Teachers			
	Related to science standards	Promote public health/safety	Address misconceptions/misinformation	Provide accurate science information
FRL (N = 631)				
Lowest Quartile	22 (3.5)	24 (3.6)	13 (2.8)	11 (2.6)
Second Quartile	21 (3.2)	17 (2.9)	11 (2.5)	7 (2.0)
Third Quartile	16 (2.8)	23 (3.2)	20 (3.0)	9 (2.2)
Highest Quartile	12 (2.5)	30 (3.5)	14 (2.7)	5 (1.7)
URM (N = 779)				
Lowest Quartile	17 (2.7)	18 (2.8)	19 (2.8)	9 (2.1)
Second Quartile	20 (2.9)	17 (2.7)	19 (2.8)	12 (2.3)
Third Quartile	20 (2.8)	22 (3.0)	12 (2.3)	7 (1.8)
Highest Quartile	13 (2.4)	30 (3.2)	12 (2.3)	5 (1.6)
Community Type (N = 809)				
Urban	16 (2.3)	23 (2.6)	13 (2.1)	9 (1.8)
Suburban	18 (1.9)	21 (2.0)	16 (1.8)	8 (1.4)
Rural	18 (3.1)	21 (3.3)	17 (3.0)	8 (2.1)
Political Leaning (N = 809)				
Democratic Presidential Candidate	18 (1.7)	23 (1.9)	14 (1.5)	7 (1.1)
Republican Presidential Candidate	17 (2.2)	19 (2.3)	18 (2.2)	10 (1.8)

When teachers did not address COVID, the most common reasons were that (1) it was not related to their standards/curriculum/course and (2) they feared pushback from parents/students. Elementary teachers also chose not to address COVID due to the young age of their students.

Teachers who did not address COVID were also asked to identify the most important reason behind their decision. As can be seen in Table 16, the most prevalent reason across all grade bands for not teaching about COVID was because the topic is not related to their curriculum/content.

I teach 10- to 12-year-olds. Diseases, bacteria, viruses are not part of my [state standards]. I have barely enough time to teach the information I am required to teach. I do not have time to teach things outside of the realm of my scope and sequence. If a student were to ask me something about COVID, then I certainly would have answered the questions of that student.
(Elementary Teacher – Survey Response)

I have found that students already had a lot of information from the previous year, and I needed to focus on science required curriculum.
(Middle School Teacher – Survey Response)

It wasn't in my curriculum. Everyone keeps talking about "getting back to normal" so that was my intention – to provide normalcy.
(High School Teacher – Survey Response)

Fear of potential parent/community pushback was also an important deterrent across grade bands (Elementary: 11 percent, Middle: 20 percent, and High: 16 percent). Additionally, 12 percent of middle school teachers and 16 percent of high school teachers indicated that they chose not to address COVID because teachers and students had fatigue around the topic (i.e., they had heard/talked about it a lot already and were not interested in discussing it further).

The parents of my students are often people who refuse to wear masks and deny that COVID is a real problem. Teaching it in my class when it isn't part of the curriculum would just be asking for more work than I already have.
(Middle School Teacher – Survey Response)

I think the students and I are burned out. The pandemic is exhausting and an emotional rollercoaster. We see, hear, and experience the effects daily. Although I understand the importance of addressing topics such as COVID from a health and science standpoint, I did not address this directly in class. I posted reputable websites for info, but that was the extent of COVID as a topic in my classroom.
(High School Teacher – Survey Response)

At the elementary level, a substantial percentage of teachers indicated that they chose not to address COVID because their students were too young (15 percent) and because the topic was already being addressed by another teacher in the school (11 percent).

We had school-based mask mandates and hygiene policies. Most of the students had been back in person the prior semester as well. Covid precautions were already the norm. And I am teaching 2nd grade for the first time. Finding age-appropriate materials as well as time to teach it within the busy curriculum schedule would have been a large challenge.
(Elementary Teacher – Survey Response)

Table 16
Most Common Reasons Why Teachers Did Not Address COVID[†]

	Percent of Teachers		
	Elementary (N = 53)	Middle (N = 59)	High (N = 96)
Not aligned with curriculum/content	26 (6.1)	34 (6.2)	50 (5.1)
Fear of parent/community pushback	11 (4.4)	20 (5.2)	16 (3.7)
COVID-related instruction fatigue	4 (2.6)	12 (4.2)	16 (3.7)
Lack of instructional time	6 (3.2)	3 (2.4)	8 (2.8)
Lack of personal knowledge about COVID	2 (1.9)	0 --- [‡]	3 (1.8)
Prohibited or discouraged by school or district	6 (3.2)	14 (4.5)	2 (1.5)
Avoid causing student fear/anxiety	4 (2.6)	5 (2.9)	2 (1.5)
COVID information changed too quickly	4 (2.6)	5 (2.9)	2 (1.5)
Behind in other academics	0 --- [‡]	0 --- [‡]	2 (1.5)
Felt it was unnecessary to address the topic	2 (1.9)	8 (3.6)	1 (1.0)
Already being addressed by another teacher	11 (4.4)	5 (2.9)	1 (1.0)
Students were too young	15 (4.9)	0 --- [‡]	0 --- [‡]

[†] Only those who indicated not devoting instructional time to COVID are included in this table.

[‡] No teachers selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

There was some variation in the most common reasons why teachers decided not to address COVID based on FRL quartile and URM quartile.

Examining the most common reasons why teachers did not teach about COVID by equity factors revealed some significant differences (see Table 17). Teachers in high-FRL and high-URM schools were less likely than teachers in low-FRL and low-URM schools to decide not to address COVID due to fear of parent/community pushback (FRL: 9 vs. 30 percent; URM: 7 vs. 21 percent).

Table 17
Equity Analysis of the Most Common Reasons Why Teachers Did Not Address COVID[†]

	Percent of Teachers			
	Not aligned with curriculum/content	Fear of parent/community pushback	COVID-related instruction fatigue	Lack of Instructional Time
FRL (N = 142)				
Lowest Quartile	28 (5.7)	30 (5.8)	10 (3.8)	5 (2.8)
Second Quartile	38 (7.7)	20 (6.3)	13 (5.2)	3 (2.5)
Third Quartile	50 (9.4)	7 (4.9)	18 (7.2)	11 (5.8)
Highest Quartile	39 (8.5)	9 (5.0)	3 (3.0)	6 (4.2)
URM (N = 200)				
Lowest Quartile	39 (6.4)	21 (5.4)	7 (3.4)	7 (3.4)
Second Quartile	31 (6.5)	22 (5.8)	14 (4.8)	2 (1.9)
Third Quartile	47 (7.1)	12 (4.7)	16 (5.3)	6 (3.4)
Highest Quartile	44 (7.6)	7 (3.9)	9 (4.4)	9 (4.4)
Community Type (N = 208)				
Urban	37 (6.3)	12 (4.2)	17 (4.9)	8 (3.6)
Suburban	42 (4.6)	19 (3.7)	9 (2.7)	4 (1.9)
Rural	36 (8.0)	14 (5.8)	11 (5.2)	8 (4.6)
Political Leaning (N = 208)				
Democratic Presidential Candidate	43 (4.4)	12 (2.9)	13 (3.0)	9 (2.5)
Republican Presidential Candidate	34 (5.2)	22 (4.6)	10 (3.3)	2 (1.7)

The majority of teachers agreed that they could find ways to teach about COVID if they wanted to and that they were confident in their ability to teach about COVID. Teachers also agreed that they had control over when and how to teach about COVID and whether to address the topic at all.

The survey included items intended to measure the extent to which various factors influenced teachers' decisions to address COVID in their instruction.⁷ Across grade bands, nearly 80 percent or more of teachers agreed that they could find ways to teach about COVID if they wanted to and that they were confident in their ability to teach about COVID (see Table 18). Similar percentages of teachers agreed that they had control over when and how to teach about COVID and whether to teach about it. At the high school level, 68 percent of teachers agreed that the topic of COVID is well-aligned with the content standards they are required to teach, compared to 57 percent of middle grades teachers and 38 percent of elementary teachers. Conversely, few teachers agreed that they were expected to teach about COVID (12–17 percent) or that they felt social pressure to teach about COVID (13–15 percent).

⁷ These items are aligned with the Theory of Planned Behavior. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211.

Table 18
Teachers Agreeing[†] With Statements About Their COVID Instruction

	Percent of Teachers		
	Elementary (N = 180)	Middle (N = 323)	High (N = 523)
I could currently find ways to teach about COVID if I wanted to.	88 (2.4)	96 (1.1)	95 (0.9)
I am confident in my ability to successfully teach about COVID.	79 (3.0)	89 (1.8)	91 (1.2)
I am able to choose when and how to teach about COVID.	74 (3.3)	79 (2.3)	89 (1.3)
It is up to me whether or not to teach about COVID.	77 (3.2)	79 (2.3)	88 (1.4)
I have adequate access to supports/resources/materials for teaching about COVID.	57 (3.7)	76 (2.4)	81 (1.7)
The topic of COVID is well aligned to the content standards I am required to teach.	38 (3.6)	57 (2.8)	68 (2.0)
I have sufficient time to plan/prepare for teaching about COVID.	30 (3.4)	44 (2.8)	47 (2.2)
People who are important to me in my profession (e.g., other teachers, principals) think I should teach about COVID.	24 (3.2)	25 (2.5)	36 (2.1)
People who are important to me in my profession (e.g., other teachers, principals) have asked if I am teaching or planning to teach about COVID.	15 (2.7)	21 (2.3)	24 (1.9)
People who are important to me in my profession (e.g., other teachers, principals) do not think it's a good idea to teach about COVID.	29 (3.4)	23 (2.4)	21 (1.8)
It is difficult for me to teach about COVID.	38 (3.6)	25 (2.4)	19 (1.7)
Other people get to decide whether or not I teach about COVID.	33 (3.5)	29 (2.6)	18 (1.7)
It is expected that I teach about COVID.	12 (2.4)	15 (2.0)	17 (1.7)
I feel social pressure to teach about COVID.	13 (2.5)	13 (1.9)	15 (1.6)
The decision about whether or not to teach about COVID is beyond my control.	32 (3.5)	22 (2.3)	14 (1.5)

[†] Includes those who indicate “slightly agree,” “agree,” or “strongly agree” on a six-point scale ranging from “strongly disagree” to “strongly agree.”

Teachers’ decisions to teach about COVID were largely influenced by their perceptions of control over teaching about COVID and feelings of self-efficacy.

The items in Table 18 were combined into three composite variables:⁸

Control Beliefs

- It is up to me whether or not to teach about COVID.
- The decision about whether or not to teach about COVID is beyond my control.
- I am able to choose when and how to teach about COVID.
- Other people get to decide whether or not I teach about COVID.

⁸ These composite definitions are aligned with the Theory of Planned Behavior. Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211.

Approval Beliefs

- It is expected that I teach about COVID.
- I feel social pressure to teach about COVID.
- People who are important to me in my profession (e.g., other teachers, principals) have asked if I am teaching or planning to teach about COVID.
- People who are important to me in my profession (e.g., other teachers, principals) think I should teach about COVID.
- People who are important to me in my profession (e.g., other teachers, principals) do not think it's a good idea to teach about COVID.

Self-Efficacy Beliefs

- I am confident in my ability to successfully teach about COVID.
- I could currently find ways to teach about COVID if I wanted to.
- The topic of COVID is well aligned to the content standards I am required to teach.
- It is difficult for me to teach about COVID.
- I have adequate access to supports/resources/materials for teaching about COVID.
- I have sufficient time to plan/prepare for teaching about COVID.

Teachers' perceptions of the presence of factors that may facilitate or hinder their teaching about COVID constitute control beliefs. For example, if a teacher does not have sufficient time to plan/prepare for teaching about COVID or adequate access to resources for teaching about COVID, the teacher may have low control beliefs. Approval beliefs are what teachers believe influential others will think about them if they exhibit the behavior. For example, a teacher in a school or district where administrators are supportive of addressing COVID would likely have high approval beliefs. Self-Efficacy Beliefs encompass teachers' confidence in teaching about COVID. For instance, if a teacher thinks it will be difficult to teach about COVID, the teacher may have low self-efficacy beliefs.

As can be seen in Table 19, control beliefs (composite means ranging from 65 to 77) and self-efficacy beliefs (composite means ranging from 55 to 69) had a substantial influence on whether teachers taught about COVID, although both factors were more influential at the high school level than the middle or elementary levels. Conversely, approval beliefs had only minimal influence on teacher decision making at any grade band.

Table 19
Teacher Beliefs Influencing COVID Instruction Composites

	Mean Score		
	Control Beliefs	Approval Beliefs	Self-Efficacy Beliefs
Elementary (N = 180)	65 (1.8)	23 (1.4)	55 (1.5)
Middle (N = 323)	70 (1.3)	24 (1.1)	65 (1.0)
High (N = 523)	77 (0.9)	27 (0.9)	69 (0.8)

Our curriculum director sent me an email . . . “Why are you teaching this material? Because that’s not part of your standards.” 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.”

(Middle School Teacher – Interview Response)

I always talked about COVID, always. I am an AP Biology teacher. I teach them about viruses. . . . I teach them science. I teach them that science changes as new data comes in.

(High School Teacher – Interview Response)

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 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.

(High School Teacher – Interview Response)

Teacher beliefs that influenced their COVID instruction varied by FRL quartile and political leaning.

Beliefs influencing teachers’ decisions to teach about COVID were also examined by equity factors (see Table 20). Control beliefs (mean scores of 73 vs. 67), approval beliefs (mean scores of 29 vs. 24), and self-efficacy beliefs (mean scores of 67 vs. 62) had a greater influence on the instructional decisions made by teachers in high-poverty schools than those in low-poverty schools. Two differences were noted when looking at these data by community type and political leaning, although the magnitude of these differences is small. Urban teachers were more likely than suburban or rural teachers to teach about COVID based on approval beliefs (mean scores of 28, 25, and 23, respectively) and self-efficacy beliefs (mean scores of 67, 64, and 64, respectively). Additionally, approval beliefs (mean scores of 27 vs. 24) and self-efficacy beliefs (mean scores of 66 vs. 63) were more likely to impact the decisions of teachers in Democratic-learning counties than teachers in Republican-learning counties.

Table 20
Equity Analysis of the Teacher Beliefs Influencing COVID Instruction Composites

	Mean Score		
	Control Beliefs	Approval Beliefs	Self-Efficacy Beliefs
FRL (N = 802)			
Lowest Quartile	67 (1.7)	24 (1.4)	62 (1.3)
Second Quartile	71 (1.6)	23 (1.3)	62 (1.3)
Third Quartile	74 (1.5)	25 (1.4)	66 (1.3)
Highest Quartile	73 (1.6)	29 (1.4)	67 (1.3)
URM (N = 988)			
Lowest Quartile	72 (1.4)	25 (1.3)	64 (1.2)
Second Quartile	73 (1.5)	25 (1.2)	66 (1.2)
Third Quartile	73 (1.4)	26 (1.3)	65 (1.2)
Highest Quartile	73 (1.4)	27 (1.3)	66 (1.2)
Community Type (N = 1026)			
Urban	75 (1.1)	28 (1.1)	67 (1.0)
Suburban	71 (1.0)	25 (0.9)	64 (0.8)
Rural	73 (1.6)	23 (1.3)	64 (1.4)
Political Leaning (N = 1026)			
Democratic Presidential Candidate	74 (0.9)	27 (0.8)	66 (0.8)
Republican Presidential Candidate	71 (1.2)	24 (0.9)	63 (0.9)

Burdens on Teachers

Another focus of the survey was on the burdens placed on teachers due to the pandemic and how teachers were supported in navigating those burdens. Teachers were asked about how much time they spent working, various feelings that might have arisen, and challenges and unexpected benefits they encountered while teaching during the pandemic. Teachers also provided information on the types of supports they were provided. This section frequently refers to the “height of the pandemic,” which we define as the 2020–21 school year. Some tables in this section also include responses from former teachers (i.e., those who left teaching after the 2019–20 school year).

Teachers across grade levels spent a substantial amount of time on instructional and non-instructional activities during the pandemic.

To understand how teachers spent their time, both prior to and during the pandemic, they were asked to estimate how many hours they spent per week on (1) science instructional activities (e.g., preparing and teaching science lessons, managing materials, grading) and (2) non-instructional tasks (e.g., writing and answering emails; troubleshooting technology; talking with students, parents, and other teachers). As can be seen in Table 21, about 40 percent of elementary teachers reported spending 10 hours or fewer on science instructional activities across all time periods. In contrast, secondary teachers spent considerably more time teaching science than elementary teachers at each timepoint, and that amount was noticeably increased at the height of the pandemic.

Table 21
Amount of Time Per Week Spent on Science Instructional Activities

	Percent of Teachers		
	Prior to the pandemic	2020–21 School Year	2021–22 School Year
Elementary (N = 180)			
< 10 hours	44 (3.7)	38 (3.7)	44 (3.7)
11-20 hours	21 (3.1)	25 (3.3)	24 (3.2)
21-30 hours	15 (2.7)	15 (2.7)	8 (2.1)
31-40 hours	9 (2.2)	9 (2.1)	9 (2.1)
41-50 hours	6 (1.8)	6 (1.8)	9 (2.2)
51-60 hours	4 (1.5)	4 (1.5)	3 (1.2)
>60 hours	1 (0.6)	3 (1.4)	3 (1.2)
Middle (N = 323)			
< 10 hours	19 (2.2)	8 (1.5)	11 (1.8)
11-20 hours	26 (2.4)	20 (2.2)	26 (2.4)
21-30 hours	13 (1.9)	24 (2.4)	19 (2.2)
31-40 hours	16 (2.1)	15 (2.0)	15 (2.0)
41-50 hours	17 (2.1)	15 (2.0)	16 (2.0)
51-60 hours	5 (1.3)	7 (1.4)	9 (1.6)
>60 hours	3 (0.9)	10 (1.7)	5 (1.2)
High (N = 523)			
< 10 hours	15 (1.6)	6 (1.1)	9 (1.3)
11-20 hours	27 (1.9)	19 (1.7)	25 (1.9)
21-30 hours	15 (1.6)	24 (1.9)	19 (1.7)
31-40 hours	20 (1.8)	19 (1.7)	19 (1.7)
41-50 hours	15 (1.6)	14 (1.5)	16 (1.6)
51-60 hours	6 (1.0)	9 (1.3)	7 (1.1)
>60 hours	3 (0.8)	8 (1.2)	6 (1.0)

When looking at the amount of time teachers spent on non-instructional tasks, differences among time points are striking. As can be seen in Table 22, prior to the pandemic, about two-thirds of teachers at each grade band spent fewer than 10 hours per week on non-instructional tasks. However, during the 2020–21 school year, only about one-quarter of teachers spent fewer than 10 hours per week on non-instructional tasks. At the other end of the scale, notable percentages of teachers spent more than 30 hours per week on tasks unrelated to their science teaching during the height of the pandemic (Elementary: 12 percent, Middle: 10 percent, High: 7 percent). These percentages rebounded only slightly during the 2021–22 school year.

Table 22
Amount of Time Per Week Spent on Non-Instructional Tasks

	Percent of Teachers		
	Prior to the pandemic	2020–21 School Year	2021–22 School Year
Elementary (N = 180)			
< 10 hours	65 (3.6)	26 (3.3)	39 (3.7)
11-20 hours	28 (3.4)	46 (3.7)	46 (3.7)
21-30 hours	3 (1.3)	16 (2.7)	8 (2.1)
>30 hours	5 (1.6)	12 (2.4)	6 (1.8)
Middle (N = 323)			
< 10 hours	68 (2.6)	23 (2.4)	36 (2.7)
11-20 hours	26 (2.5)	42 (2.8)	48 (2.8)
21-30 hours	3 (1.0)	24 (2.4)	11 (1.8)
>30 hours	2 (0.9)	10 (1.7)	4 (1.1)
High (N = 523)			
< 10 hours	65 (2.1)	24 (1.9)	43 (2.2)
11-20 hours	29 (2.0)	47 (2.2)	41 (2.2)
21-30 hours	4 (.8)	22 (1.8)	11 (1.4)
>30 hours	1 (0.5)	7 (1.1)	5 (0.9)

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 8 or 9 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.

(Middle School Teacher – Interview Response)

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.

(High School Teacher – Interview Response)

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 time commitments where it's like, "Do I devote this time to make sure my Zoom class is ready or do I sanitize? Do I sacrifice instruction for making sure the desks are sanitized?" 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. The students got off the buses, [and we were] making sure they were wearing their mask, checking their temperatures, escorting the ones whose temperatures were too high to the isolation room and getting them checked out.

(High School Teacher – Interview Response)

COVID left teachers feeling exhausted, disconnected from students and colleagues, and overwhelmed by the amount of extra work and technology issues that were required to teach science.

Teachers were shown a list of statements that represented a range of feelings and were asked to identify if and when they experienced each one (prior to the pandemic, during the 2020–21 school year, or during the 2021–22 school year). Table 23 shows teachers' reported feeling at the height of the pandemic, when the burdens placed on teachers were arguably at their greatest. The complete range of feelings experienced by teachers at all three time points can be found in Appendix D.

The most reported feeling among middle and high school teachers was being tired/exhausted from the additional effort that it took to teach science during COVID (83 and 82 percent, respectively). About two-thirds or more teachers at all grade bands also reported feeling disconnected from students and colleagues, overwhelmed by extra work as a result of student absenteeism, and stressed out by problems with technology. On a positive note, about 60 percent of all teachers indicated that they felt certain that they could adapt their science teaching to any circumstance, confident that they are a good science teacher, and enthusiastic about teaching science. In addition, only 10 percent of elementary teachers and about 20 percent of secondary teachers reported having little interest or enjoyment in teaching science during this time.

Table 23
Teachers Indicating Various Feelings During the 2020–21 School Year

	Percent of Teachers		
	Elementary (N = 180)	Middle (N = 323)	High (N = 523)
Tired/exhausted from the additional effort it takes to teach science during COVID	69 (3.5)	83 (2.1)	82 (1.7)
Disconnected/isolated from students	58 (3.7)	66 (2.6)	73 (2.0)
Overwhelmed by extra work as a result of student absenteeism	65 (3.6)	75 (2.4)	72 (2.0)
Disconnected/isolated from colleagues	69 (3.4)	65 (2.7)	68 (2.0)
Stressed out by problems with technology (for example: lack of internet access, reliable device, issues with log in)	71 (3.4)	65 (2.7)	68 (2.0)
Unprepared or under-prepared to support the social emotional needs of my students	51 (3.7)	63 (2.7)	67 (2.1)
Overwhelmed by the amount of time it takes to prepare and deliver science instruction	55 (3.7)	68 (2.6)	64 (2.1)
Certain that I can adapt my science teaching to any circumstances/situations	62 (3.6)	62 (2.7)	64 (2.1)
Anxious about balancing home and work responsibilities	64 (3.6)	68 (2.6)	63 (2.1)
Confident that I am a good science teacher	60 (3.7)	59 (2.7)	62 (2.1)
Concerned that my science teaching is not effective	56 (3.7)	62 (2.7)	61 (2.1)
Nervous, anxious, worried, or on edge about my science teaching	54 (3.7)	62 (2.7)	58 (2.2)
Enthusiastic about science teaching	61 (3.6)	58 (2.7)	57 (2.2)
Dissatisfied with the quality of my science teaching	42 (3.7)	47 (2.8)	44 (2.2)
Confident that my students are learning science	48 (3.7)	44 (2.8)	42 (2.2)
Frustrated by lack of support from my district for science teaching	39 (3.6)	43 (2.8)	42 (2.2)
Frustrated by lack of support from my community for science teaching	21 (3.0)	38 (2.7)	36 (2.1)
Frustrated by the lack of resources/materials for science teaching	46 (3.7)	39 (2.7)	36 (2.1)
Confident in my ability to actively engage students during science instruction	46 (3.7)	41 (2.7)	35 (2.1)
Overwhelmed by extra work as a result of covering classes/duties for teachers who are absent	42 (3.7)	40 (2.7)	35 (2.1)
Frustrated by lack of support from my school for science teaching	36 (3.6)	34 (2.6)	34 (2.1)
Optimistic that my school/district is headed in a positive direction	33 (3.5)	31 (2.6)	30 (2.0)
Unsure how to teach science given the school climate/context	28 (3.3)	29 (2.5)	27 (1.9)
Concerned that I am unprepared or under-prepared to teach science	38 (3.6)	29 (2.5)	22 (1.8)
Scrutinized about my ability to teach real world science and how it impacts student life	19 (2.9)	20 (2.2)	19 (1.7)
Little interest or enjoyment in teaching science	10 (2.2)	20 (2.2)	19 (1.7)

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.

(Elementary School Teacher – Interview Response)

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 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.

(Middle School Teacher – Interview Response)

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 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.

(Middle School Teacher – Interview Response)

I was not being prepared for the 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 lives. 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.

(High School Teacher – Interview Response)

The height of the pandemic saw a dip in teachers' positive feelings toward teaching science. Negative feelings, including being overwhelmed by additional burdens and frustrated by lack of support, greatly increased and have not yet returned to pre-pandemic levels.

Subsets of items in Table 23 were combined into four composite variables: (1) Positive Feelings About Teaching Science, (2) Overwhelmed by Additional Burdens due to COVID, (3) Frustrated by Lack of Support, and (4) Negative Feelings About Teaching Science. As can be seen in Table 24, composite means on the Positive Feelings About Teaching Science composite were quite high prior to the pandemic (ranging from 81 to 88) while scores on the other three composites were fairly low (ranging from 11 to 23). At the height of the pandemic, teachers' positive feelings decreased (composite means of about 60), while scores on the other composites sharply increased. For example, in the 2020–21 school year, teachers' feelings of being frustrated by lack of support rose to over 40 points at all grade bands. The 2021–22 school year saw mean scores on these composites begin to return to pre-pandemic levels, but the toll of COVID remains evident in their responses.

Table 24
Teachers' Feelings Composites

	Mean Score		
	Prior to the pandemic	2020–21 School Year	2021–22 School Year
Elementary (N = 180)			
Positive Feelings About Teaching Science	81 (2.0)	61 (2.4)	77 (2.1)
Overwhelmed by Additional Burdens due to COVID	17 (1.7)	61 (2.3)	54 (2.4)
Frustrated by Lack of Support	23 (2.1)	41 (2.6)	34 (2.6)
Negative Feelings About Teaching Science	11 (1.9)	48 (2.8)	30 (2.5)
Middle (N = 323)			
Positive Feelings About Teaching Science	88 (1.1)	57 (1.7)	71 (1.8)
Overwhelmed by Additional Burdens due to COVID	20 (1.3)	66 (1.7)	63 (1.7)
Frustrated by Lack of Support	23 (1.6)	45 (1.9)	37 (1.8)
Negative Feelings About Teaching Science	11 (1.3)	50 (1.9)	34 (1.9)
High (N = 523)			
Positive Feelings About Teaching Science	87 (0.9)	57 (1.4)	73 (1.3)
Overwhelmed by Additional Burdens due to COVID	19 (1.0)	64 (1.3)	59 (1.4)
Frustrated by Lack of Support	23 (1.3)	43 (1.5)	37 (1.5)
Negative Feelings About Teaching Science	12 (1.0)	46 (1.5)	33 (1.5)

There were some differences in the feelings of teachers from less-resourced schools compared to their more affluent counterparts.

Teachers' feelings composites at the height of the pandemic were analyzed by equity factors, revealing a few differences, as shown in Table 25. Interestingly, teachers in high-FRL schools, high-URM schools, and Democratic-leaning counties had lower scores on the Overwhelmed by Additional Burdens due to COVID composite compared to teachers in low-poverty schools, low-URM schools, and Republican-leaning counties. Additionally, teachers in schools in high-URM school reported feeling more frustrated by the lack of support than those in schools in the low-URM schools.

Table 25
Equity Analysis of the Teachers’ Feelings Composites in the 2020–21 School Year

	Mean Score			
	Negative Feelings About Teaching Science	Positive Feelings About Teaching Science	Overwhelmed by Additional Burdens due to COVID	Frustrated by Lack of Support
FRL (N = 802)				
Lowest Quartile	49 (2.3)	56 (2.2)	68 (2.0)	45 (2.3)
Second Quartile	51 (2.5)	55 (2.2)	65 (2.2)	46 (2.5)
Third Quartile	48 (2.5)	57 (2.2)	64 (2.2)	46 (2.5)
Highest Quartile	46 (2.4)	56 (2.2)	60 (2.3)	48 (2.3)
URM (N = 988)				
Lowest Quartile	50 (2.2)	57 (2.0)	69 (1.8)	41 (2.1)
Second Quartile	47 (2.2)	58 (2.1)	65 (1.9)	41 (2.1)
Third Quartile	47 (2.2)	57 (2.0)	64 (2.0)	46 (2.3)
Highest Quartile	47 (2.2)	57 (2.0)	59 (2.0)	47 (2.1)
Community Type (N = 1026)				
Urban	44 (2.0)	60 (1.8)	60 (1.7)	42 (1.8)
Suburban	50 (1.5)	56 (1.4)	66 (1.3)	46 (1.6)
Rural	46 (2.6)	58 (2.3)	66 (2.3)	40 (2.4)
Political Leaning (N = 1026)				
Democratic Presidential Candidate	48 (1.4)	57 (1.2)	63 (1.2)	44 (1.3)
Republican Presidential Candidate	46 (1.8)	60 (1.6)	67 (1.6)	42 (1.8)

Transitioning to remote/hybrid instruction and the inability to utilize hands-on or group learning were among the biggest challenges science teachers faced during the pandemic.

The survey solicited open-ended descriptions of teachers’ biggest challenges related to science teaching during the pandemic. As shown in Table 26, remote/hybrid instruction, which encompasses the various modes and timing of instruction and the effort involved in switching between those modes, was one of the most common challenges across grade bands (12–14 percent of responses).

We had a hybrid model with most students in person and a few at home joining via Zoom. This was really challenging because I had to figure out a way for kids at home to participate in the same activity as kids in person.

(Elementary Teacher – Survey Response)

Demonstrations and class discussions were very difficult online. . . . A lot of science is based on the ability to observe phenomena and share observations. Even in Zoom breakout rooms, this was difficult, as it took too long to jump from group to group to help facilitate discussions.

(Middle School Teacher – Survey Response)

It was a challenge constantly adapting lessons and curriculum to match time given to a course, or if it's online vs. in-person, synchronous vs. asynchronous.
(High School Teacher – Survey Response)

Inability or limited ability to utilize hands-on learning/group work – mainstays of science instruction that were either found to be unsafe due to increased risk of virus transmission or were logistically impaired by other COVID-related complications – was another common challenge, particularly at the elementary level and among former teachers.

Having to modify all group hands-on activities to individual activities was challenging. As I am an itinerant teacher, the challenge is supplies and set up.
(Elementary Teacher – Survey Response)

During the online phase, we had to send materials home, often driving to their homes, as kits were not picked up by the families. Once we were back in the classroom, we had to limit the number of materials used to avoid the spread of possible viruses.
(Middle School Teacher – Survey Response)

There was extra planning on how to deliver content and carry out labs to reduce exposure during times when COVID infections were high. Some labs had to be cancelled altogether.
(High School Teacher – Survey Response)

About 10 percent of responses from secondary and former teachers also mentioned lack of student engagement or behavioral issues arising from students being socially and emotionally behind as a challenge. However, this was a less common challenge at the elementary level (5 percent of responses).

Students returning from remote learning had lost socialization skills that allowed them to work in groups. They are unusually distractible and volatile, with little control over emotional and physical reactions.
(Middle School Teacher – Survey Response)

They came back to the classroom resistant to exerting maximum effort during classroom activities. I dealt with more than one student who refused to try to do the activities in our classroom.

(High School Teacher – Survey Response)

Table 26
Biggest Challenges Teachers Faced Related to Teaching Science During the COVID Pandemic

	Percent of Responses			
	Former Teachers (N = 159)	Elementary (N = 479)	Middle (N = 898)	High (N = 1449)
Remote/hybrid instruction	13 (2.7)	12 (1.5)	13 (1.1)	14 (0.9)
Inability or limited ability to use hands-on learning/group work	28 (3.6)	33 (2.1)	18 (1.3)	13 (0.9)
Lack of student engagement/attention	11 (2.5)	5 (1.0)	10 (1.0)	11 (0.8)
Misinformation/mistrust of science	5 (1.7)	6 (1.1)	9 (0.9)	11 (0.8)
Student absences	6 (1.9)	8 (1.2)	10 (1.0)	10 (0.8)
Student behavior and underdeveloped social skills	4 (1.6)	5 (1.0)	9 (1.0)	9 (0.7)
Sanitation & prevention policies	6 (1.8)	7 (1.2)	6 (0.8)	7 (0.7)
Students academically behind	2 (1.1)	6 (1.1)	4 (0.7)	6 (0.6)
Issues with parents and administration	4 (1.6)	9 (1.3)	6 (0.8)	5 (0.6)
Teacher’s personal circumstances	1 (0.9)	1 (0.4)	4 (0.7)	4 (0.5)
Assessing and holding students accountable	5 (1.7)	1 (0.4)	2 (0.5)	4 (0.5)
Backlash/controversy	1 (0.6)	3 (0.7)	4 (0.6)	3 (0.4)
Technological difficulties/access	9 (2.3)	1 (0.5)	3 (0.6)	3 (0.4)
Limited opportunities for relationship/community-building	3 (1.2)	0 ---†	2 (0.4)	2 (0.3)

† No teachers selected this response option. Thus, it is not possible to calculate the standard error of this estimate.

The pandemic brought about a variety of unanticipated benefits. Teachers reported that they adapted to new technologies and learned new skills as a result of the rapid shift to online learning. Teachers also discovered and created new materials or resources that could be used in various instructional arrangements.

Teachers were also presented with an open-ended item that asked them to list unanticipated benefits they experienced related to teaching science during the COVID pandemic. As can be seen in Table 27, increased technology skills and access (12–19 percent of responses) and the opportunity to discover and create new materials/resources (9–15 percent of responses) were the two most common benefits, though elementary teachers were less likely than secondary teachers to cite the former, and middle school teachers were less likely than elementary or high school teachers to cite the latter. Notably, both types of benefits involve teachers incorporating teaching modalities and resources in ways that they had not before the pandemic.

I’m better at using Google Classroom, Mystery Science, and other online tools.

(Elementary Teacher – Survey Response)

Prior to the pandemic, I really did not rely on technology and used it sparingly in my classroom. As a result, I have been forced to rely on and embrace technology in all of my lessons. It has brought my teaching into the 21st century!

(Middle School Teacher – Survey Response)

I made video recordings of lessons, which now allow students to learn at their own pace and frees up class time for other activities.

(High School Teacher – Survey Response)

Increased student interest/literacy in science was also mentioned as a benefit of the pandemic (5–10 percent of responses). Additionally, teachers pointed to other benefits for students (4–10 percent of responses), which includes such things as increased individualized instruction and attention from teachers and families.

Because there were less kids inside the classroom at times, there was more on-on-one time to work with students.

(Elementary Teacher – Survey Response)

Breakout rooms were a GREAT way to give personalized attention.

(Middle School Teacher – Survey Response)

Those students who are taking advantage of everything we offer are receiving a better education than pre-pandemic.

(High School Teacher – Survey Response)

I assigned some labs to be done at home. . . . I had parents tell me that the whole family got involved with the labs, opening their eyes and minds to learning science.

(Former Teacher – Survey Response)

Table 27
Unanticipated Benefits Teachers Noticed
Related to Teaching Science During the COVID Pandemic

	Percent of Responses			
	Former Teachers (N = 115)	Elementary (N = 304)	Middle (N = 615)	High (N = 991)
Increased technology skills and access	17 (3.5)	12 (1.9)	19 (1.6)	17 (1.2)
Discovered or created new materials/ resources	11 (3.0)	14 (2.0)	9 (1.2)	15 (1.1)
Increased student interest/literacy in science	5 (2.1)	10 (1.7)	10 (1.2)	9 (0.9)
Well-aligned with curriculum/content	3 (1.7)	3 (1.0)	7 (1.0)	8 (0.8)
More aware of importance of SEL and mental health	6 (2.2)	5 (1.2)	6 (0.9)	7 (0.8)
Interactions/meetings no longer constrained by physical location	3 (1.5)	4 (1.1)	5 (0.9)	7 (0.8)
Reexamined/reflected on pedagogy	3 (1.5)	6 (1.3)	7 (1.0)	6 (0.8)
Built new relationships and communities	6 (2.2)	7 (1.4)	8 (1.1)	5 (0.7)
Improvements to school/ district policies	6 (2.2)	5 (1.2)	7 (1.0)	5 (0.7)
Personal/family life benefits	10 (2.9)	3 (1.0)	4 (0.8)	5 (0.7)
Benefits for students	10 (2.9)	9 (1.6)	5 (0.9)	4 (0.6)
Logistical benefits	3 (1.5)	1 (0.5)	3 (0.7)	4 (0.6)
Improved cleanliness/health	3 (1.7)	9 (1.6)	4 (0.8)	3 (0.5)
Opportunity for choice and creativity in teaching	5 (2.1)	3 (0.9)	2 (0.6)	3 (0.5)

A majority of teachers reported having access to mental health services in their schools during the pandemic, but only about 1 in 3 teachers actually received mental health support.

The survey asked teachers (1) if they had access to mental health professionals in their school (e.g., school counselors or social workers) during the pandemic and (2) if they received support from these individuals. As seen in Table 28, the majority of elementary, middle, and high school teachers had access to mental health professionals. However, only about one-third reported receiving support. Looking specifically at former teachers, roughly two-thirds reported having access to support from mental health professionals during the pandemic and only one-quarter received support.

Table 28
Teachers Who Had Support[†] During the COVID Pandemic

	Percent of Teachers	
	Had Access to Support	Received Support
Elementary (N = 180)	74 (3.3)	37 (3.6)
Middle (N = 323)	76 (2.4)	36 (2.7)
High (N = 523)	74 (1.9)	33 (2.1)
Former teachers (N = 55)	64 (6.5)	24 (5.7)

[†] Support refers to school counselors, school social workers, and/or other school mental health professionals.

Access to and receipt of support was generally equitable.

Teachers’ access to and receipt of support from mental health professionals was also analyzed by equity factors (see Table 29). Only one difference was noted. Teachers in Democratic-leaning counties were more likely than teachers in Republican-leaning counties to have access to support, though teachers received support at similar rates regardless of political leaning of the county.

Table 29
Equity Analysis of Current Teachers Who Had Support[†] During the COVID Pandemic

	Percent of Teachers	
	Had Access to Support	Received Support
FRL (N = 802)		
Lowest Quartile	83 (2.7)	36 (3.4)
Second Quartile	68 (3.3)	30 (3.2)
Third Quartile	75 (3.1)	33 (3.3)
Highest Quartile	78 (3.0)	41 (3.5)
URM (N = 988)		
Lowest Quartile	74 (2.8)	35 (3.1)
Second Quartile	70 (2.9)	32 (3.0)
Third Quartile	79 (2.6)	33 (3.0)
Highest Quartile	76 (2.7)	37 (3.1)
Community Type (N = 1026)		
Urban	76 (2.4)	38 (2.7)
Suburban	75 (1.9)	33 (2.1)
Rural	72 (3.2)	31 (3.3)
Political Leaning (N = 1026)		
Democratic Presidential Candidate	77 (1.7)	35 (1.9)
Republican Presidential Candidate	71 (2.3)	33 (2.4)

[†] Support refers to school counselors, school social workers, and/or other school mental health professionals.

When teachers received support, it was most often focused on helping connect students to mental health services or resources. Teachers also received support for their own mental health.

Teachers who indicated that they received support were asked about the nature of that support. Table 30 reports the percentage of teachers who received each type of support to a substantial extent (i.e., rated “Moderate” or “To a great extent” on a four-point scale ranging from “Not at All” to “To a great extent”). About three-quarters of teachers at each grade band received assistance with the process of referring students to the school counselor/social worker/mental health professional for additional social-emotional services. More than 60 percent of teachers were provided with resources for supporting the mental health of students and their families. Additionally, teachers received support for their own mental health, including personal check-ins (46–49 percent) and access to resources (36–46 percent).

Table 30
Types of Supports Teachers Received
to a Substantial[†] Extent During the COVID Pandemic

	Percent of Teachers [‡]		
	Elementary (N = 64)	Middle (N = 117)	High (N = 169)
Explained how to refer a student to the school counselor/social worker/mental health professional for additional social-emotional services or support	72 (5.6)	79 (3.7)	80 (3.1)
Provided resources for the mental health of students and their families	64 (6.0)	61 (4.5)	73 (3.4)
Provided information about how to work with students who are experiencing grief or trauma	42 (6.2)	51 (4.6)	57 (3.8)
Followed up with students who are absent due to COVID (e.g., recovering from COVID, quarantining, caring for a family member)	44 (6.2)	56 (4.6)	50 (3.9)
Checked in with teachers on a regular basis about their own social-emotional well-being	49 (6.3)	48 (4.6)	46 (3.8)
Provided resources for teachers' own mental health	41 (6.1)	36 (4.4)	46 (3.8)
Assisted with classroom management	24 (5.4)	13 (3.1)	18 (2.9)

[†] Includes those who indicated “Moderate” or “To a great extent” on a four-point scale ranging from “Not at All” to “To a great extent.”

[‡] Includes only those teachers who indicated receiving support.

Teacher Retention in the Profession

The survey asked teachers to reflect on the extent to which they had considered leaving the profession since the onset of the pandemic. Additionally, teachers were asked about factors that both influenced their thinking about leaving and their decision to stay. These data are discussed in this section of the report.

The vast majority of teachers have stayed in the profession due to enjoyment in working with students and their passion for teaching/content.

Teachers who have persisted in the profession were asked why they have stayed (see Table 31). Over 90 percent of teachers across grade bands cited enjoyment in working with students and passion for teaching/content as reasons for staying. Income/job security was also mentioned by 68–75 percent of teachers as a reason why they have stayed.

Table 31
Reasons Rated to a Substantial[†] Extent Why Teachers Have Stayed in the Profession

	Percent of Teachers		
	Elementary (N = 180)	Middle (N = 323)	High (N = 523)
Enjoyment in working with students	95 (1.6)	92 (1.5)	95 (1.0)
Passion for teaching/content	94 (1.7)	92 (1.5)	93 (1.1)
Income/job security	68 (3.5)	73 (2.5)	75 (1.9)
Amount of time invested and/or being close to retirement	67 (3.5)	62 (2.7)	56 (2.2)
Optimism that teaching conditions will get better	46 (3.7)	43 (2.8)	40 (2.1)

[†] Includes those who indicated “Moderate” or “To a great extent” on a four-point scale ranging from “Not at All” to “To a Great Extent.”

Reasons teachers have stayed in the profession are generally consistent across equity factors.

Reasons why teachers have stayed in the profession were analyzed by equity factors (see Table 32). A few differences were noted. Teachers in high-FRL, high-URM, urban, and rural schools were more likely than teachers in low-FRL, low-URM, and suburban schools to stay in the profession due to optimism that teaching conditions will get better (FRL: 50 vs. 34 percent; URM: 51 vs. 40 percent; Urban: 50 percent, Rural: 44 percent, and Suburban: 36 percent).

Table 32
Equity Analysis of Reasons Why Teachers Have Stayed in the Profession

	Percent of Teachers				
	Enjoyment in working with students	Passion for teaching/content	Income/job security	Amount of time invested and/or being close to retirement	Optimism that teaching conditions will get better
FRL (N = 802)					
Lowest Quartile	91 (2.0)	94 (1.7)	81 (2.8)	65 (3.4)	34 (3.4)
Second Quartile	92 (1.9)	93 (1.9)	73 (3.1)	61 (3.5)	37 (3.4)
Third Quartile	92 (1.9)	94 (1.7)	71 (3.2)	61 (3.5)	42 (3.5)
Highest Quartile	91 (2.0)	93 (1.8)	77 (3.0)	61 (3.5)	50 (3.6)
URM (N = 988)					
Lowest Quartile	94 (1.5)	96 (1.2)	76 (2.8)	61 (3.1)	40 (3.1)
Second Quartile	93 (1.6)	94 (1.5)	72 (2.9)	55 (3.2)	38 (3.1)
Third Quartile	91 (1.8)	94 (1.5)	72 (2.9)	61 (3.1)	37 (3.1)
Highest Quartile	91 (1.8)	91 (1.8)	75 (2.8)	65 (3.0)	51 (3.2)
Community Type (N = 1026)					
Urban	93 (1.4)	93 (1.4)	74 (2.5)	63 (2.7)	50 (2.8)
Suburban	93 (1.2)	95 (1.0)	74 (1.9)	58 (2.2)	36 (2.1)
Rural	93 (1.9)	94 (1.7)	70 (3.3)	60 (3.5)	44 (3.6)
Political Leaning (N = 1026)					
Democratic Presidential Candidate	93 (1.0)	94 (1.0)	75 (1.7)	59 (1.9)	43 (2.0)
Republican Presidential Candidate	92 (1.4)	94 (1.2)	71 (2.4)	62 (2.5)	40 (2.5)

Since the onset of the pandemic, the extent to which teachers have considered leaving the profession has drastically increased. However, there were no differences by equity factors.

As can be seen in Table 33, the extent to which teachers have considered leaving the profession has drastically increased since the onset of the pandemic. In fact, 1 in 5 teachers in each grade band considered leaving the profession to a great extent at the height of the pandemic. These percentages increased to nearly 1 in 3 during the 2021–22 school year. However, as can be seen in Table 34, there were no significant differences by equity factors.

Table 33
Extent to Which Teachers Have Considered Leaving the Profession

	Percent of Teachers		
	Prior to the Pandemic	2020–21 School Year	2021–22 School Year
Elementary (N = 180)			
Not at all	55 (3.7)	27 (3.3)	26 (3.3)
Minimal	28 (3.4)	25 (3.3)	22 (3.1)
Moderate	11 (2.4)	29 (3.4)	23 (3.2)
To a great extent	6 (1.7)	19 (2.9)	29 (3.4)
Middle (N = 323)			
Not at all	54 (2.8)	19 (2.2)	16 (2.1)
Minimal	32 (2.6)	30 (2.6)	21 (2.3)
Moderate	11 (1.7)	30 (2.6)	27 (2.5)
To a great extent	3 (1.0)	20 (2.2)	36 (2.7)
High (N = 523)			
Not at all	57 (2.2)	29 (2.0)	30 (2.0)
Minimal	29 (2.0)	27 (2.0)	16 (1.6)
Moderate	9 (1.2)	26 (1.9)	25 (1.9)
To a great extent	5 (1.0)	18 (1.7)	30 (2.0)

Table 34
Equity Analysis of Teachers Who Have Substantially[†] Considered Leaving the Profession

	Percent of Teachers		
	Prior to the Pandemic	2020–21 School Year	2021–22 School Year
FRL (N = 802)			
Lowest Quartile	19 (2.7)	51 (3.5)	62 (3.4)
Second Quartile	12 (2.3)	47 (3.5)	60 (3.5)
Third Quartile	14 (2.5)	50 (3.5)	59 (3.5)
Highest Quartile	17 (2.7)	45 (3.6)	55 (3.6)
URM (N = 988)			
Lowest Quartile	12 (2.1)	52 (3.2)	55 (3.2)
Second Quartile	13 (2.2)	44 (3.2)	56 (3.2)
Third Quartile	16 (2.4)	45 (3.2)	62 (3.1)
Highest Quartile	17 (2.4)	47 (3.2)	56 (3.2)
Community Type (N = 1026)			
Urban	13 (1.9)	43 (2.8)	53 (2.8)
Suburban	14 (1.5)	49 (2.2)	59 (2.2)
Rural	17 (2.7)	48 (3.6)	56 (3.6)
Political Leaning (N = 1026)			
Democratic Presidential Candidate	14 (1.3)	47 (2.0)	57 (2.0)
Republican Presidential Candidate	16 (1.9)	46 (2.6)	56 (2.6)

[†] Includes those who indicated “Moderate” or “To a great extent” on a four-point scale ranging from “Not at All” to “To a Great Extent.”

Half of science teachers reported being at least somewhat likely to leave the profession within the next two years.

As can be seen in Table 35, about half of teachers at all grade bands reported that they are at least somewhat likely to leave teaching within the next two years. There are no significant differences among grade bands.

Table 35
Likelihood of Leaving Teaching in the Next Two Years

	Percent of Teachers		
	Elementary (N = 180)	Middle (N = 323)	High (N = 523)
Not at all likely	55 (3.7)	50 (2.8)	54 (2.2)
Somewhat likely	33 (3.5)	32 (2.6)	29 (2.0)
Very likely	3 (1.4)	7 (1.5)	7 (1.1)
Extremely likely	9 (2.1)	11 (1.7)	9 (1.3)

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.
(Elementary Teacher – Interview Response)

The stress of teaching, demands of teaching on their time, and student behavior are among the most common factors contributing to teachers leaving or considering leaving the profession.

Teachers that left or considered leaving the profession were asked what factors had influenced or were influencing their decision. As can be seen in Table 36, approximately 75 percent of current teachers across grade bands indicated that the stress of teaching factored into their thinking about leaving the profession. This sentiment was echoed by former teachers, 60 percent of whom left teaching due to stress. The demands of teaching on their time (56–67 percent) was another common reason why teachers either left or considered leaving the profession. Over two-thirds of current teachers also pointed to student behavior as a reason why they were considering leaving the profession. However, only about one-quarter of former teachers indicated that student behavior was a factor in their decision to leave. Other common reasons for leaving or considering leaving the profession included dissatisfaction with the way things are run at school, insufficient pay, and inadequate support from the school or district.

Table 36
Reasons Why Teachers Left or are Considering Leaving Teaching

	Percent of Teachers [†]			
	Former Teachers (N = 55)	Elementary (N = 145)	Middle (N = 287)	High (N = 406)
The stress of teaching	60 (6.6)	79 (3.4)	77 (2.5)	76 (2.1)
Demands of teaching on your time	56 (6.7)	64 (4.0)	66 (2.8)	67 (2.3)
Student behavior	27 (6.0)	66 (3.9)	74 (2.6)	64 (2.4)
Dissatisfaction with the way things are run at your school	42 (6.7)	42 (4.1)	54 (2.9)	52 (2.5)
Insufficient pay	25 (5.9)	60 (4.1)	45 (2.9)	50 (2.5)
Inadequate support from your school or district	53 (6.7)	45 (4.1)	46 (2.9)	44 (2.5)
Challenges of in-person instruction	33 (6.3)	42 (4.1)	40 (2.9)	39 (2.4)
Inadequate support or involvement from parents/guardians	29 (6.1)	48 (4.1)	46 (2.9)	38 (2.4)
Challenges of remote/hybrid instruction	47 (6.7)	40 (4.1)	30 (2.7)	33 (2.3)
Interest in transitioning to a job that is not education related	11 (4.2)	25 (3.6)	24 (2.5)	30 (2.3)
Interest in transitioning to a different education related job (e.g., school administration, tutoring)	22 (5.6)	15 (3.0)	15 (2.1)	22 (2.0)
Lack of support for science instruction at your school	24 (5.7)	21 (3.4)	18 (2.3)	21 (2.0)
Inadequate safety plans for COVID mitigation at your school or district	33 (6.3)	11 (2.6)	18 (2.3)	19 (1.9)
A health condition that puts you at greater risk for illness under COVID	25 (5.9)	14 (2.9)	13 (2.0)	15 (1.8)
Pressure to teach/not teach certain topics or in certain ways	24 (5.7)	23 (3.5)	13 (2.0)	13 (1.7)
Inadequate instructional materials	25 (5.9)	26 (3.7)	13 (2.0)	11 (1.5)
A loved one who you either live with or see regularly who has a high-risk condition under COVID	13 (4.5)	10 (2.5)	5 (1.3)	9 (1.4)
Childcare responsibilities	5 (3.1)	7 (2.1)	5 (1.3)	9 (1.4)

[†] Includes those who indicated they have considered leaving teaching “Minimally,” “Moderately,” or “To a Great Extent” on a four-point scale ranging from “Not at All” to “To a Great Extent.”

Reasons why teachers considered leaving the teaching profession varied by FRL, URM, and political leaning.

A subset of factors that influenced teachers’ decisions to consider leaving the profession were analyzed by equity factors. As can be seen in Table 37, several differences were apparent. Teachers in high-poverty schools were less likely than teachers in low-poverty schools to consider leaving teaching due to challenges of remote/hybrid instruction (27 vs. 37 percent). However, teachers in high-poverty schools were more likely to consider leaving teaching than teachers in low-poverty schools due to inadequate support or involvement from parents/guardians (47 vs. 37 percent). Teachers in high-URM schools were more likely than teachers in low-URM schools to consider leaving the profession due to challenges of in-person instruction (50 vs. 37 percent). Teachers in Republican-leaning counties were more likely to consider leaving the profession than teachers in Democratic-leaning counties due to student

behavior (75 vs. 63) and inadequate support or involvement from parents/guardians (50 vs. 38 percent).

Table 37
Equity Analysis of Reasons Why Teachers are Considering Leaving Teaching

	Percent of Teachers				
	Student Behavior	Challenges of in-person instruction	Challenges of remote/hybrid instruction	Inadequate support or involvement from parents/guardians	Lack of support for science instruction at your school
FRL (N = 802)					
Lowest Quartile	66 (3.7)	37 (3.7)	37 (3.7)	37 (3.7)	18 (3.0)
Second Quartile	69 (3.6)	42 (3.8)	34 (3.7)	43 (3.8)	21 (3.1)
Third Quartile	81 (3.0)	43 (3.8)	31 (3.6)	50 (3.9)	21 (3.1)
Highest Quartile	68 (3.6)	46 (3.9)	27 (3.4)	47 (3.9)	24 (3.3)
URM (N = 988)					
Lowest Quartile	63 (3.4)	37 (3.4)	36 (3.4)	40 (3.5)	20 (2.8)
Second Quartile	69 (3.2)	31 (3.2)	35 (3.3)	40 (3.4)	11 (2.2)
Third Quartile	73 (3.2)	41 (3.5)	31 (3.3)	50 (3.5)	27 (3.1)
Highest Quartile	68 (3.2)	50 (3.4)	28 (3.1)	41 (3.4)	23 (2.9)
Community Type (N = 1026)					
Urban	64 (3.0)	43 (3.1)	32 (2.9)	40 (3.1)	21 (2.5)
Suburban	69 (2.2)	39 (2.4)	33 (2.3)	42 (2.4)	20 (1.9)
Rural	70 (3.7)	37 (3.9)	35 (3.8)	47 (4.0)	21 (3.3)
Political Leaning (N = 1026)					
Democratic Presidential Candidate	63 (2.1)	41 (2.1)	33 (2.0)	38 (2.1)	20 (1.7)
Republican Presidential Candidate	75 (2.5)	37 (2.8)	33 (2.7)	50 (2.9)	21 (2.3)

About half of teachers who left the profession did so because of reasons related to the COVID pandemic.

Teachers that left the profession were asked when, how, and why they stopped teaching. As can be seen in Table 38, more than half of teachers left the profession at the end of 2020–21 school year, which was the height of the pandemic. Forty percent of teachers resigned, and at least 25 percent either took an early or scheduled retirement. Interestingly, just under half of teachers left mainly because of reasons related to the COVID pandemic.

Table 38
Information About Teachers Who Left the Profession

	Percent of Former Teachers (N = 55)
When Teachers Stopped Teaching	
At the end of the 2019–20 school year	20 (5.4)
During the 2020–21 school year	11 (4.2)
At the end of the 2020–21 school year	51 (6.7)
During the 2021–22 school year	18 (5.2)
How Teachers Stopped Teaching	
Resigned	40 (6.8)
Took early retirement	29 (6.3)
Took scheduled retirement	25 (6.0)
Took an unpaid leave of absence	4 (2.7)
Laid off	2 (1.9)
Why Teachers Stopped Teaching	
Mainly because of reasons related to the COVID pandemic	45 (6.7)
Not mainly because of reasons related to the COVID pandemic	55 (6.7)

SUMMARY

This report details findings from a research study about teachers' decisions and instruction related to COVID, as well as burdens placed on teachers due to the pandemic and their thoughts about staying in the profession. Study data indicate that teachers accessed a variety of media sources to find information about COVID, with large percentages relying on health information websites such as the CDC and NIH. Large proportions of teachers at each grade band devoted class time to COVID. While many teachers addressed COVID during the 2021–22 school year, teachers reported spending less time on the topic than they did in the 2020–21 school year. A majority of teachers addressed COVID as part of their curriculum, increasingly so with increasing grade level. Elementary teachers were more likely to address COVID as a standalone topic compared to their secondary counterparts. Across grade bands, the most commonly addressed topics included ways to prevent transmission, how the virus is transmitted and what coronavirus/COVID-19 is. Teachers relied heavily on units and lessons they created or collected from an online source to address these topics. As the pandemic persisted, teachers increasingly focused on topics related to public health, such as the impacts of social distancing and factors that place people at risk for contracting the virus.

The vast majority of teachers at each grade band indicated that students asked questions about COVID. Students asked questions most often centered around three topics; vaccines/boosters, personal concerns, and how to prevent transmission. Across grade bands, about one-quarter of teachers chose to address COVID in their instruction because it was a relevant/current event. The most common reason why elementary and middle school teachers addressed COVID was to promote public health safety. Conversely, when teachers did not address COVID, the most common reasons were that (1) it was not related to their standards/curriculum/course and (2) they feared pushback from parents/students. Elementary teachers also chose not to address COVID due to the young age of their students. Teachers' decisions about whether or not to teach about COVID were largely influenced by their perceptions of control and feelings of self-efficacy.

Teachers across grade levels spent a substantial amount of time on instructional and non-instructional activities during the pandemic, much more so than the amount of time they spent on similar activities prior to the pandemic. Teachers reported feeling exhausted, disconnected from students and colleagues, and overwhelmed by the amount of extra work and technology issues that were required to teach science during the pandemic. The height of the pandemic saw a dip in teachers' positive feelings toward teaching science. Negative feelings, including being overwhelmed by additional burdens and frustrated by lack of support, greatly increased and have not yet returned to pre-pandemic levels.

Teachers were asked to share their biggest challenges and unanticipated benefits of teaching during COVID. Transitioning to remote/hybrid instruction and the inability to utilize hands-on or group learning were among the biggest challenges science teachers faced during the pandemic.

At the same time, teachers reported that they adapted to new technologies and learned new skills as a result of the rapid shift to online learning. Teachers also discovered and created new materials or resources that could be used in various instructional arrangements.

A majority of teachers reported having access to mental health services in their schools during the pandemic, but many fewer actually received mental health support. When teachers received support, it was most often focused on helping connect students to mental health services or resources. Teachers also received support for their own mental health.

The vast majority of teachers said they have stayed in the profession due to enjoyment in working with students and their passion for teaching/content. However, since the onset of the pandemic, the extent to which teachers have considered leaving the profession has drastically increased. Half of science teachers reported being at least somewhat likely to leave the profession within the next two years. The stress of teaching, demands of teaching on their time, and student behavior were among the most common factors contributing to teachers leaving or considering leaving the profession. About half of teachers who left the profession did so because of reasons related to the COVID pandemic.

The overarching finding in this study is that science teachers played an important but often unacknowledged role as public health educators. They provided accurate information to their students and their communities while at the same time combatting misinformation. They calmed student fears and tended to students' social-emotional well-being more broadly. Teachers rose to the occasion and provided a critical service to the nation, but it took a toll on them. Large proportions report seriously considering leaving the impression, creating the potential for an even greater shortage of science teachers unless their well-being is addressed.

APPENDIX A

SCIENCE TEACHERS AS PUBLIC HEALTH EDUCATORS QUESTIONNAIRE

- 1) Do you teach **multiple subjects to a single class of students** all/most of the day?
 - Yes (typical of elementary teachers who teach in a self-contained classroom)
 - No (typical of teachers who teach in departmentalized or teaming situations)

- 2) **During the 2021-22 school year**, have you addressed COVID in any of your science instruction (for example: class discussion, formal lesson, student presentation, current event coverage)?
 - Yes
 - No

- 3) How does your teaching about COVID this school year (2021-22) compare to your teaching about COVID last school year (2020-21)?
 - I've spent **much less time addressing COVID this school year** than I did last school year.
 - I've spent **slightly less time addressing COVID this school year** than I did last school year.
 - I've spent **about the same amount of time addressing COVID this school year** as I did last school year.
 - I've spent **slightly more time addressing COVID this school year** than I did last school year.
 - I've spent **much more time addressing COVID this school year** than I did last school year.

- 4) K-12 science teachers tend to be responsible for instructional activities and non-instructional tasks. About how many hours did you spend in a typical week on:
 If you began teaching during the pandemic, please select N/A in the "Prior to Pandemic" column.
[Response options: N/A, <10 hours, 11-20, 21-30, 31-40, 40-50, 51-60, >60 hours]

	Prior to the pandemic	Last school year (2020-21)	This school year (2021-22)
a. Science instructional activities (for example: preparing science lessons, teaching science lessons, <u>managing materials</u> , and <u>grading</u>)			
b. Non-instructional tasks (for example: writing/answering emails, troubleshooting technology, talking with students/parents/other teachers)			

- 5) **During the 2021-22 school year**, have you used COVID to address topics that are part of your science curriculum?
 - Yes
 - No

- 6) **During the 2021-22 school year**, have you addressed COVID as a stand-alone topic, unrelated to the rest of your science curriculum (for example: a current event topic outside of the specified curriculum of your classes)?
- Yes
 - No
- 7) **During the 2021-22 school year**, which of the following topics have you covered? *Select all that apply.*
- What COVID is (for example: the difference between the virus and the disease)
Symptoms of COVID
 - How COVID is diagnosed
 - Types and accuracy of COVID tests (for example: antigen/rapid, PCR)
 - How COVID tests work
 - How COVID is treated
 - Common misconceptions about COVID
 - How coronavirus is transmitted among humans
 - Ways to prevent coronavirus transmission (for example: masking, hand washing)
 - Factors that place people at risk for contracting coronavirus (for example: age, immunocompromised)
 - Local/national COVID policies and procedures (for example: mask mandates, quarantining, contact tracing)
 - Access to COVID vaccines (nationally and/or globally)
 - Types of COVID vaccines (mRNA, viral vector) and how they work
 - The process/timeline for developing COVID vaccines
 - Side effects of COVID vaccines
 - Efficacy of COVID vaccines
 - Safety of COVID vaccines
 - COVID vaccine hesitancy
 - COVID immunity
 - How the virus has changed/mutated over time
 - Differences among strains of COVID (for example: Delta, Omicron)
 - Differences between outbreaks, epidemics, pandemics, and endemics
 - How COVID compares to other pandemics (for example: influenza 1918)
 - Social disparities in COVID transmission/treatment/impacts
 - Environmental impacts of COVID supplies (for example: masks, gloves, testing kits)
 - Broader impacts of COVID (for example: impacts on the economy, education, etc.)
 - How to evaluate sources of information about COVID

8) **During the 2021-22 school year**, which of the following have you used in your COVID instruction? *Select all that apply.*

- Commercially published materials (printed or electronic)
- Commercially published kits/modules (printed or electronic)
- State, county, or district-developed units or lessons
- Lessons or resources from websites that have a subscription fee or per lesson cost (for example: BrainPop, ShareMyLesson, Teachers Pay Teachers)
- Lessons or resources from websites that are free (for example: Khan Academy)
- Units or lessons you created (either by yourself or with others)
- Units or lessons you collected from any other source (for example: conferences, journals, colleagues, university, or museum partners)
- None of the above

9) **During the 2021-22 school year**, which of the following sources/materials have you used to teach about COVID? *Select all that apply.*

- [COVID-19! How Can I Protect Myself and Others?](#) from the Smithsonian Science Education Center
- Materials from the [Responding to an Emerging Epidemic through Science Education \(REESE\) project](#)
- [Responding to a Mystery Illness](#) from Amgen Biotech Experience
- [COVID-19 Lesson Plans from NIH](#)
- [Exploring Infectious Diseases](#)
- [National Geographic's Interdisciplinary K-12 Resources](#)
- [CDC's Toolkit for K-12 Schools](#)
- [Discovery Education](#)
- [TedEd](#)
- [Mystery Science](#)
- None of the above

10) **During the 2021-22 school year**, have your students asked questions about COVID?

- Yes
- No

11) Please list up to five (5) questions your students have asked about COVID.

- 1.
- 2.
- 3.
- 4.
- 5.

12) What was the single most important factor that made you decide to address COVID **during the 2021-22 school year**?

13) What was the single most important factor that made you decide **not** to address COVID **during the 2021-22 school year**?

14) **During the 2021-22 school year**, to what extent has each of the following been a **source of information** for you about COVID, *whether for instruction or for your personal use? Select one on each row.*

	Not at All	Minimal	Moderate	To a Great Extent
a. Local news station (for example: NBC4), via radio, TV, or internet	()	()	()	()
b. National broadcast TV news program (for example: NBC Nightly News, CBS Nightly News)	()	()	()	()
c. 24 hour TV news (for example: CNN, MSNBC, FOX, BBC)	()	()	()	()
d. TV talk show (for example: the View, Today Show, Daily Show)	()	()	()	()
e. Radio/internet/podcast program (for example: NPR, TedTalk)	()	()	()	()
f. Online-only sources (for example: Huffington Post, Yahoo News, AOL)	()	()	()	()
g. Newspapers, whether print or online (for example: NY Times, Boston Globe)	()	()	()	()
h. Popular science magazines (for example: Scientific American, Discover)	()	()	()	()
i. Other magazines, whether print or online (for example: Time, New Yorker)	()	()	()	()
j. Centers for Disease Control and Prevention (CDC) website	()	()	()	()
k. Johns Hopkins Coronavirus Resource Center website	()	()	()	()
l. National Institutes of Health (NIH) website	()	()	()	()
m. World Health Organization (WHO) website	()	()	()	()
n. Websites from other health organizations (besides CDC, Johns Hopkins, NIH, and WHO)	()	()	()	()
o. Websites from teacher professional organizations (for example: National Science Teaching Association, National Association of Biology Teachers)	()	()	()	()
p. Social media (for example: Facebook, Instagram, LinkedIn, Twitter)	()	()	()	()
q. Printed publications from federal agencies (for example: the Centers for Disease Control, National Institutes of Health)	()	()	()	()
r. Printed publications from international health organizations (for example: World Health Organization)	()	()	()	()
s. Printed publications from teacher professional organizations (for example: National Science Teaching Association, National Association of	()	()	()	()

Biology Teachers)				
t. Resources provided by your school district	()	()	()	()
u. Conversations with health professionals (for example: nurses, doctors)	()	()	()	()
v. Conversations with other teachers	()	()	()	()
w. Conversations with others (i.e., not health professionals or teachers)	()	()	()	()

15) The COVID pandemic created a number of challenges for science teachers. Please **describe up to three (3) of the biggest challenges related to your science teaching** that you have experienced during the pandemic.

- 1.
- 2.
- 3.

16) Interestingly, some science teachers also experienced a number of unanticipated benefits as a result of the pandemic. If this is true of you, please **describe up to three (3) benefits of the pandemic related to your science teaching** that you have experienced.

- 1.
- 2.
- 3.

17) Please rate the extent to which you disagree/agree with each of the following statements. *Select one on each row.*

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
a. I am confident in my ability to successfully teach about COVID.	()	()	()	()	()	()
b. I could currently find ways to teach about COVID if I wanted to.	()	()	()	()	()	()
c. It is up to me whether or not to teach about COVID.	()	()	()	()	()	()
d. The topic of COVID is well aligned to the content standards I am required to teach.	()	()	()	()	()	()
e. It is expected that I teach about COVID.	()	()	()	()	()	()
f. The decision about whether or not to teach about COVID is beyond my control.	()	()	()	()	()	()
g. It is difficult for me to teach about COVID.	()	()	()	()	()	()
h. I am able to choose when and how to teach about COVID.	()	()	()	()	()	()
i. I feel social pressure to teach about COVID.	()	()	()	()	()	()
j. I have adequate access to	()	()	()	()	()	()

supports/resources/materials for teaching about COVID.						
k. Other people get to decide whether or not I teach about COVID.	()	()	()	()	()	()
l. People who are important to me in my profession (for example: other teachers, principals) have asked if I am teaching or planning to teach about COVID.	()	()	()	()	()	()
m. People who are important to me in my profession (for example: other teachers, principals) think I should teach about COVID.	()	()	()	()	()	()
n. I am confident in my ability to successfully teach about COVID.	()	()	()	()	()	()
o. I could currently find ways to teach about COVID if I wanted to.	()	()	()	()	()	()

18) The following statements represent a range of feelings science teachers may experience. Teachers may have experienced some of these feelings prior to the pandemic. Other feelings may have surfaced last school year (2020-21) or this school year (2021-22). Please indicate which of the following you have personally felt and when. **(Check all that apply in each row. You may have multiple checkmarks in a single row.)**

	Prior to the pandemic	Last school year (2020-21)	This school year (2021-22)	Never
a. nervous, anxious, worried, or on edge about my science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. concerned that my science teaching is not effective	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. concerned that I am unprepared or under-prepared to teach science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. little interest or enjoyment in teaching science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. confident that I am a good science teacher	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. dissatisfied with the quality of my science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. certain that I can adapt my science teaching to any circumstances/situations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. enthusiastic about science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. tired/exhausted from the additional effort it takes to teach science during COVID	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. confident that my students are learning science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k. confident in my ability to actively engage students during science instruction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l. unprepared or under-prepared to support the social emotional needs of my students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

m. disconnected/isolated from students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
n. disconnected/isolated from colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
o. frustrated by lack of support from my district for science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
p. frustrated by lack of support from my school for science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
q. frustrated by lack of support from my community for science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
r. frustrated by the lack of resources/materials for science teaching	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
s. optimistic that my school/district is headed in a positive direction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
t. unsure how to teach science given the school climate/context	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
u. overwhelmed by extra work as a result of student absenteeism	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
v. overwhelmed by extra work as a result of covering classes/duties for teachers who are absent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
w. overwhelmed by the amount of time it takes to prepare and deliver science instruction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
x. stressed out by problems with technology (for example: lack of internet access, reliable device, issues with log in)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
y. anxious about balancing home and work responsibilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
z. scrutinized about my ability to teach real world science and how it impacts student life	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19) To what extent have you considered **leaving** the teaching profession: *Select one on each row.*

	Not at All	Minimal	Moderate	To a Great Extent
a. Prior to the pandemic	()	()	()	()
b. Last school year (2020-21)	()	()	()	()
c. This school year (2021-22)	()	()	()	()

20) How likely are you to leave teaching in the next two years (for reasons other than scheduled retirement)?

- Not at all likely
- Somewhat likely
- Very likely
- Extremely likely

21) Please indicate which of the following factors have influenced your interest in leaving the teaching profession. *Select all that apply.*

- A health condition that puts you at greater risk for illness under COVID
- A loved one who you either live with or see regularly who has a high-risk condition under COVID
- Inadequate safety plans for COVID mitigation at your school or district
- Challenges of remote/hybrid instruction

- Challenges of in-person instruction
- Inadequate support from your school or district
- Inadequate support or involvement from parents/guardians
- Student behavior
- Inadequate instructional materials
- Childcare responsibilities
- Interest in transitioning to a different education-related job (for example: school administration, tutoring)
- Interest in transitioning to a job that is not education-related
- Insufficient pay
- Demands of teaching on your time
- The stress of teaching
- Dissatisfaction with the way things are run at your school
- Pressure to teach/not teach certain topics or in certain ways
- Lack of support for science instruction at your school

22) To what extent have each of the following influenced your decision to **stay** in the teaching profession?

	Not at All	Minimal	Moderate	To a Great Extent
a. Passion for teaching/content	()	()	()	()
b. Enjoyment in working with students	()	()	()	()
c. Income/job security	()	()	()	()
d. Amount of time invested and/or being close to retirement	()	()	()	()
e. Optimism that teaching conditions will get better	()	()	()	()

23) [Former teachers only] At what point did you stop teaching?

- At the end of the 2019-2020 school year
- During the 2020-2021 school year
- At the end of the 2020-2021 school year
- During the 2021-2022 school year

24) [Former teachers only] How did you leave your teaching position?

- I took early retirement
- I took scheduled retirement
- I resigned
- I was furloughed
- I was laid off
- I took an unpaid leave of absence

25) [Former teachers only] Did you leave teaching mainly because of reasons related to the COVID pandemic?

- Yes
- No

26) [Former teachers only] Please indicate which of the following factors contributed to your decision to leave the teaching profession. *Select all that apply.*

- A health condition that puts you at greater risk for illness under COVID
- A loved one who you either live with or see regularly who has a high-risk condition under COVID
- Inadequate safety plans for COVID mitigation at your school or district
- Challenges of remote/hybrid instruction
- Challenges of in-person instruction
- Inadequate support from your school or district
- Inadequate support or involvement from parents/guardians
- Student behavior
- Inadequate instructional materials
- Childcare responsibilities
- Interest in transitioning to a different education-related job (for example: school administration, tutoring)
- Interest in transitioning to a job that is not education-related
- Insufficient pay
- Demands of teaching on your time
- The stress of teaching
- Dissatisfaction with the way things are run at your school
- Pressure to teach/not teach certain topics or in certain ways
- Lack of support for science instruction at your school

During the pandemic, some science teachers partnered with school counselors, school social workers, and/or school mental health professionals. These individuals provided support to teachers, students, and families.

27) Did you have access to school counselors, school social workers, or school mental health professionals during the pandemic?

- Yes
- No

28) Did you receive support from school counselors, school social workers, or school mental health professionals during the pandemic?

- Yes
- No

29) To what extent did you receive the following types of supports from school counselors, school social workers, or school mental health professionals during the pandemic? *Select one on each row.*

	Not at All	Minimal	Moderate	To a Great Extent
a. Explained how to refer a student to the school counselor/social worker/mental health professional for additional social emotional services or support	()	()	()	()
b. Checked in with teachers on a regular basis about their own social emotional well-being	()	()	()	()
c. Provided resources for teachers' own mental health	()	()	()	()
d. Provided resources for the mental health of students and their families	()	()	()	()

e. Provided information about how to work with students who are experiencing grief or trauma	()	()	()	()
f. Assisted with classroom management	()	()	()	()
g. Followed up with students who are absent due to COVID (for example: recovering from COVID, quarantining, caring for a family member)	()	()	()	()

30) [Former teachers only] Your responses to the previous questions will give us some information about your experiences during the pandemic, but we would really like to know “the rest of the story.” Please describe in your own words how you felt about teaching during the pandemic and what factors were most influential in your decision to leave the profession.

The next few questions ask about your participation on professional development focused on science or science teaching. When answering these questions, please include:

- face-to-face and/or online courses
- professional meetings/conferences
- workshops
- professional learning communities/lesson studies/teacher study groups
- coaching and mentoring

Do not include:

- courses you took prior to becoming a teacher
- time spent providing professional development for others (including coaching and mentoring)

31) When did you **last participate** in professional development focused on science or science teaching?

- | | |
|---|---|
| <ul style="list-style-type: none"> ○ In the last 12 months ○ 1–3 years ago ○ 4–6 years ago | <ul style="list-style-type: none"> ○ 7–10 years ago ○ More than 10 years ago ○ Never |
|---|---|

32) Which of the following types of professional development related to science or science teaching have you had in the last three years? *Select all that apply on each row.*

	In Person	Online	Did not attend
a. I attended a professional development program/workshop.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. I attended a national, state, or regional science teacher association meeting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. I completed an online course/webinar.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. I participated in a professional learning community/lesson study/teacher study group	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. I received assistance or feedback from a formally designated coach/mentor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. I took a formal course for college credit.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

33) What is the **total** amount of time you have spent on professional development related to science or science teaching **in the last 3 years**?

- | | |
|--|---|
| <ul style="list-style-type: none"> ○ Less than 6 hours ○ 6–15 hours ○ 16–35 hours | <ul style="list-style-type: none"> ○ 36–80 hours ○ More than 80 hours |
|--|---|

34) Did you complete any of the following types of biology/life science courses at the undergraduate or graduate level? *Select one on each row.*

	Yes	No
a. General/introductory biology/life science courses (for example: Biology I, Introduction to Biology)	()	()
b. Biology/life science courses beyond the general/introductory level	()	()

35. We will select 40 teachers who complete this survey to participate in a follow-up video conference interview. These one-on-one interviews will last approximately 45-minutes and will cover many of the same topics as the survey, but in greater depth. All teachers who participate in a follow-up interview will receive a \$75 honorarium.

Would you be willing to take part in a follow-up interview if selected? (Your indication of interest now does not obligate you to participate. You can change your mind later and decide not to participate.)

- Yes
- No

APPENDIX B

SAMPLE DEMOGRAPHICS

**Table B-1
Elementary Grades Teacher Sample Demographics**

	Study Sample (N = 180)	National
Race/Ethnicity		
American Indian or Alaska Native	2 (1.0)	1 (0.6)
Asian	2 (1.0)	2 (0.6)
Black or African American	4 (1.4)	8 (1.2)
Hispanic/Latino	7 (1.9)	9 (1.6)
Native Hawaiian or Other Pacific Islander	0 ---	1 (0.4)
White	88 (2.4)	88 (1.5)
Sex		
Female	90 (2.2)	94 (0.7)
Male	9 (2.2)	6 (0.7)
Type of School		
Public	87 (2.5)	93 (1.1)
Private	13 (2.5)	7 (1.1)
Region		
Midwest	25 (3.2)	22 (1.5)
Northeast	18 (2.9)	16 (1.4)
South	26 (3.3)	37 (1.6)
West	31 (3.5)	25 (1.6)
Community Type		
Rural	18 (2.9)	19 (1.3)
Suburban	47 (3.7)	55 (1.8)
Urban	34 (3.5)	26 (1.2)
Grades Taught		
K	26 (3.3)	Unavailable
1	31 (3.5)	Unavailable
2	33 (3.5)	Unavailable
3	44 (3.7)	Unavailable
4	41 (3.7)	Unavailable
5	49 (3.7)	Unavailable
6 th Self Contained	10 (2.2)	Unavailable

**Table B-2
Elementary School Sample Demographics**

	Study Sample (N = 180)		National	
	Mean	Standard Deviation	Mean	Standard Deviation
Student Race/Ethnicity				
American Indian or Alaska Native	1.68	8.79	3.45	15.49
Asian	5.70	11.12	4.15	12.74
Black or African American	12.95	21.52	16.99	24.97
Hispanic/Latino	22.35	25.90	19.47	29.23
Native Hawaiian or Pacific Islander	0.53	1.68	0.76	3.70
White	52.19	31.48	51.34	36.93
Two or more races	4.60	3.83	4.87	9.87
Percent of Students Eligible Free or Reduced-Price Lunch	51.65	28.56	53.96	32.93

**Table B-3
Middle Grades Teacher Sample Demographics**

	Study Sample (N = 323)	National
Race/Ethnicity		
American Indian or Alaska Native	1 (0.4)	2 (0.6)
Asian	2 (0.8)	2 (0.5)
Black or African American	5 (1.2)	8 (1.5)
Hispanic/Latino	5 (1.2)	7 (1.2)
Native Hawaiian or Other Pacific Islander	0 ---	0 (0.2)
White	88 (1.8)	91 (1.5)
Sex		
Female	81 (2.2)	71 (1.8)
Male	16 (2.0)	28 (1.8)
Type of School		
Public	87 (1.9)	87 (1.9)
Private	13 (1.9)	13 (1.9)
Region		
Midwest	28 (2.5)	23 (1.8)
Northeast	21 (2.3)	17 (1.7)
South	21 (2.3)	40 (2.2)
West	30 (2.6)	20 (2.2)
Community Type		
Rural	19 (2.2)	26 (2.1)
Suburban	51 (2.8)	48 (2.3)
Urban	30 (2.6)	26 (2.2)
Subjects Taught		
Life science	38 (2.7)	27 (1.8)
General science	59 (2.7)	49 (2.4)
Earth science	29 (2.5)	24 (2.0)
Physical science	33 (2.6)	25 (2.2)
Health and Wellness	2 (0.8)	Unavailable
Grades Taught		
6	30 (2.6)	Unavailable
7	59 (2.7)	Unavailable
8	59 (2.7)	Unavailable

**Table B-4
Middle School Sample Demographics**

	Study Sample (N = 323)		National	
	Mean	Standard Deviation	Mean	Standard Deviation
Student Race/Ethnicity				
American Indian or Alaska Native	1.15	6.45	1.34	8.15
Asian	5.33	9.40	3.36	8.24
Black or African American	12.03	18.14	15.81	24.48
Hispanic/Latino	20.94	24.88	22.8	30.21
Native Hawaiian or Pacific Islander	0.66	2.00	0.48	2.89
White	55.69	29.31	52.42	34.89
Two or more races	4.20	3.31	4.31	10.85
Percent of Students Eligible Free or Reduced-Price Lunch	46.69	26.35	50.28	30.53

**Table B-5
High School Teacher Sample Demographics**

	Study Sample (N = 523)	National
Race/Ethnicity		
American Indian or Alaska Native	2 (0.6)	2 (0.5)
Asian	4 (0.9)	5 (0.9)
Black or African American	5 (0.9)	5 (0.9)
Hispanic/Latino	5 (0.9)	6 (0.8)
Native Hawaiian or Other Pacific Islander	1 (0.3)	0 (0.1)
White	89 (1.4)	91 (1.2)
Sex		
Female	71 (2.0)	57 (1.9)
Male	28 (2.0)	43 (1.9)
Transgender/Gender non-conforming	1 (0.4)	0 (0.0)
Type of School		
Public	84 (1.6)	85 (1.7)
Private	16 (1.6)	15 (1.7)
Region		
Midwest	29 (2.0)	24 (1.9)
Northeast	25 (1.9)	19 (1.5)
South	19 (1.7)	36 (1.5)
West	27 (1.9)	20 (1.6)
Community Type		
Rural	19 (1.7)	24 (1.4)
Suburban	51 (2.2)	47 (1.6)
Urban	30 (2.0)	28 (1.7)
Subjects Taught		
Life science	57 (2.2)	53 (1.3)
Earth/space science	18 (1.7)	11 (1.2)
Environmental science	23 (1.8)	15 (1.5)
Chemistry	34 (2.1)	31 (1.1)
Physics	25 (1.9)	22 (1.2)
Multi-discipline science	20 (1.8)	27 (1.5)
Health and Wellness	2 (0.7)	Unavailable
Grades Taught		
9	58 (2.2)	Unavailable
10	76 (1.9)	Unavailable
11	85 (1.6)	Unavailable
12	80 (1.7)	Unavailable

**Table B-6
High School Sample Demographics**

	Study Sample (N = 523)		National	
	Mean	Standard Deviation	Mean	Standard Deviation
Student Race/Ethnicity				
American Indian or Alaska Native	1.08	6.31	1.57	9.33
Asian	6.15	10.56	5.87	12.93
Black or African American	13.16	19.69	13.05	25.58
Hispanic/Latino	17.58	23.26	18.01	29.40
Native Hawaiian or Pacific Islander	1.02	2.82	1.01	13.03
White	57.48	30.50	58.89	34.38
Two or more races	3.54	3.28	3.43	10.92
Percent of Students Eligible Free or Reduced-Price Lunch	43.93	25.83	41.08	30.44

APPENDIX C

DESCRIPTION OF REPORTING VARIABLES

Reporting Variables

Grade Range

Teachers were classified by grade range (elementary, middle, and high) according to the information they provided about their teaching schedule. Elementary was defined as grades K–5 plus 6th grade self-contained; middle was defined as 6th grade non-self-contained and grades 7–8; high was defined as grades 9–12.

Percentage of Students in School Eligible for Free/Reduced-Price Lunch

Each teacher was classified into 1 of 4 categories based on the proportion of students in their school eligible for free/reduced-price lunch (FRL). The categories were defined as quartiles within groups of schools serving the same grades—e.g., schools with grades K–5, schools with grades 6–8 (see Table C-1).

Table C-1
Cut Points for Percentage of Students in the School Eligible for FRL

	Percent Of Teachers	Percent FRL Used as Cut Point		
		Quartile 1/Quartile 2	Quartile 2/Quartile 3	Quartile 3/Quartile 4
K–5 Schools	18	28.75	49.49	75.64
6–8 Schools	31	25.77	46.96	64.31
9–12 Schools	51	23.40	38.98	60.54

Percentage of Students from Race/Ethnicity Groups Historically Underrepresented in STEM in Class

Each teacher was classified into 1 of 4 categories based on the proportion of students in their school identified as being from underrepresented minority (URM) groups in STEM (i.e., American Indian or Alaskan Native, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, multi-racial). As this proportion is similar in schools regardless of grades served, the categories were defined as quartiles across all classes (see Table C-2).

Table C-2
Cut Points for Percentage of Students in the
Class From Underrepresented Minority Groups

	Percent URM Used as Cut Point
Quartile 1/Quartile 2	13.96
Quartile 2/Quartile 3	29.21
Quartile 3/Quartile 4	58.64

Community Type

Each teacher was classified as belonging to 1 of 3 types of communities based on the location of their school:

- Urban: Central city;
- Suburban: Area surrounding a central city, but still located within the counties constituting a Metropolitan Statistical Area (MSA); or
- Rural: Area outside any MSA.

Political Leaning of County

Teachers were coded into 1 of 2 categories based on whether the majority of voters in their school’s county voted for the Democratic presidential candidate or Republican presidential candidate in the 2020 election.

Overview of Composites

To facilitate the reporting of large amounts of survey data, and because individual questionnaire items are potentially unreliable, HRI used factor analysis to identify survey questions that could be combined into “composites.” Each composite represents an important construct related to COVID in science education.

Each composite is calculated by summing the responses to the items associated with that composite and then dividing by the total points possible. In order for the composites to be on a 100-point scale, the lowest response option on each scale was set to 0 and the others were adjusted accordingly. For example, an item with a scale ranging from 1 to 4 was re-coded to have a scale of 0 to 3. By doing this, someone who marks the lowest point on every item in a composite receives a composite score of 0 rather than some positive number. It also assures that 50 is the true mid-point. The denominator for each composite is determined by computing the maximum possible sum of responses for a series of items and dividing by 100; e.g., a 9-item composite where each item is on a scale of 0–3 would have a denominator of 0.27. Composites values were not computed for participants who respond to fewer than two-thirds of the items that form the composite.

The composites were derived through a multi-stage process. As a first step, to test whether the items intended to target the same underlying construct indeed showed similar response patterns,

an exploratory factor analysis was conducted on a subset of the data. (The complete dataset was split randomly into two subsets to allow for independent exploratory and confirmatory factor analyses.) Using Mplus version 8.1, several different factor solutions were produced and scree plots, eigenvalues, and factor patterns were examined. Based on item fit and conceptual coherence, preliminary composite definitions were created. Next, the preliminary composite definitions were applied to a different subset of the data and a confirmatory factor analysis was performed, again using Mplus. Mplus provides two fit indices to evaluate the model: the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR). The psychometric literature provides multiple criteria for judging acceptable model fit using this index, ranging from 0.05–0.10.⁹ The obtained values from final models are presented in the tables, allowing the reader to apply their preferred criteria for evaluating fit. Lastly, to further aid in the assessment of the composites, Cronbach’s coefficient alpha, a common measure of reliability, was calculated and is presented in the tables. An alpha of 0.6–0.8 is evidence of moderate reliability and a value over 0.8 is considered evidence of strong reliability.

Definitions of Composites

Composite definitions are presented below with the item numbers from the questionnaire, along with the reliability and fit indices.

Sources of Information About COVID

These composites estimate the extent to which teachers used various sources for their own information about COVID.

Table C-3
Local/National Television News Stations

	Item
Local news station (e.g., NBC4), via radio, TV, or Internet	Q14a
National broadcast TV news program (e.g., NBC Nightly News, CBS Nightly News)	Q14b
24-hour TV news (e.g., CNN, MSNBC, FOX, BBC)	Q14c
Number of Items in Composite	3
Reliability – Cronbach’s Coefficient Alpha	0.678
Confirmatory Factor Analysis Fit Index – RMSEA	0.068
Confirmatory Factor Analysis Fit Index – SRMR	0.066

⁹ Hu, L., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6, 1–55.

**Table C-4
Health/Science Organization Websites**

	Item
Centers for Disease Control and Prevention (CDC) website	Q14j
Johns Hopkins Coronavirus Resource Center website	Q14k
National Institutes of Health (NIH) website	Q14l
World Health Organization (WHO) website	Q14m
Websites from other health organizations (besides CDC, Johns Hopkins, NIH, and WHO)	Q14n
Websites from teacher professional organizations (e.g., National Science Teachers Association, National Association of Biology Teachers)	Q14o
Number of Items in Composite	6
Reliability – Cronbach’s Coefficient Alpha	0.800
Confirmatory Factor Analysis Fit Index – RMSEA	0.068
Confirmatory Factor Analysis Fit Index – SRMR	0.066

**Table C-5
Personal Conversations/Social Media**

	Item
Social Media	Q14p
Conversations with other teachers	Q14s
Conversations with others (i.e., not health professionals or teachers)	Q14t
Number of Items in Composite	3
Reliability – Cronbach’s Coefficient Alpha	0.657
Confirmatory Factor Analysis Fit Index – RMSEA	0.068
Confirmatory Factor Analysis Fit Index – SRMR	0.066

Teacher Decision Making

These composites estimate the extent to which various factors influenced whether teachers addressed COVID in their instruction.

**Table C-6
Control Beliefs**

	Item
It is up to me whether or not to teach about COVID.	Q17c
The decision about whether or not to teach about COVID is beyond my control.	Q17f
I am able to choose when and how to teach about COVID.	Q17h
Other people get to decide whether or not I teach about COVID.	Q17k
Number of Items in Composite	4
Reliability – Cronbach’s Coefficient Alpha	0.854
Confirmatory Factor Analysis Fit Index – RMSEA	0.102
Confirmatory Factor Analysis Fit Index – SRMR	0.099

**Table C-7
Approval Beliefs**

	Item
It is expected that I teach about COVID.	Q17e
I feel social pressure to teach about COVID.	Q17i
People who are important to me in my profession (e.g., other teachers, principals) have asked if I am teaching or planning to teach about COVID.	Q17l
People who are important to me in my profession (e.g., other teachers, principals) think I should teach about COVID.	Q17m
People who are important to me in my profession (e.g., other teachers, principals) do not think it's a good idea to teach about COVID.	Q17n
Number of Items in Composite	5
Reliability – Cronbach's Coefficient Alpha	0.753
Confirmatory Factor Analysis Fit Index – RMSEA	0.102
Confirmatory Factor Analysis Fit Index – SRMR	0.099

**Table C-8
Self-Efficacy Beliefs**

	Item
I am confident in my ability to successfully teach about COVID.	Q17a
I could currently find ways to teach about COVID if I wanted to.	Q17b
The topic of COVID is well aligned to the content standards I am required to teach.	Q17d
It is difficult for me to teach about COVID.	Q17g
I have adequate access to supports/resources/materials for teaching about COVID.	Q17j
I have sufficient time to plan/prepare for teaching about COVID.	Q17o
Number of Items in Composite	6
Reliability – Cronbach's Coefficient Alpha	0.789
Confirmatory Factor Analysis Fit Index – RMSEA	0.102
Confirmatory Factor Analysis Fit Index – SRMR	0.099

Teacher Feelings

These composites estimate the range of feelings science teachers may have experienced prior to the pandemic, during the 2020-21 school year, and during the 2021-22 school year.

**Table C-9
Negative Feelings About Teaching Science**

	Item		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Nervous, anxious, worried, or on edge about my science teaching		Q18a	
Concerned that my science teaching is not effective		Q18b	
Concerned that I am unprepared or under-prepared to teach science		Q18c	
Dissatisfied with the quality of my science teaching		Q18f	
Number of Items in Composite		4	
Reliability – Cronbach's Coefficient Alpha	0.751	0.691	0.711
Confirmatory Factor Analysis Fit Index – RMSEA	0.059	0.055	0.055
Confirmatory Factor Analysis Fit Index – SRMR	0.152	0.085	0.083

**Table C-10
Positive Feelings About Teaching Science**

	Item		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Little interest or enjoyment in teaching science [†]		Q18d	
Confident that I am a good science teacher		Q18e	
Certain that I can adapt my science teaching to any circumstances/situations		Q18g	
Enthusiastic about science teaching		Q18h	
Confident that my students are learning science		Q18j	
Confident in my ability to actively engage students during science instruction		Q18k	
Number of Items in Composite		6	
Reliability – Cronbach’s Coefficient Alpha	0.731	0.743	0.781
Confirmatory Factor Analysis Fit Index – RMSEA	0.059	0.055	0.055
Confirmatory Factor Analysis Fit Index – SRMR	0.152	0.085	0.083

[†] Responses were flipped when computing the composite to account for the negative polarity of the item.

**Table C-11
Overwhelmed by Additional Burdens Due to COVID**

	Item		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Tired/exhausted from the additional effort it takes to teach science during COVID	n/a	Q18i	Q18i
Overwhelmed by extra work as a result of student absenteeism		Q18u	
Overwhelmed by extra work as a result of covering classes/duties for teachers who are absent		Q18v	
Overwhelmed by the amount of time it takes to prepare and deliver science instruction		Q18w	
Stressed out by problems with technology (e.g., lack of internet access, reliable devices, issues with log in)		Q18x	
Anxious about balancing home and work responsibilities		Q18y	
Number of Items in Composite	5	6	6
Reliability – Cronbach’s Coefficient Alpha	0.573	0.731	0.738
Confirmatory Factor Analysis Fit Index – RMSEA	0.059	0.055	0.055
Confirmatory Factor Analysis Fit Index – SRMR	0.152	0.085	0.083

**Table C-12
Frustrated by Lack of Support**

	Item		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Frustrated by lack of support from my district for science teaching		Q18o	
Frustrated by lack of support from my school for science teaching		Q18p	
Frustrated by lack of support from my community for science teaching		Q18q	
Frustrated by the lack of resources/materials for science teaching		Q18r	
Optimistic that my school/district is headed in a positive direction [†]		Q18s	
Number of Items in Composite		5	
Reliability – Cronbach’s Coefficient Alpha	0.742	0.760	0.774
Confirmatory Factor Analysis Fit Index – RMSEA	0.059	0.055	0.055
Confirmatory Factor Analysis Fit Index – SRMR	0.152	0.085	0.083

[†] Responses were flipped when computing the composite to account for the positive polarity of the item.

APPENDIX D

ADDITIONAL TABLES

**Table D-1
Elementary Teachers Indicating Various Feelings Throughout the Pandemic**

	Percent of Teachers (N = 180)		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Certain that I can adapt my science teaching to any circumstances/situations	67 (3.5)	62 (3.6)	76 (3.2)
Enthusiastic about science teaching	80 (3.0)	61 (3.6)	76 (3.2)
Confident that I am a good science teacher	75 (3.2)	60 (3.7)	76 (3.2)
Confident that my students are learning science	82 (2.8)	48 (3.7)	76 (3.2)
Confident in my ability to actively engage students during science instruction	85 (2.7)	46 (3.7)	74 (3.3)
Overwhelmed by extra work as a result of student absenteeism	7 (2.0)	65 (3.6)	63 (3.6)
Anxious about balancing home and work responsibilities	35 (3.6)	64 (3.6)	63 (3.6)
Overwhelmed by extra work as a result of covering classes/duties for teachers who are absent	4 (1.5)	42 (3.7)	55 (3.7)
Tired/exhausted from the additional effort it takes to teach science during COVID	n/a	69 (3.5)	54 (3.7)
Optimistic that my school/district is headed in a positive direction	58 (3.7)	33 (3.5)	53 (3.7)
Overwhelmed by the amount of time it takes to prepare and deliver science instruction	22 (3.1)	55 (3.7)	51 (3.7)
Unprepared or under-prepared to support the social emotional needs of my students	13 (2.5)	51 (3.7)	46 (3.7)
Stressed out by problems with technology (for example: lack of internet access, reliable device, issues with log in)	19 (2.9)	71 (3.4)	40 (3.7)
Nervous, anxious, worried, or on edge about my science teaching	11 (2.3)	54 (3.7)	38 (3.6)
Frustrated by the lack of resources/materials for science teaching	28 (3.3)	46 (3.7)	37 (3.6)
Frustrated by lack of support from my district for science teaching	22 (3.1)	39 (3.6)	35 (3.6)
Concerned that my science teaching is not effective	9 (2.1)	56 (3.7)	32 (3.5)
Frustrated by lack of support from my school for science teaching	18 (2.9)	36 (3.6)	32 (3.5)
Disconnected/isolated from colleagues	4 (1.4)	69 (3.4)	28 (3.4)
Dissatisfied with the quality of my science teaching	13 (2.5)	42 (3.7)	27 (3.3)
Concerned that I am unprepared or under-prepared to teach science	11 (2.3)	38 (3.6)	22 (3.1)
Unsure how to teach science given the school climate/context	2 (1.0)	28 (3.3)	19 (2.9)
Scrutinized about my ability to teach real world science and how it impacts student life	9 (2.1)	19 (2.9)	19 (2.9)
Frustrated by lack of support from my community for science teaching	8 (2.0)	21 (3.0)	19 (2.9)
Little interest or enjoyment in teaching science	5 (1.6)	10 (2.2)	15 (2.7)
Disconnected/isolated from students	0 ---	58 (3.7)	13 (2.5)

Table D-2
Middle School Teachers Indicating Various Feelings Throughout the Pandemic

	Percent of Teachers (N = 323)		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Certain that I can adapt my science teaching to any circumstances/situations	70 (2.5)	62 (2.7)	73 (2.5)
Overwhelmed by extra work as a result of student absenteeism	5 (1.2)	75 (2.4)	72 (2.5)
Tired/exhausted from the additional effort it takes to teach science during COVID	n/a	83 (2.1)	72 (2.5)
Confident that I am a good science teacher	81 (2.2)	59 (2.7)	71 (2.5)
Confident that my students are learning science	92 (1.5)	44 (2.8)	70 (2.6)
Confident in my ability to actively engage students during science instruction	92 (1.5)	41 (2.7)	69 (2.6)
Overwhelmed by extra work as a result of covering classes/duties for teachers who are absent	7 (1.4)	40 (2.7)	68 (2.6)
Anxious about balancing home and work responsibilities	45 (2.8)	68 (2.6)	67 (2.6)
Enthusiastic about science teaching	91 (1.6)	58 (2.7)	66 (2.6)
Overwhelmed by the amount of time it takes to prepare and deliver science instruction	27 (2.5)	68 (2.6)	56 (2.8)
Unprepared or under-prepared to support the social emotional needs of my students	15 (2.0)	63 (2.7)	56 (2.8)
Nervous, anxious, worried, or on edge about my science teaching	15 (2.0)	62 (2.7)	49 (2.8)
Optimistic that my school/district is headed in a positive direction	66 (2.6)	31 (2.6)	46 (2.8)
Stressed out by problems with technology (for example: lack of internet access, reliable device, issues with log in)	16 (2.0)	65 (2.7)	43 (2.8)
Concerned that my science teaching is not effective	12 (1.8)	62 (2.7)	39 (2.7)
Frustrated by lack of support from my district for science teaching	22 (2.3)	43 (2.8)	36 (2.7)
Frustrated by lack of support from my community for science teaching	17 (2.1)	38 (2.7)	35 (2.7)
Dissatisfied with the quality of my science teaching	8 (1.5)	47 (2.8)	31 (2.6)
Frustrated by the lack of resources/materials for science teaching	27 (2.5)	39 (2.7)	31 (2.6)
Disconnected/isolated from colleagues	2 (0.9)	65 (2.7)	29 (2.5)
Frustrated by lack of support from my school for science teaching	14 (2.0)	34 (2.6)	28 (2.5)
Little interest or enjoyment in teaching science	1 (0.6)	20 (2.2)	26 (2.5)
Unsure how to teach science given the school climate/context	4 (1.1)	29 (2.5)	23 (2.4)
Scrutinized about my ability to teach real world science and how it impacts student life	8 (1.5)	20 (2.2)	23 (2.3)
Disconnected/isolated from students	2 (0.8)	66 (2.6)	19 (2.2)
Concerned that I am unprepared or under-prepared to teach science	8 (1.5)	29 (2.5)	16 (2.0)

**Table D-3
High School Teachers Indicating Various Feelings Throughout the Pandemic**

	Percent of Teachers (N = 523)		
	Prior to the pandemic	2020-21 School Year	2021-22 School Year
Certain that I can adapt my science teaching to any circumstances/situations	70 (2.0)	64 (2.1)	77 (1.8)
Confident that I am a good science teacher	79 (1.8)	62 (2.1)	72 (2.0)
Confident that my students are learning science	93 (1.1)	42 (2.2)	71 (2.0)
Confident in my ability to actively engage students during science instruction	91 (1.2)	35 (2.1)	71 (2.0)
Tired/exhausted from the additional effort it takes to teach science during COVID	n/a	82 (1.7)	70 (2.0)
Overwhelmed by extra work as a result of student absenteeism	9 (1.3)	72 (2.0)	69 (2.0)
Enthusiastic about science teaching	90 (1.3)	57 (2.2)	68 (2.0)
Anxious about balancing home and work responsibilities	41 (2.2)	63 (2.1)	66 (2.1)
Overwhelmed by extra work as a result of covering classes/duties for teachers who are absent	5 (1.0)	35 (2.1)	60 (2.1)
Unprepared or under-prepared to support the social emotional needs of my students	18 (1.7)	67 (2.1)	54 (2.2)
Overwhelmed by the amount of time it takes to prepare and deliver science instruction	25 (1.9)	64 (2.1)	52 (2.2)
Optimistic that my school/district is headed in a positive direction	66 (2.1)	30 (2.0)	46 (2.2)
Nervous, anxious, worried, or on edge about my science teaching	16 (1.6)	58 (2.2)	46 (2.2)
Concerned that my science teaching is not effective	16 (1.6)	61 (2.1)	42 (2.2)
Stressed out by problems with technology (for example: lack of internet access, reliable device, issues with log in)	13 (1.5)	68 (2.0)	39 (2.1)
Frustrated by lack of support from my district for science teaching	24 (1.9)	42 (2.2)	38 (2.1)
Frustrated by lack of support from my community for science teaching	18 (1.7)	36 (2.1)	34 (2.1)
Frustrated by lack of support from my school for science teaching	18 (1.7)	34 (2.1)	30 (2.0)
Frustrated by the lack of resources/materials for science teaching	24 (1.9)	36 (2.1)	30 (2.0)
Dissatisfied with the quality of my science teaching	8 (1.2)	44 (2.2)	28 (2.0)
Disconnected/isolated from colleagues	4 (0.9)	68 (2.0)	26 (1.9)
Little interest or enjoyment in teaching science	2 (0.5)	19 (1.7)	22 (1.8)
Scrutinized about my ability to teach real world science and how it impacts student life	9 (1.2)	19 (1.7)	22 (1.8)
Disconnected/isolated from students	2 (0.6)	73 (2.0)	21 (1.8)
Unsure how to teach science given the school climate/context	2 (0.6)	27 (1.9)	21 (1.8)
Concerned that I am unprepared or under-prepared to teach science	8 (1.2)	22 (1.8)	17 (1.6)