Changes in school climate during COVID-19 in a sample of Pennsylvania schools

Appendix A. Data and methods

Appendix B. Supporting analyses

Appendix C. Nonresponse bias analysis

See https://ies.ed.gov/ncee/rel/Products/Region/midatlantic/Publication/107259 for the accompanying briefing slides.

The Regional Educational Laboratory (REL) Mid-Atlantic partnered with the Pennsylvania Department of Education (PDE) to explore the relationship between the COVID-19 pandemic and school climate in Pennsylvania schools. A detailed discussion of this research project and key findings are included in the accompanying briefing slides, which are available at the above link. These technical appendixes are meant to supplement the slideshow to provide extended detail on the methods and analyses used to answer this study's research questions.

Appendix A. Data and methods

The analysis of school climate during COVID-19 addresses three research questions:

1. Did pandemic-related disruptions affect the validity of the school climate survey?

2. Did school climate scores change from before the pandemic to the years during the pandemic?

3. Did school climate scores in 2021/22 vary according to the amount of virtual and hybrid instruction used during the 2020/21 school year?

This appendix provides information about the data sources, sample, and research methods used in the analysis of these questions.

Data

Key data sources for this study are PDE's Pennsylvania School Climate Survey and data from the National Center for Education Statistics' (NCES's) Common Core of Data (CCD) and ED*Facts* on student demographics, enrollment, and achievement. To track learning modalities, the study uses the Return to Learn Tracker of instructional modality during the COVID-19 pandemic and a survey administered by Mathematica to Pennsylvania school districts.

Pennsylvania School Climate Survey

The Pennsylvania School Climate Survey was developed by PDE, drawing from the Conditions for Learning Survey and the Alaska School Climate and Connectedness Survey, which were both developed by American Institutes for Research (American Institutes of Research, 2011). PDE offers the survey on an optional basis to schools. The survey is administered via a web-based instrument to school staff (including classroom teachers and noninstructional staff),

elementary school students (grades 3–5), middle school students (grades 6–8), and high school students (grades 9–12).

The current survey domains include (1) social-emotional learning, (2) student support and academic engagement, and (3) safe and respectful school climate. Initially, the student support and academic engagement domain represented two separate domains: (1) student support and (2) high expectations/academic rigor and challenge. A 2021 study by a REL Mid-Atlantic team (Amos & Xue, 2021) investigated the validity of the surveys from the 2016/17 and 2017/18 school years. The study team determined that those two domains were highly correlated and suggested combining the two domains into one domain for future administrations of the surveys. The study team also recommended removing survey items that did not improve the measurement of the school climate survey domains. After incorporating the recommended changes, the research team established the validity and reliability of the school climate survey for teachers, noninstructional staff, and middle and high school students, but not elementary students.

The elementary school student survey differed from the other surveys in that responses only included three categories (no, sometimes, and yes), while the other surveys had four response categories for all items (for example, strongly disagree, disagree, agree, and strongly agree). To improve the reliability of the elementary student survey, the study team recommended changing the rating scales to include four categories instead of three to increase variation in student responses. The team also recommended replacing elementary student items from the social-emotional learning domain with social-emotional learning items from the Delaware School Climate Survey (Bear et al., 2014). PDE has implemented these recommendations in recent years, and the study team plans to re-assess the validity and reliability of the elementary student survey in a follow-up report. Therefore, the present analysis of research questions regarding changes to school climate during COVID-19 excludes the elementary student survey and focuses only on middle and high school students and on elementary, middle, and high school teachers and noninstructional staff.

REL Mid-Atlantic received de-identified individual-level responses to the school climate surveys from PDE for 2016/17 through 2021/22. Because the purpose of the study was to understand how school climate changed from before COVID to during COVID, we excluded the 2019/20 school year from the analyses. For the schools that administered the survey in 2019/20, some completed the survey in the fall before COVID, and others took it in the spring after COVID began causing disruptions in March 2020. As a result, the 2019/20 survey respondents reflect a mix of people who are in schools that are and are not experiencing COVID disruptions.

After receiving the individual-level responses, we calculated school climate scores for each domain for the middle and high school students, teachers, and noninstructional staff respondents to use as the outcomes for the analyses in research questions 2 and 3. To calculate the overall school climate index and school climate domain scores, we first ran Rasch models for each respondent-domain-year (e.g., teachers' social-emotional learning domain in the year 2020/21) to calculate Rasch scores for each respondent. For all years after 2016/17, we anchored item difficulty estimates using the estimates for the 2016/17 surveys (in effect, putting the item difficulties on the same scale) so that the scores are comparable across years. We estimated the Rasch models using Winsteps software.

For each survey item, a Rasch model estimates the likelihood of selecting a response option as a function of the respondent's perception of school climate. (For additional details on Rasch modeling, please see another source, such as Fischer and Molenaar (1995).) The team used the step values from the Rasch model to define interpretable cut points for different ranges of the school climate scores. (The step values are estimates of the point at which respondents switch from being more likely to select one response category to being more likely to select the next response category.) Specifically, the Rasch step values aligned with scaled score points of 20, 50, and 80. In scaled score points, values over 80 indicate a respondent is most likely to respond "strongly agree" to an item with a positive valence (that is, an item for which agreement indicates a favorable response, such as agreement to the following survey question: "Students in my school treat each other with respect"). Values from over 50 to 80 indicate a respondent is most likely to respond "agree" and more likely to select "strongly agree" than "disagree" or "strongly disagree" to an item with a positive valence. Values from over 20 to 50 indicate a respondent is most likely to respond "agree" but more likely to select "disagree" or "strongly disagree" than select "strongly agree" to

an item with a positive valence. Values from 20 or less indicate a respondent is most likely to respond "disagree" or "strongly disagree" to an item with a positive valence. Within each of these ranges, we used a linear transformation to convert Rasch scores for each domain to scaled score points on a 1–99 point scale. (See Amos & Xue [2021] for additional detail.)

We then examined nonresponse patterns (see appendix D for a detailed overview of the nonresponse bias analysis) and adjusted for them by applying nonresponse weights. Specifically, we compared the student demographics reported in the school climate survey to those in the school's entire population from the same school year as reported in CCD. We then adjusted for nonresponse bias by weighting student subgroups in the sample according to their proportion in the school's population. We were not able to apply nonresponse weights to teachers or noninstructional staff given that demographic data on teachers and noninstructional staff are not available for the whole school from CCD. Using the scaled scores and nonresponse weights, the study team calculated school climate scores for each school year the surveys were administered beginning in the 2016/17 school year and ending in the 2021/22 school year (excluding the 2019/20 school year). For each respondent in each year, we first calculated an index score, which was a simple average across all school climate domain scores. Then, the team calculated school-level climate indices and domain scores by averaging across individual respondents' index and domain scores within each school and year, applying nonresponse weights to student respondents where applicable.

The team also created scores for adults in schools, which included both teachers and staff. The adult index and adult domain scores are weighted averages of the scores for teachers and noninstructional staff, where the weights are based on the share of each group as a proportion of all the staff in the school. For the schools in the sample, teachers represent the vast majority of adult respondents (75 percent or more of the staff in the school), while noninstructional staff represent the remainder. For the analyses in research questions 2 and 3, we use scores for students, teachers, and adults but do not report results for noninstructional staff separately because there are far fewer noninstructional staff than teachers. (See table A1 for a list of the school climate index and domain scores created.)

Return to Learn Tracker

The Return to Learn Tracker was assembled by the American Enterprise Institute (AEI) and includes weekly data on districts' learning modalities from September through June of the 2020/21 school year for 98 percent of local education agencies with three or more schools nationally. AEI assembled the data primarily through web-scraping. Based on information available on districts' websites, social media announcements, and direct contact with districts, AEI categorized the districts as fully in-person, hybrid, or fully remote on a weekly basis, reporting one learning modality across all grade levels.

In the Return to Learn Tracker dataset, fully in-person refers to when all instruction occurs in-person at school, fully remote refers to when teachers deliver instruction in one location and students are located elsewhere, and hybrid learning refers to when students receive any mix of in-person and remote learning. Hybrid can mean that different students received either in-person, remote, or a blend of in-person and remote instruction, or that all students received a blend of in-person and remote instruction.

Using the Return to Learn Tracker data, the study team calculated the percentage of weeks in the 2020/21 school year that the schools used each learning modality: fully in-person, hybrid, and fully remote. The study team relied on the Return to Learn Tracker data because it reports the learning modality for each week from September through June and covers approximately 80–90 percent of schools that participated in the school climate survey in the years the team will use for the analyses of learning modality and school climate (2018/19 and 2021/22). Specifically, it covers 83 percent of the schools with school climate data for students and 90 percent of the schools with school climate data for teachers.

Mathematica survey of Pennsylvania school districts

To assess the validity of the Return to Learn Tracker data, the study team also used data from Mathematica's survey about instruction during the COVID-19 pandemic. In a project with PDE funded by the Institute of Education Sciences, Mathematica administered a survey to the 50 largest local education agencies in Pennsylvania and a

random sample of 150 others in Pennsylvania at the end of the 2020/21 school year. This survey asked questions about the learning modalities offered to each grade level band (K–2, 3–5, 6–8, 9–12) at three points in time: the first 30 days of school, the 30 days following winter break, and the last 30 days of school. The Mathematica survey was used to validate the Return to Learn Tracker data but was not used for the analyses for research question 3, because it the Mathematica survey only covers approximately 35–37 percent of schools that participated in the school climate survey in 2021/22 school year (specifically, it covers 37 percent of the schools with school climate data for students and 35 percent of the schools with school climate data for teachers.)

CCD data and EDFacts data

The study team gathered data on schools' names, location, size, and student demographics from the NCES's CCD for school years 2016/17 through 2021/22. Student achievement data (defined as proficiency rates in math and reading/language arts) were gathered from the NCES's ED*Facts* data for school years 2016/17 through 2021/22.

Table A1 describes which variables from these data sources are used in the analyses examining changes in school climate during COVID-19.

Table A1. Variables used in the study

Variable	Description
Pennsylvania School Climate Survey	
School climate index score (students)	School-level average score for all student survey respondents, calculated from each respondent's average scaled score across all three domain scores
Social-emotional learning domain score (students)	School-level average score for all student survey respondents, calculated from each respondents' scaled score for the social-emotional learning domain
Safe and respectful school climate domain score (students)	School-level average score for all student survey respondents, calculated from each respondents' scaled score for the safe and respectful school climate domain
Student support and academic engagement domain score (students)	School-level average score for all student survey respondents, calculated from each respondents' scaled score for the support and academic engagement domain
School climate index score (teachers)	School-level average score for all classroom teacher survey respondents, calculated from each respondent's average scaled score across all three domain scores
Social-emotional learning domain score (teachers)	School-level average score for all classroom teacher survey respondents, calculated from each respondents' scaled score for the social-emotional learning domain
Safe and respectful school climate domain score (teachers)	School-level average score for all classroom teacher survey respondents, calculated from each respondents' scaled score for the safe and respectful school climate domain
Student support and academic engagement domain score (teachers)	School-level average score for all classroom teacher survey respondents, calculated from each respondent's scaled score for the support and academic engagement domain
School climate index score (adults)	School-level average score for all teachers and noninstructional staff survey respondents, calculated from each respondent's average scaled score across all three domain scores
Social-emotional learning domain score adults)	School-level average score for all teachers and noninstructional staff survey respondents, calculated from each respondent's scaled score for the social-emotional learning domain. In calculating the average, scores from teachers and noninstructional staff are weighted by the proportion of each group in a school, relative to all staff in the school.
Safe and respectful school climate domain score (adults)	School-level average score for all teachers and noninstructional staff survey respondents, calculated from each respondent's scaled score for the safe and respectful school climate domain. In calculating the average, scores from teachers and noninstructional staff are weighted by the proportion of each group in a school, relative to all staff in the school.
Student support and academic engagement domain score (adults)	School-level average score for all teachers and noninstructional staff survey respondents, calculated from each respondent's scaled score for the support and academic engagement domain. In calculating the average, scores from teachers and noninstructional staff are weighted by the proportion of each group in a school, relative to all staff in the school.

Variable	Description
Return to Learn Tracker	
In-person	Whether a school district was listed as "in-person" for each week of the 2020/21 school year. In-person was defined as when all instruction occurs in-person at school.
Hybrid	Whether a school district was listed as "hybrid" for each week of the 2020/21 school year. Hybrid was defined as when students receive any mix of in-person and remote learning, including when different students receive either in-person, remote, or a blend of in-person and remote instruction or when all students received a blend of in-person and remote instruction.
Remote	Whether a school district was listed as "remote" for each week of the 2020/21 school year. Remote was defined as when teachers deliver instruction in one location and students are located elsewhere.
Mathematica survey of Pennsylvania districts	
In-person	Whether a school's district responded that their modality was "in-person," measured separately for grades 3–5, 6–8, and 9–12 at the first 30 days of school, the 30 days following winter break, and the last 30 days of school. In-person was defined as when all instruction occurs in person at school and in real time between teachers and students.
Hybrid	Whether a school's district responded that their modality was "hybrid," measured separately for grades 3–5, 6–8, and 9–12 at the first 30 days of school, the 30 days following winter break, and the last 30 days of school. Hybrid was defined as when students receive a mix of in-person, in-school instruction and remote learning on alternating days or weeks, or with different start and end times to the school day.
Remote	Whether a school's district responded that their modality was "remote," measured separately for grades 3–5, 6–8, and 9–12 at the first 30 days of school, the 30 days following winter break, and the last 30 days of school. Remote was defined as when teachers are at one location, generally either their homes or the school, and students are elsewhere, usually at home. Teachers and students typically interact using an online platform in this modality.
Common Core of Data and ED*Facts* data	
Percentage of female students	Percentage of all students enrolled in a school in a given year who were female
Percentage of male students	Percentage of all students enrolled in a school in a given year who were male
Percentage of American Indian/Alaska Native students	Percentage of all students enrolled in a school in a given year who were American Indian or Alaska Native
Percentage of Asian American/Pacific Islander students	Percentage of all students enrolled in a school in a given year who were Asian American or Pacific Islander
Percentage of Black students	Percentage of all students enrolled in a school in a given year who were Black
Percentage of Hispanic students	Percentage of all students enrolled in a school in a given year who were Hispanic
Percentage of White students	Percentage of all students enrolled in a school in a given year who were White
School urbanicity	Whether a school was urban, suburban, in a town, or rural
Percentage of students eligible for free or reduced-price lunch	Percentage of all students enrolled in a school in a given year who were eligible for free or reduced-price lunch under the National School Lunch Program
Percentage of students proficient in English language arts	Percentage of all students enrolled in a school in a given year who were proficient in English language arts
Percentage of students proficient in math	Percentage of all students enrolled in a school in a given year who were proficient in math

Sample

Because schools could choose to take the school climate survey and did not have to administer the survey to all types of respondents (teachers, staff, and students), the number of participating respondents and schools varies widely across school years. We use data from participating schools in 2016/17 through 2021/22, excluding the

2019/20 school year. Table A2 provides information on the sample sizes used for all the analyses. The first panel of table A2, titled Research question 1, provides information on the sample sizes used for the psychometric analyses of the school climate survey by respondents and schools. Overall, the numbers of schools participating in the school climate survey across school years varied. The 2021/22 school year had the largest number of school climate survey respondents. Note that the number of schools is larger for classroom teacher and noninstructional staff surveys compared to middle and high school student surveys, because the data includes teachers and staff in elementary schools. In a previous REL project with PDE, the REL research team established the reliability and validity of the Pennsylvania school climate survey for middle and high school students and teachers and noninstructional staff. However, the findings from the elementary school student surveys indicated a need to revise the survey to improve reliability estimates of the domains and factors (Amos and Xue, 2021). While the revised elementary school student survey will need to be reassessed to confirm that the domain structure still holds, surveys from teachers and noninstructional staff in elementary schools have already been validated. The team chose to include teachers and noninstructional staff in elementary schools to maximize the sample of schools available for the analysis.

For research question 1, we employed several sample restrictions for the school climate survey psychometric analyses. First, we removed cases with missing NCES school and district identifiers because we could not link these cases to districts and schools for later merging and analyses. After employing this restriction, across the survey years, 0.9% of middle and 2.4% of high school students and 7.5% of teachers and noninstructional staff cases were removed. Second, we removed duplicate cases across all respondents with the same exact responses on student and school identifiers, demographic variables, and all survey items. Removing duplicate cases occurred most often with middle (4.4%) and high (5.1%) school students, compared to teacher and noninstructional staff (1.1%). Third, we removed cases with missing values for survey items. This approach only applied to noninstructional staff who could choose "I do not know" as a response category in the survey for some items and resulted in the removal of 6.4% of cases for noninstructional staff. Following the approach used on the prior project with PDE, we recoded these responses as missing and removed respondents with any missing values. Fourth, sometimes schools administered the surveys multiple times during the year (for example, in the fall, winter, and spring). To avoid overcounting students for the purposes of response rates, we retained respondents from the earliest survey window (fall, winter, or spring) in each school in each year based on survey administration start and end dates provided by PDE (An alternative approach could have been to construct an average score for each respondent across survey windows, but the data did not include a unique identifier for each respondent, so this was not possible.). Last, we excluded student respondents with listed grade levels that were outside the CCD-reported grade range for middle and high school students. In addition to the analyses in research question 1, the school climate index and domain scores used in research questions 2 and 3 also were calculated based on data that included these sample restrictions.

For research questions 2 and 3, we conducted analyses with several samples of schools. Because these analyses focus on understanding how school climate scores change over time, it was important to use samples that had the same schools present in each year. In both samples, a school was counted as having data for teachers or students, respectively, if the school had at least five teacher respondents and 25 student respondents in a given year.

For the main analyses, there were two samples of interest: (1) a sample of schools with student data in 2018/19, 2020/21, and 2021/22 and (2) a sample of schools with teacher data in 2018/19, 2020/21, and 2021/22. (In all cases, schools with teacher data also had noninstructional staff respondents, so this sample is also used for any adult respondent.). This sample was smaller than expected because many schools who took the survey only took it for a single year. To supplement analyses with this sample, we also constructed an alternative set of samples: (1) a sample of schools with student data in 2018/19 and 2021/22 and (2) a sample of schools with teacher data in 2018/19 and 2021/22. Last, we also used a set of pre-COVID samples, which enabled the team to understand how school climate scores tended to change from year to year in a set of pre-COVID years. This included (1) a sample of schools with student data in 2016/17, 2017/18, and 2018/19 and (2) a sample of schools with teacher data in 2016/17, 2017/18, and 2018/19. The purpose of this analysis is to understand whether there were typically changes in school climate from one year to the next before COVID and whether there were any preexisting trends in school climate before COVID. This helps place the patterns observed in the main analysis (assessing school climate in the 2018/19, 2020/21, and 2021/22 school years) into context. For instance, if school climate was steadily decreasing before

COVID and continued to do so after COVID, one would be able to interpret this pattern in the context of preexisting declines. The counts for schools included in each analysis are presented in table A2.

The sample used in research question 3 analyses included the group of schools that have school climate data for the 2018/19 school year and the 2021/22 school year. In addition, all schools in this analysis are required to belong to a school district that has Return to Learn Tracker data. The team further aggregated this sample of schools to the district level for the analyses.

Table A2. Sample sizes by research question and analysis sample for the analyses presented in the slides

Research question	Analysis sample	Sample size
Research question 1		
Middle school survey 2016/17	Middle school student respondents	8,265 students 39 schools
Middle school survey 2017/18	Middle school student respondents	10,860 students 43 schools
Middle school survey 2018/19	Middle school student respondents	16,400 students 71 schools
Middle school survey 2020/21	Middle school student respondents	9,092 students 41 schools
Middle school survey 2021/22	Middle school student respondents	22,011 students 70 schools
High school survey 2016/17	High school student respondents	15,444 students 46 schools
High school survey 2017/18	High school student respondents	20,857 students 61 schools
High school survey 2018/19	High school student respondents	23,602 students 77 schools
High school survey 2020/21	High school student respondents	12,739 students 46 schools
High school survey 2021/22	High school student respondents	29,781 students 73 schools
Classroom teacher survey 2016/17	Classroom teacher respondents	2,221 classroom teachers 94 schools
Classroom teacher survey 2017/18	Classroom teacher respondents	4,075 classroom teachers 181 schools
Classroom teacher survey 2018/19	Classroom teacher respondents	4,565 classroom teachers 214 schools
Classroom teacher survey 2020/21	Classroom teacher respondents	3,047 classroom teachers 126 schools
Classroom teacher survey 2021/22	Classroom teacher respondents	6,390 classroom teachers 262 schools
Noninstructional staff survey 2016/17	Noninstructional staff respondents	926 noninstructional staff 88 schools
Noninstructional staff survey 2017/18	Noninstructional staff respondents	1,851 noninstructional staff 176 schools
Noninstructional staff survey 2018/19	Noninstructional staff respondents	1,971 noninstructional staff 213 schools
Noninstructional staff survey 2020/21	Noninstructional staff respondents	1,513 noninstructional staff 128 schools
Noninstructional staff survey 2021/22	Noninstructional staff respondents	2,752 noninstructional staff 259 schools
Research question 2		
Change in students' school climate scores pre-COVID	Schools with at least 25 student respondents in all the following school years: 2016/17, 2017/18, and 2018/19	29 schools
Change in teachers' or adults' school climate scores pre-COVID	Schools with at least 5 teacher respondents in all the following school years: 2016/17, 2017/18, and 2018/19	28 schools
Change in students' school climate in school years included in the main analysis.	Schools with at least 25 student respondents in all the following school years: 2018/19, 2020/21, and 2021/22	18 schools

Research question	Analysis sample	Sample size
Change in students' school climate scores in school years included in the main analysis. (alternative)	Schools with at least 25 student respondents in all the following school years: 2018/19 and 2021/22	30 schools
Change in teachers' or adults' school climate scores in school years included in the main analysis.	Schools with at least 5 teacher respondents in all the following school years: 2018/19, 2020/21, and 2021/22	28 schools
Change in teachers' or adults' school climate scores in school years included in the main analysis. (alternative)	Schools with at least 5 teacher respondents in all the following school years: 2018/19 and 2021/22	52 schools
Research question 3		
Were different learning modalities used in the 2020/21 school year associated with students' school climate scores in 2021/22 (controlling for 2018/19 school climate scores)?	Districts with at least one school that has 25 student respondents in the 2018/19 and 2021/22 school years **as well as** learning modality data from the Return to Learn Tracker	25 schools; 15 districts
Were different learning modalities used in the 2020/2021 school year associated with teachers' or adults' school climate scores in 2021/22 (controlling for 2018/19 school climate scores)?	Districts with at least one school that has at least 5 teacher respondents in the 2018/19 and 2021/22 school years **as well as** learning modality data from the Return to Learn Tracker	47 schools; 18 districts

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22 (all research questions) and Return to Learn Tracker data (research question 3).

Descriptive comparisons of schools in the sample to all other schools in the state

For research questions 2 and 3, we were interested in assessing how comparable the schools included in these analytical samples were to the rest of schools in Pennsylvania that were not in our sample, given that the responses are limited to schools that chose to use the surveys. The study team assessed whether the schools in each analytic sample were similar to all other schools in Pennsylvania by testing for differences in school characteristics among schools included in research question 2 and 3 analyses and all other schools in the state within the 2018/19 school year. This particular school year was selected for this analysis because all schools in the analytic samples for research questions 2 and 3 have survey data in 2018/19 and because it is a pre-COVID year. The school-level characteristics used to assess representativeness were student gender, student race, urbanicity, and percentage of students eligible for free or reduced-price lunch under the National School Lunch Program (table A3 for student samples and A4 for teacher samples). All school-level characteristics were taken from CCD.

To test for differences among schools in the analysis samples and all other schools across the state, the team compared the school-level characteristics for schools in each sample to the school-level characteristics for all other schools in Pennsylvania. To do so, an independent samples *t*-test was used to assess whether the schools in the sample differed from all other schools in the state with a significance level of 0.05.

All schools in the sample had an overrepresentation of White students and an underrepresentation of students that identified as Asian /Pacific Islander or Black. In addition, urban schools were less represented in the samples compared to the rest of schools in the state. Last, schools serving higher percentages of students eligible for the National School Lunch Program were underrepresented in all samples except for two (student and teacher pre-COVID samples) relative to the rest of the state.

Table A3. Differences between schools in the student analysis samples for RQ2 and RQ3 and all other schools in Pennsylvania, 2018/19

Covariates and units	RQ2 student sample (pre-COVID)			RQ2 student sample (main analysis)			RQ2 student alternative sample (main analysis)			RQ3 student sample		
	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference
Students' gender												
Female	0.482	0.485	-0.003	0.482	0.485	-0.003	0.483	0.485	-0.002	0.483	0.485	0.001
Students' race/ethnicity												
American Indian/ Alaska Native	0.002	0.002	0.000	0.001	0.002	0.000	0.001	0.002	0.000	0.001	0.002	0.000*
Asian or Pacific Islander	0.006	0.035	-0.029*	0.011	0.035	-0.024*	0.009	0.035	-0.026*	0.010	0.035	-0.024*
Black	0.053	0.149	-0.096*	0.050	0.149	-0.099*	0.043	0.150	-0.107*	0.045	0.151	-0.120*
Hispanic	0.089	0.104	-0.014	0.036	0.104	-0.068*	0.055	0.104	-0.049*	0.060	0.104	-0.045*
Multiracial	0.031	0.043	-0.012	0.039	0.043	-0.004	0.034	0.043	-0.009	0.034	0.043	-0.008
White	0.818	0.667	0.151*	0.863	0.668	0.195*	0.858	0.667	0.191*	0.850	0.665	0.196*
Urbanicity												
Urban	0.083	0.207	-0.124*	0.000	0.207	-0.207*	0.000	0.208	-0.208*	0.000	0.209	-0.187*
Suburban	0.250	0.461	-0.211*	0.667	0.458	0.209	0.536	0.458	0.078	0.520	0.457	0.121
Town	0.417	0.092	0.325*	0.133	0.094	0.039	0.214	0.093	0.121	0.240	0.094	0.040
Rural	0.250	0.241	0.009	0.200	0.241	-0.041	0.250	0.241	0.009	0.240	0.240	0.026
Students' income												
Eligible for free or reduced-price lunch	0.563	0.527	0.036	0.379	0.528	-0.150*	0.436	0.528	-0.092*	0.425	0.530	-0.133*
Number of schools	**24**	**2637-2644**		**15**	**2646-2653**		**28**	**2633-2640**		**25**	**2636-2643**	

RQ is research question.

Note: Every analysis sample of students used in research questions 2 and 3 was compared to all other schools in Pennsylvania. The mean difference represents the simple difference between the average of schools in the sample (sample mean) and all other schools in the state (out-of-sample mean). * Indicates a statistical difference between the sample mean and the state mean at $p < .05$. The number of schools varies in the state sample because some schools in the state are missing data from Common Core of Data for some school characteristics.

Source: National Center for Education Statistics' Common Core of Data, 2018/19.

Table A4. Differences between schools in the teacher analysis samples for RQ2 and RQ3 and all other schools in Pennsylvania, 2018/19

Covariates and units	RQ2 teacher sample (pre-COVID)			RQ2 teacher sample (main analysis)			RQ2 teacher alternative sample (main analysis)			RQ3 teacher sample		
	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference	Sample mean	Out-of-sample mean	Mean difference
Students' gender												
Female	0.474	0.485	-0.011*	0.494	0.485	0.009	0.486	0.485	0.001	0.486	0.485	0.001
Students' race/ethnicity												
American Indian/ Alaska Native	0.002	0.002	0.000	0.001	0.002	0.000	0.001	0.002	0.000	0.001	0.002	0.000*
Asian or Pacific Islander	0.007	0.035	-0.029*	0.015	0.035	-0.020*	0.011	0.035	-0.025*	0.012	0.035	-0.024*
Black	0.035	0.150	-0.115*	0.025	0.150	-0.125*	0.032	0.151	-0.119*	0.031	0.151	-0.120*
Hispanic	0.066	0.104	-0.038	0.030	0.104	-0.075*	0.057	0.104	-0.047*	0.060	0.104	-0.045*
Multiracial	0.032	0.043	-0.011	0.039	0.043	-0.004	0.036	0.043	-0.007	0.035	0.043	-0.008
White	0.859	0.667	0.192*	0.890	0.667	0.224*	0.864	0.665	0.199*	0.861	0.665	0.196*
Urbanicity												
Urban	0.043	0.208	-0.164*	0.000	0.208	-0.208*	0.020	0.210	-0.189*	0.022	0.209	-0.187*
Suburban	0.217	0.461	-0.243*	0.708	0.457	0.252*	0.571	0.457	0.115	0.578	0.457	0.121
Town	0.435	0.091	0.343*	0.083	0.095	-0.011	0.122	0.094	0.029	0.133	0.094	0.040
Rural	0.304	0.240	0.064	0.208	0.241	-0.033	0.286	0.240	0.046	0.267	0.240	0.026
Students' income												
Eligible for free or reduced-price lunch	0.485	0.528	-0.043	0.308	0.529	-0.221*	0.414	0.530	-0.115*	0.396	0.530	-0.133*
Number of schools	23	2638-2645		24	2637-2644		49	2612-2619		45	2616-2623	

RQ is research question.

Note: Every analysis sample of teachers used in research questions 2 and 3 was compared to all schools in Pennsylvania. The mean difference represents the simple difference between the average of schools in the sample (sample mean) and all other schools in the state (out-of-sample mean). * Indicates a statistical difference between the sample mean and the state mean at $p < .05$. The number of schools varies in the state sample because some schools in the state are missing data from Common Core of Data for some school characteristics.

Source: National Center for Education Statistics' Common Core of Data, 2018/19.

Research Methods

Research question 1. Did pandemic-related disruptions affect the validity of the school climate survey?

One concern with using the school climate survey to assess changes in school climate during COVID is that it was developed and validated before COVID-19 school shutdowns, and a few survey items assume students are receiving in-person instruction. Students, teachers, and non-instructional staff were not given explicit instructions on responding to these questions if they were only experiencing virtual instruction during the survey. As such, survey items assuming in-person learning may perform more poorly in the years with hybrid or remote instruction.

To assess whether COVID-19 pandemic-related disruptions affected the psychometric properties of the school climate survey, we estimated a structural equation model for confirmatory factor analysis (CFA) using Stata 17 software separately for each respondent type (middle school students, high school students, classroom teachers, and noninstructional staff) by year to test whether the grouping of items is appropriate in each previously specified domain and whether the domain structure changed during the COVID-affected years. Because the survey items differ for classroom teachers and noninstructional staff (seven items within the student support and academic engagement domain only apply to classroom teachers), we conducted the analyses separately for the teachers and noninstructional staff groups. The study team then compared the CFA results for the school years before COVID-19 (2016/17, 2017/18, and 2018/19) to those for school years affected by COVID-19 (2020/21 and 2021/22) to assess whether any survey items performed worse than usual during both COVID years (2020/21 and 2021/22) or during 2020/21 alone. (The 2020/21 school year was the year with the most hybrid/remote instruction, but some disruptions continued into 2021/22).

The CFA models estimate standardized factor loadings and correlations between latent factors. Standardized factor loadings indicate the strength of the associations between the survey items and the underlying latent construct corresponding to each domain. Latent constructs are theoretical; they exist in the world but are challenging to observe directly (for example, safe and respectful school climate). If all factor loadings are greater than 0.70, this is good evidence for convergent validity, meaning the items are closely related to each other and the underlying laten construct. Items with factor loadings less than 0.40 suggest weaker associations with the latent construct (Stevens, 2012), suggesting that the item is not contributing to the measurement of the latent construct and, therefore, is recommended for removal from the scale for that domain. Correlations between latent factors provide evidence of discriminant validity (the extent to which the individual factors capture different underlying constructs). A high correlation (greater than 0.85) between two latent factors suggests that they measure the same underlying construct.

We used the maximum likelihood estimator to produce our results. We modeled the survey items as continuous variables. The analyses also account for the clustering of respondents within schools. For each survey in each year, we estimated two sets of models: initial models and revised/final models. Each model includes three latent factors that correspond to the three domains of school climate defined in the survey: (1) social-emotional learning, (2) student support and academic engagement, and (3) safe and respectful school climate. First, we fit models with the items grouped in the domains validated in the prior work for PDE for the 2016/17 and 2017/18 school years to examine how the model fits the data across the 2016/17 to 2021/22 school years. Table A5 presents the three overall model fit criteria we considered for assessing whether the data support the grouping of items into the specified domains (that is, assessing model fit)[1]. As displayed in table A6, most initial models demonstrated poor fit across respondents and years. In addition, as indicated in tables A7 to A10, the initial models show factor loadings below the acceptable 0.40 cutoff for some items in the models, suggesting that these items do not contribute much to the measurement of the latent constructs and can be removed from the measurement model. The poor model fit statistics also suggest the need for consideration of alternative configurations of items.

---

[1] These are standard thresholds used in the structural equation model literature to assess whether the model has acceptable fit.

Next, we revised, finalized, and re-estimated the models to improve the overall fit (revised/final models) by excluding survey items with less than 0.40 factor loadings across all school years, adding covariances between error term indicators based on modification indices (post-hoc empirical and theory-based criteria) provided in the CFA output to improve overall fit and calculating correlations to confirm discriminant validity. In measurement models, it is assumed that each item partially captures the latent construct (true score) and that all other omitted causes or components are due to noise (measurement error, the residual variance in an item not explained by the latent factor). The error terms of items are assumed to be independent of one another and the factors. However, if in fact the error terms are correlated across items, then the fit statistics might suggest poor fit, even though the item groupings in the domain are appropriate. Therefore, we respecified the model to consider the alternative configuration of items by removing restrictions on correlations between error terms and examining modification indices provided in the CFA output to suggest how the overall model fit would change in a particular way if we applied correlations between error terms, as specified in the modification indices.

As displayed in table A11, after excluding the items with less than 0.40 factor loadings across all years and remodeling based on the modification indices, the revised/final models demonstrated acceptable overall model fit consistently across school years for all respondent surveys. The Comparative Fit Index and the Tucker-Lewis Index estimates (except for some Tucker-Lewis Index statistics falling just under the cutoff of 0.90) are at or above the acceptable limit of 0.90, and all the Root Mean Square Error of Approximation estimates are at less than 0.05 or between the 0.05 and 0.08 cutoff for the models. As seen in tables A12 to A15, the revised CFA models show that most of the factor loadings are above the acceptable 0.40 cutoff. A few factor loadings fall below the acceptable 0.40 cutoff, but this is inconsistent across years, so we retain these items. See table A16 for the list of survey items with less than 0.40 factor loadings that were removed from the revised/final models.

Tables A17 to A21 show correlations between the latent factors for the revised/final models across surveys and school years. The correlations between the latent factors were less than or equal to 0.85 across all school years for the middle and high school surveys, suggesting that the factors do not exhibit discriminant validity; that is, they measure the same underlying construct. For the classroom teacher and noninstructional staff surveys, the correlations between latent factors were above 0.85 for some of the latent factors for some school years, but not all.[2] In the previous REL study that was focused on assessing the validity of PDE's school climate survey in 2016/17 and 2017/18, the REL research team combined domains that showed high correlations between latent factors across all types of respondents (students, teachers, noninstructional staff) in all years (Amos and Xue, 2021). Using this rule, the team combined two domains into a single domain, which created three distinct survey domains for use in this study (social-emotional learning, student support and academic engagement, and safe and respectful school climate). For consistency, in this study we use the same approach as the previous study. Therefore, we do not combine the domains into a single factor in the revised/final models because these correlation findings are not consistently above the 0.85 cutoff for all types of respondents in all years.[3] This ensures that the domains for students and the domains for classroom teachers and non-instructional staff are consistent with one another. It is also important to note that if the team had combined the three domains for teachers and noninstructional staff into a single domain, the main findings from the study would have been unchanged. (The two main takeaways from the study are that school climate scores were higher overall and in almost all domains in 2020/21 compared to either 2018/19 or 2021/22 for both teachers and students, and that there was no evidence of a decline in students' or teachers' perceptions of school climate between 2018/19 and 2021/22.)

---

[2] While we follow the threshold used in Amos and Xue (2021) that domains should be combined if their correlations are above 0.85, some authors in the literature suggest a cutoff of 0.90 to assess if constructs are conceptually similar enough to be combined (for example, Henseler et al., 2015; Kline, 2011).

[3] For example, in several school years, the social-emotional learning and safe and respectful school climate domains had correlations above 0.85 for the classroom teacher (2017/18, 2018/19, 2021/22) and noninstructional staff (2016/17, 2017/18, 2021/22) surveys. Also, in the COVID-affected school years, the student support and academic engagement and safe and respectful school climate domains had correlations above 0.85 for the classroom teacher (2020/21, 2021/22) and noninstructional staff (2020/21) surveys.

Last, to confirm that the COVID-19 pandemic did not influence the psychometric properties of the school climate surveys in the COVID-affected school years, we examined whether any items in the revised/final models exhibited poor fit during both COVID school years (2020/21 and 2021/22) or during 2020/21 alone, as this year was the one with the most hybrid and remote instruction. We discuss the findings from this exercise in appendix B.

Table A5. Recommended overall model fit statistics for confirmatory factor analysis

Fit statistics	Recommended fit
Comparative Fit Index (CFI; Bentler, 1990)	Brown (2015) suggests that a value of 0.90 or above is acceptable.
Tucker-Lewis Index (TLI; Tucker & Lewis, 1973)	The TLI is designed to correct for the complexity of the model and is sensitive to small sample sizes. Brown (2015) suggests that a value of 0.90 or above is acceptable.
Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980)	RMSEA is sensitive to model complexity. MacCallum et al. (1996) suggest that 0.01, 0.05, and 0.08 for RMSEA indicate excellent, good, and mediocre fit, respectively.

Table A6. Fit statistics for the initial models

Statistic	Suggested	Year	Middle school student survey	High school student survey	Classroom teacher survey	Noninstructional staff survey
Comparative Fit Index	≥ 0.90	2016/17	**0.769**	**0.738**	**0.711**	**0.719**
		2017/18	**0.773**	**0.719**	**0.708**	**0.764**
		2018/19	**0.785**	**0.725**	**0.711**	**0.742**
		2020/21	**0.793**	**0.780**	**0.702**	**0.740**
		2021/22	**0.778**	**0.736**	**0.751**	**0.806**
Tucker-Lewis Index	≥ 0.90	2016/17	**0.756**	**0.723**	**0.695**	**0.701**
		2017/18	**0.760**	**0.703**	**0.692**	**0.748**
		2018/19	**0.773**	**0.709**	**0.695**	**0.726**
		2020/21	**0.781**	**0.768**	**0.686**	**0.723**
		2021/22	**0.765**	**0.721**	**0.737**	**0.793**
Root Mean Square Error of Approximation	< 0.05–0.08	2016/17	0.065	0.076	**0.081**	**0.094**
		2017/18	0.066	**0.081**	**0.081**	**0.086**
		2018/19	0.064	0.078	**0.081**	**0.088**
		2020/21	0.066	0.080	**0.083**	**0.087**
		2021/22	0.066	0.079	0.080	**0.082**

Note: Statistics that do not meet the threshold are bolded in the table.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, 2021/22.

Table A7. Factor loadings for middle school student survey, initial model

	2016/17		2017/18		2018/19		2020/21		2021/22	
Item	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE
Social-emotional learning										
Mq27stpt: Students in my school stop and think before doing anything when they get angry.	0.558	0.013	0.565	0.010	0.570	0.008	0.573	0.013	0.581	0.009
Mq28grpp: Students in my school do their share of the work when we have group projects.	0.481	0.012	0.492	0.011	0.475	0.009	0.468	0.018	0.437	0.012
Mq29givu: Students in my school give up when they can't solve a problem easily.	0.563	0.011	0.554	0.014	0.555	0.008	0.588	0.011	0.558	0.010

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Mq30argu: Students in my school get into arguments when they disagree with people.	0.589	0.010	0.574	0.009	0.590	0.007	0.645	0.012	0.617	0.007
Mq31dbst: Students in my school do their best, even when their school work is difficult.	0.628	0.011	0.632	0.011	0.635	0.009	0.621	0.012	0.627	0.010
Mq32okfg: Students in my school think it's OK to fight if someone insults them.	0.662	0.010	0.645	0.011	0.652	0.008	0.646	0.012	0.666	0.007
Mq33dohw: Students in my school do all their homework.	0.580	0.015	0.551	0.010	0.550	0.008	0.555	0.014	0.512	0.012
Mq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.689	0.010	0.688	0.011	0.695	0.007	0.733	0.007	0.705	0.006
Mq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.600	0.012	0.605	0.010	0.609	0.008	0.583	0.014	0.587	0.010
Mq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.645	0.010	0.621	0.010	0.642	0.008	0.646	0.009	0.657	0.007
Mq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.643	0.008	0.645	0.010	0.659	0.006	0.635	0.009	0.621	0.014
Student support and academic engagement										
Mq38cnct: My teachers often connect what I am learning to life outside the classroom.	0.527	0.015	0.567	0.011	0.576	0.009	0.577	0.011	0.587	0.009
Mq40shid: My teachers encourage students to share their ideas about things we are studying in class.	0.600	0.009	0.600	0.010	0.596	0.009	0.619	0.011	0.619	0.009
Mq43care: My teachers really care about me.	0.629	0.016	0.651	0.011	0.646	0.009	0.689	0.009	0.680	0.009
Mq44mkup: My teachers help me make up work after an excused absence.	0.627	0.011	0.640	0.011	0.641	0.009	0.641	0.011	0.650	0.008
Mq47hmwk: My teachers often assign homework that helps me learn.	0.643	0.012	0.651	0.010	0.656	0.008	0.675	0.009	0.658	0.007
Mq49adtb: Adults in this school are often too busy to give students extra help.	0.462	0.023	0.491	0.018	0.493	0.013	0.508	0.017	0.448	0.016
Mq50ruls: Adults in this school apply the same rules to all students equally.	0.576	0.011	0.583	0.010	0.592	0.007	0.610	0.018	0.607	0.008
Mq51difs: I wish I went to a different school.	0.488	0.018	0.506	0.015	0.516	0.012	0.556	0.012	0.500	0.011

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Mq52exth: I can get extra help at school outside of my regular classes.	0.432	0.016	0.458	0.017	0.457	0.012	0.475	0.016	0.454	0.011
Mq53cnsl: A counselor at this school has helped me plan for life after high school.	0.364	0.012	0.361	0.020	0.352	0.016	0.394	0.019	0.355	0.011
Mq55extra: Adults in this school are usually willing to take the time to give students extra help.	0.656	0.010	0.673	0.010	0.697	0.008	0.685	0.010	0.677	0.007
Mq64ntct: Teachers notice if I have trouble learning something.	0.601	0.010	0.610	0.010	0.589	0.008	0.620	0.014	0.611	0.010
Mq65hlpi: This school will help me improve my work if I do poorly on an assignment.	0.657	0.010	0.659	0.008	0.657	0.007	0.685	0.009	0.664	0.006
Mq66trtd: This school treats some students better than others.	0.547	0.020	0.527	0.018	0.550	0.011	0.588	0.013	0.534	0.011
Mq67topc: In my classes, the topics we are studying are interesting and challenging.	0.546	0.011	0.557	0.010	0.546	0.009	0.546	0.014	0.551	0.009
Mq68mkth: This class really makes me think.	0.544	0.015	0.503	0.014	0.489	0.009	0.537	0.011	0.506	0.013
Mq69ubrd: I am usually bored in this class.	0.543	0.017	0.458	0.016	0.486	0.013	0.516	0.014	0.459	0.014
Safe and respectful school climate										
Mq13blly: Students at this school are often bullied.	0.667	0.018	0.702	0.010	0.694	0.009	0.730	0.011	0.715	0.008
Mq14thrn: Students at this school are often threatened.	0.627	0.015	0.647	0.013	0.646	0.009	0.661	0.011	0.675	0.009
Mq15tsed: Students at this school are often teased or picked on.	0.652	0.016	0.678	0.010	0.673	0.010	0.699	0.012	0.685	0.006
Mq16blyc: Students at this school are often bullied because of certain characteristics (for example, race, religion, or weight).	0.593	0.015	0.645	0.010	0.629	0.009	0.686	0.012	0.665	0.008
Mq18sthm: I sometimes stay home because I don't feel safe at school.	0.392	0.011	0.415	0.016	0.399	0.011	0.454	0.017	0.458	0.012
Mq19sfos: How safe do you feel outside around the school?	0.375	0.020	0.403	0.018	0.367	0.015	0.401	0.016	0.383	0.012
Mq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.463	0.016	0.475	0.016	0.454	0.013	0.491	0.015	0.481	0.013
Mq21sfcs: How safe do you feel in your classes?	0.408	0.019	0.433	0.016	0.412	0.014	0.440	0.014	0.436	0.013
Mq22dntc: Students in my school don't really care about each other.	0.608	0.017	0.620	0.013	0.614	0.010	0.622	0.011	0.605	0.010

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Mq23ptth: Students in my school like to put others down.	0.701	0.013	0.708	0.010	0.720	0.009	0.733	0.010	0.725	0.007
Mq24dntg: Students in my school don't get along together well.	0.648	0.014	0.647	0.011	0.629	0.009	0.633	0.013	0.631	0.007
Mq25lkot: Students in my school just look out for themselves.	0.482	0.016	0.531	0.010	0.502	0.012	0.536	0.014	0.473	0.011
Mq26trtr: Students in my school treat each other with respect.	0.483	0.023	0.491	0.015	0.512	0.011	0.510	0.014	0.483	0.014

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A8. Factor loadings for high school student survey, initial model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Hq27stpt: Students in my school stop and think before doing anything when they get angry.	0.551	0.011	0.538	0.013	0.524	0.009	0.630	0.024	0.539	0.011
Hq28grpp: Students in my school do their share of the work when we have group projects.	0.522	0.008	0.510	0.012	0.486	0.008	0.526	0.016	0.466	0.013
Hq29givu: Students in my school give up when they can't solve a problem easily.	0.577	0.015	0.561	0.015	0.558	0.009	0.632	0.019	0.575	0.011
Hq30argu: Students in my school get into arguments when they disagree with people.	0.575	0.018	0.571	0.014	0.563	0.010	0.701	0.036	0.632	0.011
Hq31dbst: Students in my school do their best, even when their school work is difficult.	0.624	0.008	0.615	0.013	0.612	0.009	0.643	0.017	0.585	0.012
Hq32okfg: Students in my school think it's OK to fight if someone insults them.	0.652	0.012	0.628	0.017	0.628	0.008	0.708	0.030	0.664	0.008
Hq33dohw: Students in my school do all their homework.	0.607	0.010	0.600	0.012	0.586	0.009	0.635	0.013	0.581	0.011
Hq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.660	0.013	0.658	0.015	0.649	0.009	0.760	0.029	0.700	0.009
Hq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.581	0.010	0.577	0.013	0.575	0.010	0.637	0.022	0.559	0.010
Hq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.633	0.013	0.614	0.012	0.608	0.009	0.708	0.029	0.636	0.010
Hq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.633	0.008	0.621	0.012	0.626	0.009	0.659	0.016	0.596	0.011

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Student support and academic engagement										
Hq38cnct: My teachers often connect what I am learning to life outside the classroom.	0.637	0.011	0.658	0.009	0.634	0.007	0.675	0.012	0.646	0.012
Hq40shid: My teachers encourage students to share their ideas about things we are studying in class.	0.667	0.013	0.685	0.009	0.661	0.008	0.701	0.013	0.671	0.008
Hq43care: My teachers really care about me.	0.687	0.010	0.709	0.006	0.695	0.005	0.726	0.008	0.708	0.008
Hq44mkup: My teachers help me make up work after an excused absence.	0.682	0.008	0.685	0.007	0.689	0.006	0.701	0.008	0.688	0.007
Hq47hmwk: My teachers often assign homework that helps me learn.	0.662	0.008	0.660	0.011	0.669	0.005	0.729	0.013	0.686	0.008
Hq49adtb: Adults in this school are often too busy to give students extra help.	0.459	0.015	0.426	0.020	0.441	0.014	0.547	0.021	0.420	0.019
Hq50ruls: Adults in this school apply the same rules to all students equally.	0.540	0.011	0.556	0.010	0.533	0.008	0.621	0.014	0.549	0.009
Hq51difs: I wish I went to a different school.	0.467	0.017	0.461	0.019	0.444	0.013	0.556	0.016	0.443	0.018
Hq52exth: I can get extra help at school outside my regular classes.	0.493	0.015	0.511	0.016	0.533	0.013	0.556	0.022	0.507	0.009
Hq53cnsl: A counselor at this school has helped me plan for life after high school.	0.389	0.013	0.390	0.014	0.390	0.012	0.441	0.031	0.386	0.012
Hq54advw: When students in this school already know the material that is being taught, the teacher gives them more advanced assignments.	0.364	0.012	0.396	0.013	0.366	0.011	0.356	0.017	0.364	0.012
Hq55extra: Adults in this school are usually willing to take the time to give students extra help.	0.675	0.008	0.679	0.007	0.687	0.007	0.703	0.014	0.670	0.006
Hq64ntct: Notice if I have trouble learning something.	0.626	0.009	0.650	0.006	0.636	0.006	0.684	0.012	0.653	0.007
Hq65hlpi: Will help me improve my work if I do poorly on an assignment.	0.691	0.006	0.703	0.006	0.694	0.006	0.743	0.010	0.700	0.007
Hq67topc: The topics we are studying are interesting and challenging.	0.624	0.012	0.630	0.009	0.617	0.008	0.679	0.014	0.628	0.012
Hq68mkth: This class really makes me think.	0.586	0.013	0.591	0.010	0.563	0.008	0.638	0.016	0.585	0.012
Hq69ubrd: I am usually bored in this class.	0.439	0.024	0.412	0.022	0.418	0.012	0.546	0.019	0.436	0.023
Safe and respectful school climate										
Hq13blly: Students at this school are often bullied.	0.750	0.014	0.778	0.012	0.730	0.013	0.837	0.021	0.781	0.009
Hq14thrn: Students at this school are often threatened.	0.708	0.012	0.733	0.011	0.683	0.009	0.780	0.021	0.737	0.010
Hq15tsed: Students at this school are often teased or picked on.	0.731	0.017	0.757	0.014	0.704	0.012	0.819	0.029	0.751	0.010

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Hq16blyc: Students at this school are often bullied because of certain characteristics (for example, race, religion, or weight).	0.696	0.014	0.733	0.013	0.685	0.010	0.800	0.024	0.733	0.010
Hq18sthm: I sometimes stay home because I don't feel safe at school.	0.443	0.013	0.428	0.009	0.435	0.011	0.505	0.014	0.506	0.008
Hq19sfos: How safe do you feel outside around the school?	0.442	0.012	0.424	0.014	0.412	0.011	0.471	0.015	0.450	0.011
Hq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.501	0.011	0.505	0.013	0.490	0.010	0.541	0.011	0.534	0.010
Hq21sfcs: How safe do you feel in your classes?	0.454	0.013	0.446	0.013	0.445	0.012	0.490	0.014	0.468	0.010
Hq22dntc: Students in my school don't really care about each other.	0.594	0.014	0.615	0.011	0.636	0.011	0.638	0.011	0.621	0.009
Hq23ptth: Students in my school like to put others down.	0.726	0.009	0.734	0.009	0.751	0.007	0.796	0.012	0.752	0.006
Hq24dntg: Students in my school don't get along together well.	0.676	0.011	0.674	0.010	0.693	0.007	0.724	0.015	0.684	0.007
Hq25lkot: Students in my school just look out for themselves.	0.571	0.014	0.584	0.012	0.596	0.010	0.624	0.012	0.576	0.011
Hq26trtr: Students in my school treat each other with respect.	0.486	0.010	0.442	0.020	0.461	0.012	0.539	0.018	0.461	0.016

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A9. Factor loadings for classroom teacher survey, initial model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Sq27stpt: Students in my school stop and think before doing anything when they get angry.	0.666	0.020	0.674	0.016	0.668	0.016	0.631	0.020	0.695	0.013
Sq28grpp: Students in my school do their share of the work on group projects.	0.600	0.018	0.616	0.013	0.618	0.013	0.645	0.018	0.650	0.011
Sq29givu: Students in my school give up when they can't solve a problem easily.	0.650	0.017	0.664	0.013	0.657	0.012	0.677	0.015	0.658	0.012
Sq30argu: Students in my school get into arguments when they disagree with people.	0.675	0.020	0.676	0.016	0.688	0.014	0.670	0.015	0.694	0.012
Sq31dbst: Students in my school do their best, even when their school work is difficult.	0.665	0.019	0.687	0.013	0.700	0.010	0.728	0.014	0.717	0.010
Sq32okfg: Students in my school think it's OK to fight if someone insults them.	0.716	0.020	0.717	0.016	0.733	0.014	0.686	0.013	0.756	0.012
Sq33dohw: Students in my school do all their homework.	0.557	0.020	0.608	0.016	0.625	0.015	0.667	0.016	0.651	0.012
Sq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.695	0.018	0.683	0.016	0.718	0.012	0.700	0.017	0.735	0.012
Sq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.597	0.021	0.640	0.014	0.624	0.012	0.622	0.017	0.653	0.012
Sq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.589	0.019	0.618	0.020	0.627	0.016	0.633	0.034	0.680	0.014
Sq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.667	0.018	0.686	0.013	0.676	0.012	0.703	0.013	0.705	0.010
Student support and academic engagement										
Sq40shid: I encourage students to share their ideas about things we are studying in class.	0.358	0.031	0.400	0.021	0.460	0.024	0.498	0.025	0.461	0.019
Sq42prep: I prepare all students for success in the next grade, in college, or in a job.	0.434	0.030	0.444	0.022	0.463	0.026	0.530	0.025	0.503	0.018
Sq43care: I really care about my students.	0.366	0.034	0.363	0.019	0.361	0.023	0.370	0.027	0.339	0.021
Sq44mkup: I help my students make up work after an excused absence.	0.407	0.029	0.410	0.022	0.408	0.032	0.436	0.028	0.398	0.026

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Sq45fdbk: I give my students feedback on class assignments that helps improve their work.	0.383	0.035	0.438	0.020	0.426	0.029	0.460	0.030	0.432	0.024
Sq46acom: I provide accommodations to students who need them.	0.372	0.029	0.400	0.019	0.410	0.029	0.415	0.028	0.378	0.022
Sq48chwk: I believe all students can do challenging school work.	0.345	0.029	0.372	0.019	0.391	0.018	0.435	0.020	0.395	0.017
Sq54advw: When students in this school already know the material that is being taught, they are given more advanced assignments.	0.539	0.021	0.519	0.018	0.520	0.015	0.581	0.019	0.573	0.014
Sq70asks: The principal asks students about their ideas.	0.500	0.026	0.520	0.019	0.494	0.025	0.512	0.025	0.553	0.020
Sq71effc: Students and parents receive effective communication about academic progress.	0.554	0.022	0.488	0.017	0.539	0.015	0.548	0.023	0.542	0.017
Sq72frtr: When students break rules, they are treated fairly.	0.585	0.026	0.573	0.020	0.572	0.023	0.603	0.021	0.647	0.016
Sq73hpwk: I am happy working at this school.	0.675	0.019	0.674	0.017	0.661	0.019	0.649	0.022	0.697	0.014
Sq74schp: This school is making steady progress implementing rigorous academic standards.	0.691	0.021	0.674	0.018	0.673	0.019	0.680	0.017	0.719	0.014
Sq76stfa: In this school, staff members have a 'can do' attitude.	0.620	0.021	0.593	0.019	0.585	0.018	0.618	0.019	0.609	0.017
Sq78hnra: Students in this school are encouraged to take advanced classes, such as honors, Advanced Placement (AP), or International Baccalaureate (IB), or classes that lead to professional certification.	0.448	0.033	0.354	0.028	0.324	0.029	0.369	0.028	0.358	0.023
Sq79poss: This school provides positive experiences for students.	0.749	0.018	0.719	0.013	0.720	0.012	0.761	0.013	0.752	0.011
Safe and respectful school climate										
Sq7crime: This school is badly affected by crime and violence in the community.	0.544	0.041	0.538	0.023	0.517	0.027	0.462	0.028	0.550	0.021
Sq8posp: This school provides positive experiences for parents/community members.	0.492	0.030	0.506	0.024	0.549	0.020	0.533	0.023	0.562	0.017
Sq9welcm: This school provides a welcoming environment.	0.594	0.022	0.582	0.022	0.597	0.023	0.612	0.021	0.649	0.018
Sq14thrn: Students at this school are often threatened.	0.650	0.031	0.624	0.020	0.622	0.017	0.551	0.021	0.683	0.016

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Sq16blyc: Students at this school are often bullied because of certain characteristics (for example, their race, religion, weight, or sexual orientation).	0.572	0.027	0.582	0.017	0.586	0.024	0.549	0.018	0.622	0.014
Sq17sfen: This school provides a safe environment for teaching and learning.	0.685	0.027	0.636	0.022	0.657	0.022	0.604	0.024	0.714	0.017
Sq19sfos: How safe do you feel outside around the school?	0.615	0.034	0.517	0.024	0.477	0.027	0.442	0.027	0.544	0.021
Sq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.656	0.030	0.593	0.022	0.569	0.029	0.523	0.025	0.668	0.019
Sq21sfcs: How safe do you feel in classroom or work area?	0.600	0.029	0.554	0.022	0.500	0.026	0.480	0.026	0.590	0.019
Sq22dntc: Students in my school don't really care about each other.	0.685	0.018	0.705	0.014	0.713	0.012	0.682	0.022	0.727	0.011
Sq23ptth: Students in my school like to put others down.	0.724	0.022	0.749	0.014	0.746	0.013	0.728	0.017	0.750	0.012
Sq24dntg: Students in my school don't get along together very well.	0.698	0.022	0.718	0.014	0.718	0.012	0.702	0.017	0.727	0.012
Sq25lkot: Students in my school just look out for themselves.	0.667	0.016	0.697	0.016	0.697	0.012	0.677	0.028	0.716	0.011
Sq26trtr: Students in my school treat each other with respect.	0.702	0.020	0.686	0.014	0.692	0.016	0.633	0.019	0.716	0.012
Sq75stfi: School staff members have a lot of informal opportunities to influence what happens here.	0.450	0.027	0.443	0.022	0.468	0.025	0.502	0.028	0.513	0.021
Sq80stfs: School staff members are supported by administration.	0.517	0.028	0.507	0.026	0.504	0.028	0.519	0.027	0.556	0.025

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A10. Factor loadings for noninstructional staff survey, initial model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Sq27stpt: Students in my school stop and think before doing anything when they get angry.	0.635	0.028	0.670	0.021	0.667	0.019	0.619	0.025	0.698	0.016
Sq28grpp: Students in my school do their share of the work on group projects.	0.603	0.032	0.619	0.020	0.579	0.020	0.607	0.024	0.638	0.017

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Sq29givu: Students in my school give up when they can't solve a problem easily.	0.664	0.028	0.707	0.018	0.685	0.017	0.642	0.027	0.725	0.013
Sq30argu: Students in my school get into arguments when they disagree with people.	0.697	0.026	0.706	0.019	0.687	0.017	0.695	0.025	0.764	0.012
Sq31dbst: Students in my school do their best, even when their school work is difficult.	0.666	0.035	0.728	0.016	0.690	0.018	0.660	0.023	0.691	0.016
Sq32okfg: Students in my school think it's OK to fight if someone insults them.	0.716	0.019	0.729	0.016	0.694	0.018	0.691	0.019	0.766	0.014
Sq33dohw: Students in my school do all their homework.	0.629	0.028	0.643	0.018	0.637	0.017	0.605	0.019	0.655	0.016
Sq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.687	0.021	0.731	0.016	0.704	0.017	0.728	0.017	0.765	0.012
Sq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.627	0.022	0.664	0.020	0.653	0.017	0.604	0.023	0.699	0.016
Sq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.653	0.023	0.645	0.021	0.672	0.019	0.655	0.023	0.684	0.014
Sq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.683	0.028	0.700	0.021	0.690	0.017	0.644	0.022	0.700	0.014
Student support and academic engagement										
Sq54advw: When students in this school already know the material that is being taught, they are given more advanced assignments.	0.583	0.032	0.561	0.021	0.525	0.023	0.566	0.023	0.583	0.019
Sq70asks: The principal asks students about their ideas.	0.659	0.029	0.567	0.023	0.593	0.022	0.634	0.022	0.617	0.019
Sq71effc: Students and parents receive effective communication about academic progress.	0.639	0.034	0.584	0.022	0.597	0.019	0.668	0.021	0.620	0.020
Sq72frtr: When students break rules, they are treated fairly.	0.692	0.025	0.629	0.020	0.666	0.021	0.686	0.022	0.695	0.014
Sq73hpwk: I am happy working at this school.	0.658	0.020	0.644	0.023	0.643	0.018	0.684	0.020	0.721	0.014
Sq74schp: This school is making steady progress implementing rigorous academic standards.	0.740	0.023	0.736	0.016	0.699	0.016	0.724	0.017	0.765	0.011
Sq76stfa: In this school, staff members have a 'can do' attitude.	0.579	0.024	0.656	0.019	0.659	0.018	0.662	0.021	0.654	0.015

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Sq78hnra: Students in this school are encouraged to take advanced classes, such as honors, Advanced Placement (AP), or International Baccalaureate (IB), or classes that lead to professional certification.	0.480	0.043	0.363	0.033	0.379	0.028	0.389	0.031	0.390	0.026
Sq79poss: This school provides positive experiences for students.	0.768	0.019	0.775	0.016	0.746	0.013	0.760	0.016	0.803	0.011
Safe and respectful school climate										
Sq7crime: This school is badly affected by crime and violence in the community.	0.452	0.040	0.518	0.023	0.462	0.029	0.450	0.027	0.522	0.022
Sq8posp: This school provides positive experiences for parents/ community members.	0.546	0.038	0.534	0.028	0.529	0.025	0.592	0.024	0.589	0.021
Sq9welcm: This school provides a welcoming environment.	0.586	0.033	0.563	0.026	0.527	0.025	0.591	0.025	0.628	0.020
Sq14thrn: Students at this school are often threatened.	0.601	0.038	0.641	0.019	0.617	0.022	0.571	0.024	0.672	0.016
Sq16blyc: Students at this school are often bullied because of certain characteristics (for example, their race, religion, weight, or sexual orientation).	0.576	0.045	0.617	0.020	0.620	0.022	0.599	0.023	0.640	0.016
Sq17sfen: This school provides a safe environment for teaching and learning.	0.635	0.035	0.619	0.026	0.584	0.028	0.602	0.030	0.673	0.021
Sq19sfos: How safe do you feel outside around the school?	0.565	0.037	0.507	0.029	0.492	0.026	0.417	0.034	0.548	0.023
Sq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.567	0.032	0.570	0.024	0.557	0.025	0.460	0.031	0.653	0.020
Sq21sfcs: How safe do you feel in classroom or work area?	0.531	0.032	0.535	0.026	0.495	0.027	0.422	0.030	0.591	0.022
Sq22dntc: Students in my school don't really care about each other.	0.660	0.042	0.714	0.021	0.707	0.020	0.656	0.032	0.709	0.019
Sq23ptth: Students in my school like to put others down.	0.713	0.044	0.759	0.019	0.770	0.018	0.725	0.029	0.773	0.014
Sq24dntg: Students in my school don't get along together very well.	0.696	0.048	0.734	0.019	0.746	0.020	0.711	0.031	0.771	0.012
Sq25lkot: Students in my school just look out for themselves.	0.714	0.029	0.714	0.019	0.740	0.017	0.684	0.034	0.735	0.013
Sq26trtr: Students in my school treat each other with respect.	0.615	0.027	0.680	0.022	0.683	0.021	0.615	0.028	0.707	0.015

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Sq75stfi: School staff members have a lot of informal opportunities to influence what happens here.	0.470	0.049	0.456	0.030	0.425	0.030	0.534	0.030	0.544	0.020
Sq80stfs: School staff members are supported by administration.	0.583	0.040	0.534	0.028	0.496	0.028	0.583	0.035	0.587	0.024

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A11. Fit statistics for the revised/final models

Statistic	Suggested	Year	Middle school student survey	High school student survey	Classroom teacher survey	Noninstructional staff survey
Comparative Fit Index	≥ 0.90	2016/17	0.915	0.928	0.916	0.915
		2017/18	0.917	0.918	0.912	0.923
		2018/19	0.923	0.918	0.914	0.907
		2020/21	0.917	0.929	0.916	0.918
		2021/22	0.908	0.910	0.920	0.925
Tucker-Lewis Index	≥ 0.90	2016/17	0.903	0.917	0.903	0.901
		2017/18	0.907	0.905	**0.898**	0.910
		2018/19	0.913	0.905	0.900	**0.891**
		2020/21	0.906	0.918	0.902	0.905
		2021/22	**0.896**	**0.896**	0.908	0.913
Root Mean Square Error of Approximation	< 0.05–0.08	2016/17	0.043	0.042	0.050	0.054
		2017/18	0.044	0.047	0.052	0.052
		2018/19	0.042	0.045	0.051	0.056
		2020/21	0.045	0.048	0.051	0.052
		2021/22	0.046	0.049	0.052	0.054

Note: Bolded statistic indicates that threshold is not met, but close to being met.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A12. Factor loadings for middle school student survey, revised/final model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Mq27stpt: Students in my school stop and think before doing anything when they get angry.	0.540	0.014	0.547	0.010	0.557	0.008	0.561	0.014	0.563	0.009
Mq28grpp: Students in my school do their share of the work when we have group projects.	0.466	0.013	0.477	0.012	0.462	0.009	0.457	0.019	0.419	0.013
Mq29givu: Students in my school give up when they can't solve a problem easily.	0.556	0.010	0.549	0.013	0.547	0.008	0.581	0.010	0.552	0.010

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Mq30argu: Students in my school get into arguments when they disagree with people.	0.576	0.010	0.564	0.010	0.573	0.007	0.629	0.011	0.605	0.007
Mq31dbst: Students in my school do their best, even when their school work is difficult.	0.617	0.012	0.611	0.011	0.621	0.010	0.599	0.013	0.615	0.011
Mq32okfg: Students in my school think it's OK to fight if someone insults them.	0.663	0.010	0.648	0.010	0.651	0.009	0.643	0.012	0.667	0.007
Mq33dohw: Students in my school do all their homework.	0.573	0.015	0.542	0.011	0.544	0.008	0.547	0.014	0.504	0.012
Mq34symn: students in my school say mean things to other students when they think the other students deserve it.	0.683	0.010	0.684	0.011	0.691	0.007	0.727	0.007	0.696	0.006
Mq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.590	0.013	0.594	0.010	0.603	0.008	0.577	0.014	0.575	0.010
Mq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.649	0.010	0.628	0.010	0.647	0.008	0.650	0.009	0.661	0.007
Mq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.621	0.010	0.618	0.011	0.637	0.006	0.611	0.009	0.598	0.014
Student support and academic engagement										
Mq38cnct: My teachers often connect what I am learning to life outside the classroom.	0.517	0.016	0.556	0.011	0.567	0.009	0.568	0.012	0.580	0.009
Mq40shid: My teachers encourage students to share their ideas about things we are studying in class.	0.599	0.009	0.596	0.010	0.591	0.009	0.613	0.012	0.616	0.009
Mq43care: My teachers really care about me.	0.638	0.016	0.657	0.012	0.653	0.009	0.696	0.009	0.689	0.009
Mq44mkup: My teachers help me make up work after an excused absence.	0.640	0.011	0.652	0.011	0.652	0.009	0.650	0.011	0.661	0.008
Mq47hmwk: My teachers often assign homework that helps me learn.	0.651	0.012	0.657	0.010	0.662	0.008	0.679	0.009	0.663	0.007
Mq49adtb: Adults in this school are often too busy to give students extra help.	0.451	0.024	0.484	0.020	0.484	0.014	0.502	0.017	0.440	0.016
Mq50ruls: Adults in this school apply the same rules to all students equally.	0.566	0.011	0.574	0.010	0.583	0.007	0.599	0.018	0.598	0.008
Mq51difs: I wish I went to a different school.	0.479	0.018	0.499	0.016	0.508	0.012	0.552	0.013	0.494	0.012
Mq52exth: I can get extra help at school outside of my regular classes.	0.434	0.016	0.462	0.017	0.461	0.013	0.477	0.017	0.457	0.011

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Mq55extra: Adults in this school are usually willing to take the time to give students extra help.	0.661	0.010	0.677	0.010	0.702	0.008	0.692	0.010	0.681	0.007
Mq64ntct: Teachers notice if I have trouble learning something.	0.581	0.010	0.593	0.010	0.575	0.008	0.605	0.014	0.595	0.011
Mq65hlpi: This school will help me improve my work if I do poorly on an assignment.	0.644	0.011	0.648	0.009	0.649	0.007	0.677	0.010	0.654	0.007
Mq66trtd: This school treats some students better than others.	0.497	0.020	0.502	0.019	0.524	0.012	0.562	0.013	0.508	0.011
Mq67topc: In my classes, the topics we are studying are interesting and challenging.	0.511	0.012	0.539	0.009	0.530	0.009	0.530	0.014	0.533	0.010
Mq68mkth: This class really makes me think.	0.486	0.015	0.485	0.013	0.471	0.009	0.520	0.011	0.487	0.013
Mq69ubrd: I am usually bored in this class.	0.458	0.018	0.447	0.017	0.474	0.013	0.508	0.015	0.448	0.015
Safe and respectful school climate										
Mq13blly: Students at this school are often bullied.	0.499	0.022	0.533	0.015	0.531	0.014	0.589	0.014	0.565	0.011
Mq14thrn: Students at this school are often threatened.	0.485	0.020	0.504	0.017	0.513	0.013	0.539	0.015	0.563	0.011
Mq15tsed: Students at this school are often teased or picked on.	0.509	0.019	0.540	0.013	0.542	0.013	0.603	0.017	0.574	0.010
Mq16blyc: Students at this school are often bullied because of certain characteristics (for example, race, religion, or weight).	0.446	0.017	0.501	0.015	0.489	0.013	0.570	0.017	0.548	0.011
Mq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	**0.368**	0.018	**0.375**	0.018	**0.370**	0.013	0.412	0.016	0.401	0.012
Mq22dntc: Students in my school don't really care about each other.	0.656	0.016	0.690	0.012	0.668	0.011	0.683	0.012	0.655	0.011
Mq23ptth: Students in my school like to put others down.	0.769	0.011	0.774	0.007	0.772	0.008	0.774	0.007	0.782	0.006
Mq24dntg: Students in my school don't get along together well.	0.664	0.013	0.678	0.010	0.650	0.009	0.652	0.016	0.645	0.009
Mq25lkot: Students in my school just look out for themselves.	0.504	0.019	0.570	0.011	0.535	0.013	0.566	0.014	0.498	0.012
Mq26trtr: Students in my school treat each other with respect.	0.601	0.016	0.600	0.012	0.616	0.009	0.603	0.013	0.598	0.009

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A13. Factor loadings for high school student survey, revised/final model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Hq27stpt: Students in my school stop and think before doing anything when they get angry.	0.519	0.011	0.500	0.015	0.489	0.010	0.611	0.027	0.511	0.012
Hq28grpp: Students in my school do their share of the work when we have group projects.	0.556	0.008	0.539	0.012	0.516	0.008	0.562	0.015	0.507	0.012
Hq29givu: Students in my school give up when they can't solve a problem easily.	0.571	0.015	0.563	0.014	0.557	0.009	0.627	0.019	0.569	0.011
Hq30argu: Students in my school get into arguments when they disagree with people.	0.581	0.017	0.598	0.013	0.579	0.009	0.709	0.033	0.643	0.010
Hq31dbst: Students in my school do their best, even when their school work is difficult.	0.596	0.010	0.583	0.015	0.582	0.009	0.632	0.024	0.570	0.013
Hq32okfg: Students in my school think it's OK to fight if someone insults them.	0.690	0.010	0.684	0.014	0.680	0.007	0.731	0.025	0.700	0.008
Hq33dohw: Students in my school do all their homework.	0.548	0.013	0.523	0.016	0.511	0.010	0.592	0.020	0.515	0.014
Hq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.689	0.012	0.706	0.011	0.695	0.008	0.778	0.024	0.729	0.008
Hq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.531	0.012	0.517	0.015	0.517	0.010	0.602	0.028	0.512	0.012
Hq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.627	0.013	0.615	0.011	0.606	0.009	0.699	0.028	0.626	0.010
Hq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.612	0.009	0.592	0.012	0.599	0.009	0.653	0.020	0.584	0.011
Student support and academic engagement										
Hq38cnct: My teachers often connect what I am learning to life outside the classroom.	0.621	0.011	0.642	0.009	0.620	0.007	0.666	0.012	0.634	0.013
Hq40shid: My teachers encourage students to share their ideas about things we are studying in class.	0.656	0.014	0.675	0.010	0.651	0.008	0.697	0.014	0.663	0.009
Hq43care: My teachers really care about me.	0.701	0.010	0.723	0.007	0.709	0.005	0.736	0.008	0.721	0.009
Hq44mkup: My teacher help me make up work after an excused absence.	0.699	0.008	0.702	0.008	0.706	0.006	0.711	0.008	0.703	0.007
Hq47hmwk: My teachers often assign homework that helps me learn.	0.671	0.008	0.670	0.011	0.678	0.005	0.734	0.013	0.693	0.008
Hq49adtb: Adults in this school are often too busy to give students extra help.	0.465	0.016	0.430	0.020	0.445	0.014	0.551	0.022	0.424	0.019

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Hq50ruls: Adults in this school apply the same rules to all students equally.	0.543	0.011	0.559	0.010	0.536	0.008	0.625	0.014	0.553	0.009
Hq51difs: I wish I went to a different school.	0.463	0.017	0.457	0.019	0.439	0.013	0.551	0.016	0.439	0.018
Hq52exth: I can get extra help at school outside my regular classes.	0.478	0.015	0.494	0.016	0.515	0.013	0.542	0.023	0.491	0.009
Hq53cnsl: A counselor at this school has helped me plan for life after high school.	0.387	0.013	0.388	0.013	0.386	0.012	0.440	0.031	0.383	0.012
Hq55extra: Adults in this school are usually willing to take the time to give students extra help.	0.671	0.008	0.673	0.007	0.681	0.007	0.698	0.014	0.664	0.006
Hq64ntct: Notice if I have trouble learning something.	0.599	0.009	0.622	0.007	0.607	0.007	0.664	0.012	0.628	0.008
Hq65hlpi: Will help me improve my work if I do poorly on an assignment.	0.673	0.006	0.683	0.006	0.674	0.007	0.730	0.011	0.682	0.008
Hq67topc: The topics we are studying are interesting and challenging.	0.594	0.012	0.600	0.009	0.590	0.008	0.656	0.014	0.600	0.013
Hq68mkth: This class really makes me think.	0.552	0.013	0.557	0.010	0.530	0.008	0.611	0.017	0.553	0.013
Hq69ubrd: I am usually bored in this class.	0.433	0.023	0.405	0.021	0.414	0.012	0.539	0.019	0.431	0.023
Safe and respectful school climate										
Hq13blly: Students at this school are often bullied.	0.579	0.017	0.616	0.017	0.588	0.015	0.730	0.022	0.657	0.011
Hq14thrn: Students at this school are often threatened.	0.607	0.012	0.635	0.014	0.612	0.011	0.707	0.017	0.674	0.010
Hq15tsed: Students at this school are often teased or picked on.	0.587	0.017	0.619	0.017	0.590	0.013	0.740	0.031	0.656	0.012
Hq16blyc: Students at this school are often bullied because of certain characteristics (for example, race, religion, or weight)?	0.559	0.015	0.597	0.016	0.571	0.012	0.715	0.023	0.638	0.011
Hq18sthm: I sometimes stay home because I don't feel safe at school.	0.401	0.014	0.387	0.009	0.396	0.013	0.468	0.015	0.469	0.009
Hq19sfos: How safe do you feel outside around the school?	0.384	0.012	0.381	0.013	0.354	0.012	0.439	0.014	0.407	0.011
Hq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.441	0.011	0.469	0.014	0.437	0.010	0.512	0.011	0.497	0.011
Hq21sfcs: How safe do you feel in your classes?	0.410	0.012	0.416	0.014	0.403	0.013	0.474	0.012	0.436	0.011
Hq22dntc: Students in my school don't really care about each other.	0.670	0.012	0.676	0.009	0.690	0.009	0.697	0.008	0.665	0.008
Hq23ptth: Students in my school like to put others down.	0.784	0.007	0.791	0.005	0.798	0.006	0.828	0.011	0.796	0.006
Hq24dntg: Students in my school don't get along together well.	0.689	0.010	0.691	0.009	0.698	0.007	0.737	0.020	0.686	0.008

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Hq25lkot: Students in my school just look out for themselves.	0.597	0.013	0.618	0.012	0.614	0.010	0.647	0.014	0.592	0.012
Hq26trtr: Students in my school treat each other with respect.	0.583	0.009	0.545	0.015	0.545	0.009	0.611	0.017	0.546	0.012

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A14. Factor loadings for classroom teacher survey, revised/final model

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Social-emotional learning										
Sq27stpt: Students in my school stop and think before doing anything when they get angry.	0.674	0.021	0.681	0.016	0.674	0.016	0.636	0.020	0.702	0.013
Sq28grpp: Students in my school do their share of the work on group projects.	0.613	0.018	0.630	0.012	0.628	0.013	0.658	0.017	0.661	0.011
Sq29givu: Students in my school give up when they can't solve a problem easily.	0.650	0.018	0.661	0.014	0.654	0.012	0.678	0.015	0.656	0.012
Sq30argu: Students in my school get into arguments when they disagree with people.	0.650	0.019	0.646	0.016	0.666	0.015	0.638	0.016	0.670	0.012
Sq31dbst: Students in my school do their best, even when their school work is difficult.	0.655	0.019	0.672	0.014	0.684	0.010	0.707	0.016	0.704	0.011
Sq32okfg: Students in my school think it's OK to fight if someone insults them.	0.692	0.021	0.693	0.017	0.713	0.015	0.660	0.015	0.734	0.013
Sq33dohw: Students in my school do all their homework.	0.531	0.021	0.593	0.018	0.612	0.015	0.650	0.017	0.640	0.013
Sq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.662	0.021	0.648	0.017	0.695	0.012	0.677	0.017	0.706	0.012
Sq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.604	0.021	0.648	0.014	0.630	0.012	0.630	0.017	0.659	0.012
Sq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.589	0.019	0.622	0.019	0.630	0.017	0.638	0.034	0.683	0.014
Sq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.651	0.018	0.670	0.014	0.660	0.012	0.678	0.015	0.688	0.011

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2018/19 Factor loading	SE	2020/21 Factor loading	SE	2021/22 Factor loading	SE
Student support and academic engagement										
Sq42prep: I prepare all students for success in the next grade, in college, or in a job.	0.337	0.025	0.333	0.019	0.346	0.021	0.431	0.022	0.410	0.015
Sq54advw: When students in this school already know the material that is being taught, they are given more advanced assignments.	0.523	0.022	0.514	0.019	0.521	0.016	0.577	0.020	0.563	0.015
Sq70asks: The principal asks students about their ideas.	0.448	0.035	0.490	0.021	0.475	0.026	0.503	0.027	0.532	0.023
Sq71effc: Students and parents receive effective communication about academic progress.	0.534	0.026	0.472	0.019	0.527	0.017	0.532	0.025	0.526	0.019
Sq72frtr: When students break rules, they are treated fairly.	0.594	0.024	0.590	0.017	0.599	0.020	0.636	0.018	0.669	0.014
Sq73hpwk: I am happy working at this school.	0.684	0.018	0.692	0.015	0.691	0.015	0.675	0.019	0.714	0.012
Sq74schp: This school is making steady progress implementing rigorous academic standards.	0.705	0.018	0.689	0.016	0.694	0.015	0.709	0.015	0.740	0.011
Sq76stfa: In this school, staff members have a 'can do' attitude.	0.634	0.019	0.616	0.017	0.611	0.015	0.638	0.019	0.610	0.019
Sq78hnra: Students in this school are encouraged to take advanced classes, such as honors, Advanced Placement (AP), or International Baccalaureate (IB), or classes that lead to professional certification.	0.450	0.035	0.350	0.031	0.315	0.032	0.366	0.028	0.344	0.025
Sq79poss: This school provides positive experiences for students.	0.772	0.016	0.732	0.012	0.734	0.011	0.779	0.011	0.759	0.010
Safe and respectful school climate										
Sq7crime: This school is badly affected by crime and violence in the community.	0.520	0.044	0.511	0.023	0.499	0.029	0.445	0.030	0.534	0.022
Sq8posp: This school provides positive experiences for parents/community members.	0.513	0.032	0.530	0.023	0.569	0.019	0.551	0.022	0.582	0.017
Sq9welcm: This school provides a welcoming environment.	0.604	0.024	0.605	0.022	0.614	0.022	0.623	0.019	0.661	0.017
Sq14thrn: Students at this school are often threatened.	0.618	0.033	0.585	0.021	0.588	0.018	0.502	0.023	0.657	0.017
Sq16blyc: Students at this school are often bullied because of certain characteristics (for example, their race, religion, weight, or sexual orientation).	0.543	0.030	0.552	0.019	0.559	0.025	0.502	0.020	0.596	0.016

Item	2016/17		2017/18		2018/19		2020/21		2021/22	
	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE
Sq17sfen: This school provides a safe environment for teaching and learning.	0.688	0.027	0.647	0.022	0.662	0.019	0.606	0.023	0.723	0.016
Sq19sfos: How safe do you feel outside around the school?	0.569	0.036	0.472	0.023	0.449	0.024	**0.404**	0.025	0.513	0.020
Sq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.612	0.034	0.549	0.022	0.544	0.028	0.478	0.023	0.645	0.019
Sq21sfcs: How safe do you feel in classroom or work area?	0.547	0.033	0.511	0.021	0.473	0.023	0.431	0.024	0.558	0.018
Sq22dntc: Students in my school don't really care about each other.	0.635	0.023	0.640	0.015	0.648	0.014	0.593	0.023	0.672	0.012
Sq23ptth: Students in my school like to put others down.	0.690	0.029	0.697	0.016	0.698	0.014	0.640	0.017	0.702	0.013
Sq24dntg: Students in my school don't get along together very well.	0.644	0.027	0.639	0.016	0.652	0.014	0.611	0.017	0.668	0.012
Sq25lkot: Students in my school just look out for themselves.	0.634	0.017	0.646	0.016	0.646	0.013	0.609	0.025	0.672	0.012
Sq26trtr: Students in my school treat each other with respect.	0.689	0.024	0.673	0.016	0.674	0.019	0.613	0.020	0.699	0.014
Sq75stfi: School staff members have a lot of informal opportunities to influence what happens here.	0.489	0.030	0.494	0.022	0.509	0.024	0.566	0.026	0.549	0.020
Sq80stfs: School staff members are supported by administration.	0.562	0.029	0.560	0.024	0.546	0.026	0.586	0.025	0.594	0.024

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A15. Factor loadings for noninstructional staff survey, revised/final model

Item	2016/17		2017/18		2016/17		2017/18		2021/22	
	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE	Factor loading	SE
Social-emotional learning										
Sq27stpt: Students in my school stop and think before doing anything when they get angry.	0.622	0.030	0.659	0.023	0.658	0.020	0.615	0.027	0.696	0.017
Sq28grpp: Students in my school do their share of the work on group projects.	0.612	0.032	0.628	0.020	0.591	0.020	0.620	0.024	0.650	0.016
Sq29givu: Students in my school give up when they can't solve a problem easily.	0.661	0.030	0.710	0.018	0.682	0.018	0.642	0.029	0.728	0.013
Sq30argu: Students in my school get into arguments when they disagree with people.	0.656	0.030	0.685	0.020	0.662	0.020	0.664	0.028	0.743	0.013

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Sq31dbst: Students in my school do their best, even when their school work is difficult.	0.668	0.034	0.725	0.015	0.694	0.018	0.654	0.023	0.690	0.016
Sq32okfg: Students in my school think it's OK to fight if someone insults them.	0.672	0.024	0.703	0.019	0.664	0.020	0.659	0.021	0.737	0.015
Sq33dohw: Students in my school do all their homework.	0.634	0.026	0.645	0.017	0.642	0.018	0.611	0.019	0.661	0.016
Sq34symn: Students in my school say mean things to other students when they think the other students deserve it.	0.643	0.024	0.705	0.017	0.681	0.019	0.691	0.020	0.731	0.014
Sq35wkot: Students in my school try to work out their disagreements with other students by talking to them.	0.637	0.023	0.666	0.020	0.659	0.017	0.611	0.023	0.705	0.016
Sq36okch: Students in my school think it's OK to cheat if other students are cheating.	0.653	0.022	0.650	0.021	0.670	0.020	0.655	0.024	0.684	0.015
Sq37dogd: Students in my school try to do a good job on school work, even when it is not interesting.	0.692	0.028	0.697	0.021	0.694	0.017	0.649	0.021	0.706	0.014
Student support and academic engagement										
Sq54advw: When students in this school already know the material that is being taught, they are given more advanced assignments.	0.589	0.031	0.565	0.021	0.527	0.023	0.568	0.023	0.587	0.019
Sq70asks: The principal asks students about their ideas.	0.609	0.036	0.526	0.026	0.561	0.026	0.602	0.026	0.580	0.023
Sq71effc: Students and parents receive effective communication about academic progress.	0.634	0.035	0.582	0.022	0.594	0.019	0.667	0.021	0.616	0.020
Sq72frtr: When students break rules, they are treated fairly.	0.686	0.025	0.625	0.020	0.662	0.021	0.685	0.022	0.691	0.014
Sq73hpwk: I am happy working at this school.	0.643	0.019	0.629	0.024	0.626	0.019	0.670	0.021	0.704	0.015
Sq74schp: This school is making steady progress implementing rigorous academic standards.	0.741	0.023	0.734	0.016	0.697	0.016	0.720	0.016	0.764	0.011
Sq76stfa: In this school, staff members have a 'can do' attitude.	0.581	0.024	0.657	0.019	0.658	0.018	0.660	0.021	0.652	0.015
Sq78hnra: Students in this school are encouraged to take advanced classes, such as honors, Advanced Placement (AP), or International Baccalaureate (IB), or classes that lead to professional certification.	0.476	0.045	0.360	0.033	0.376	0.028	0.386	0.031	0.388	0.026
Sq79poss: This school provides positive experiences for students.	0.770	0.020	0.775	0.016	0.747	0.013	0.761	0.017	0.801	0.011

Item	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2016/17 Factor loading	SE	2017/18 Factor loading	SE	2021/22 Factor loading	SE
Safe and respectful school climate										
Sq7crime: This school is badly affected by crime and violence in the community.	0.408	0.042	0.481	0.025	0.428	0.030	0.406	0.031	0.496	0.023
Sq8posp: This school provides positive experiences for parents/community members.	0.551	0.036	0.542	0.028	0.545	0.026	0.609	0.026	0.595	0.022
Sq9welcm: This school provides a welcoming environment.	0.584	0.030	0.574	0.025	0.540	0.026	0.598	0.024	0.633	0.020
Sq14thrn: Students at this school are often threatened.	0.559	0.043	0.605	0.022	0.584	0.024	0.520	0.027	0.646	0.017
Sq16blyc: Students at this school are often bullied because of certain characteristics (for example, their race, religion, weight, or sexual orientation).	0.538	0.049	0.597	0.021	0.599	0.025	0.541	0.026	0.624	0.018
Sq17sfen: This school provides a safe environment for teaching and learning.	0.607	0.035	0.607	0.025	0.581	0.028	0.582	0.029	0.663	0.020
Sq20sfhl: How safe do you feel in the hallways and bathrooms of the school?	0.512	0.027	0.511	0.025	0.503	0.023	0.415	0.029	0.611	0.021
Sq22dntc: Students in my school don't really care about each other.	0.574	0.041	0.646	0.023	0.626	0.022	0.563	0.033	0.645	0.021
Sq23ptth: Students in my school like to put others down.	0.712	0.043	0.750	0.021	0.744	0.021	0.670	0.029	0.759	0.015
Sq24dntg: Students in my school don't get along together very well.	0.637	0.046	0.672	0.021	0.675	0.024	0.618	0.034	0.727	0.015
Sq25lkot: Students in my school just look out for themselves.	0.655	0.028	0.656	0.021	0.675	0.020	0.591	0.035	0.682	0.014
Sq26trtr: Students in my school treat each other with respect.	0.616	0.030	0.685	0.023	0.694	0.022	0.619	0.028	0.704	0.017
Sq75stfi: School staff members have a lot of informal opportunities to influence what happens here.	0.524	0.039	0.498	0.029	0.474	0.031	0.594	0.026	0.589	0.020
Sq80stfs: School staff members are supported by administration.	0.622	0.034	0.587	0.026	0.555	0.028	0.647	0.030	0.624	0.022

SE is standard error.

Note: Factor loadings lower than 0.40 are bolded in the table. Factor loadings are (completely) standardized estimates. All loadings are significant at $p < .01$.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A16. Removed survey items with less than 0.40 factor loadings for the revised/final models

Respondent	Domain	Survey items
Middle school student survey	Student support and academic engagement	Mq53cnsl: A counselor at this school has helped me plan for life after high school.
	Safe and respectful school climate	Mq18sthm: I sometimes stay home because I don't feel safe at school.
		Mq19sfos: How safe do you feel outside around the school?
		Mq21sfcs: How safe do you feel in your classes?
High school student survey	Student support and academic engagement	Hq54advw: When students in this school already know the material that is being taught, the teacher gives them more advanced assignments.

Respondent	Domain	Survey items
Classroom teacher survey	Student support and academic engagement	Sq40shid: I encourage students to share their ideas about things we are studying in class.
		Sq43care: I really care about my students.
		Sq44mkup: I help my students make up work after an excused absence.
		Sq45fdbk: I give my students feedback on class assignments that helps improve their work.
		Sq46acom: I provide accommodations to students who need them.
		Sq48chwk: I believe all students can do challenging school work
Noninstructional staff survey	Safe and respectful school climate	Sq19sfos: How safe do you feel outside around the school?
		Sq21sfcs: How safe do you feel in classroom or work area?

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, 2018/19, 2020/21, and 2021/22.

Table A17. Correlations between latent factors for the surveys in 2016/17

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
Middle school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.50	--	
Safe and respectful school climate	0.75	0.40	--
High school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.50	--	
Safe and respectful school climate	0.75	0.46	--
Classroom teacher survey			
Social-emotional learning	--		
Student support and academic engagement	0.64	--	
Safe and respectful school climate	0.83	0.82	--
Noninstructional staff survey			
Social-emotional learning	--		
Student support and academic engagement	0.63	--	
Safe and respectful school climate	0.88	0.82	--

Note: Correlations over 0.85 are bolded in the table. '--' refers to cells that are not applicable.
Source: Pennsylvania School Climate Survey, 2016/17.

Table A18. Correlations between latent factors for the surveys in 2017/18

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
Middle school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.56	--	
Safe and respectful school climate	0.78	0.46	--
High school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.50	--	
Safe and respectful school climate	0.76	0.44	--
Classroom teacher survey			
Social-emotional learning	--		
Student support and academic engagement	0.65	--	
Safe and respectful school climate	0.86	0.84	--
Noninstructional staff survey			
Social-emotional learning	--		
Student support and academic engagement	0.66	--	
Safe and respectful school climate	0.86	0.82	--

Note: Correlations over 0.85 are bolded in the table. '--' refers to cells that are not applicable.
Source: Pennsylvania School Climate Survey, 2017/18.

Table A19. Correlations between latent factors for the surveys in 2018/19

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
Middle school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.55	--	
Safe and respectful school climate	0.79	0.47	--
High school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.48	--	
Safe and respectful school climate	0.74	0.41	--
Classroom teacher survey			
Social-emotional learning	--		
Student support and academic engagement	0.62	--	
Safe and respectful school climate	0.87	0.83	--
Noninstructional staff survey			
Social-emotional learning	--		
Student support and academic engagement	0.62	--	
Safe and respectful school climate	0.83	0.80	--

Note: Correlations over 0.85 are bolded in the table. '--' refers to cells that are not applicable.
Source: Pennsylvania School Climate Survey, 2018/19.

Table A20. Correlations between latent factors for the surveys in 2020/21

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
Middle school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.57	--	
Safe and respectful school climate	0.80	0.53	--
High school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.64	--	
Safe and respectful school climate	0.83	0.60	--
Classroom teacher survey			
Social-emotional learning	--		
Student support and academic engagement	0.68	--	
Safe and respectful school climate	0.83	0.90	--
Noninstructional staff survey			
Social-emotional learning	--		
Student support and academic engagement	0.64	--	
Safe and respectful school climate	0.83	0.87	--

Note: Correlations over 0.85 are bolded in the table. '--' refers to cells that are not applicable.
Source: Pennsylvania School Climate Survey, 2020/21.

Table A21. Correlations between latent factors for the surveys in 2021/22

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
Middle school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.55	--	
Safe and respectful school climate	0.79	0.47	--

Domain	Social-emotional learning	Student support and academic engagement	Safe and respectful school climate
High school student survey			
Social-emotional learning	--		
Student support and academic engagement	0.49	--	
Safe and respectful school climate	0.77	0.45	--
Classroom teacher survey			
Social-emotional learning	--		
Student support and academic engagement	0.71	--	
Safe and respectful school climate	0.87	0.86	--
Noninstructional staff survey			
Social-emotional learning	--		
Student support and academic engagement	0.66	--	
Safe and respectful school climate	0.86	0.85	--

Note: Correlations over 0.85 are bolded in the table. '--' refers to cells that are not applicable.
Source: Pennsylvania School Climate Survey, 2021/22.

Research question 2. Did school climate scores change from before the pandemic to the years during the pandemic?

To test for differences in school climate across school years before and during COVID, the study team conducted two analyses: (1) the main analysis, which is a test of changes in school climate scores across three school years including one pre-COVID school year and two school years affected by COVID (2018/19, 2020/21, and 2021/22) and (2) a test of changes in school climate scores across three pre-COVID school years (2016/17, 2017/18, and 2018/19). The first test shed light on differences between the pre-COVID time period to the school years affected by COVID and between the two COVID-affected school years as schools returned to in-person instruction. The second test was intended to show how much school climate scores typically change from year to year in the pre-COVID time period to serve as a point of comparison for the first test. Because the number of schools with school climate data available in 2018/19, 2020/21, and 2021/22 for the first test was smaller than initially expected, we also did another analysis testing for changes in school climate between 2018/19 and 2021/22 in a slightly larger sample of schools. We used repeated measures of analysis of variance (RM ANOVA) for both approaches and tested differences across all combinations of school years within each RM ANOVA. Differences across school years were assessed with post-hoc tests using a Tukey's HSD (honestly significant difference) adjustment for multiple comparisons. This offered a comprehensive view of the differences in school climate scores across school years.

Research question 3. Did school climate scores in 2021/22 vary according to the amount of virtual and hybrid instruction used during the 2020/21 school year?

Before testing for the relationship between learning modalities and school climate, we first needed to choose a data source for information about the learning modalities schools used in 2020/21. The research team had access to two data sources for information about which learning modalities school districts used in the 2020/21 school year: the Return to Learn Tracker and a Mathematica-led survey of school districts in Pennsylvania. We compared these two data sources to assess consistency between the two sources and to select a source to use for analyses. The Mathematica survey was likely more accurate because it asked districts directly about what kind of instruction they offered at specific times, while the Return to Learn Tracker relied more heavily on district websites and social media postings. It is possible that some school districts in Pennsylvania notified parents by phone of the learning modality on a given week without updating their website. The Mathematica survey may also be more precise because it reported separate learning modalities for different grade level bands, while the Return to Learn Tracker reported one learning modality across all grade levels. If there were differences in learning modality between middle and high schools, this would be captured in the Mathematica survey but not in the Return to Learn Tracker.

While the Return to Learn Tracker measures modality weekly, the Mathematica survey collected modality data at three points in the school year: the first 30 days, the 30 days after winter break, and the last 30 days. To compare

the Return to Learn Tracker data with the Mathematica survey, the team used the first week of school year, the week of February 1, and the last week of the school year from the Return to Learn Tracker data (table A22).

Table A22. Comparison of district learning modality in 2020/21 data from the Return to Learn Tracker and the Mathematica survey

Dataset	Number of districts	First 30 days			30 days after winter break			Last 30 days		
		Percent in-person	Percent hybrid	Percent remote	Percent in-person	Percent hybrid	Percent remote	Percent in-person	Percent hybrid	Percent remote
Return to Learn Tracker	134	13.4	56.7	29.9	11.9	71.6	16.4	26.9	71.6	1.5
Mathematica survey grades 3–5	133	40.6	23.3	36.1	41.4	32.3	23.3	64.7	30.8	1.5
Mathematica survey grades 6–8	133	30.6	30.6	38.1	28.4	41.8	26.1	56	39.6	1.5
Mathematica survey grades 9–12	133	24.6	35.8	38.8	22.4	47.8	26.1	50	44.8	2.2

Note: This table displays the percentage of districts that used a given learning modality during that portion of the school year—either the first 30 days, 30 days after winter break, and the last 30 days. Return to Learn Tracker data were matched within districts to their school year's first week and last week as reported in the Mathematica survey. Dates of winter break were not reported in the Mathematica survey; therefore, we used the week of February 1 for this reference date. The Mathematica survey asked for learning modalities used for different grade bands, but the Return to Learn Tracker does not stratify along grade level.
Source: Return to Learn Tracker data, 2020/21, and Mathematica survey of Pennsylvania districts, 2020/21.

In table A22, we present the percentage of districts that report using each learning modality type at one of three timepoints during the school year from the Return to Learn Tracker and Mathematica survey. The percentage of districts using fully remote instruction is similar across both sources (differences of less than 10 percentage points), and both show a decrease in remote instruction as the school year progresses. In comparison, there are large differences (up to 38 percentage points) between the two sources for the percentage of districts using in-person instruction, though both sources show a similar pattern of in-person instruction over the course of the year—stable from the first 30 days to the 30 days after winter break and increasing in the last 30 days of the school year. Similarly, for reports of hybrid instruction there were large discrepancies between the two sources (upwards of 39 percentage points) but a similar pattern across the course of the school year—increasing from the first 30 days to the 30 days after winter break and remaining stable from the 30 days after winter break to the last 30 days of the school year. The definition of hybrid differed between the two data sources. The Mathematica survey defined hybrid as "when students receive a mix of in-person, in-school instruction and remote learning on alternating days or weeks, or with different start and end times to the school day," while Return to Learn defined hybrid as "different students received either in-person, remote, or a blend of in-person and remote instruction, or that all students received a blend of in-person and remote instruction." Some of the differences between the two sources may also be driven by the fact that the Mathematica survey was designed to capture learning modality for specific grade ranges, while the Return to Learn tracker data only captured learning modality at the district level. If there was variation in learning modality across students within districts, Return to Learn would have classified these districts as "hybrid".

In addition, there were far fewer districts in the Mathematica survey than the Return to Learn Tracker data. Among schools eligible to be included in the sample for research question 3, only 11 out of 30 schools in the student sample and 18 out of 52 schools in the teacher sample had Mathematica survey data. Therefore, because the Return to Learn Tracker data had greater coverage of Pennsylvania districts and moderate overlap in outcomes with the Mathematica survey data, we opted to move forward using Return to Learn Tracker data as our source for learning modality data.

After selecting the Return to Learn Tracker data as our source for learning modality data, we first examined the variation in learning modalities used across schools in the sample. For every school that could be included in either

the student or the teacher sample, we plotted the percentage of weeks in the 2020/21 school year in which each modality type was used in a stacked bar chart. The distribution of each school's use of the three learning modalities in the 2020/21 school year is presented in figure A23 below. This distribution shows that most schools used hybrid learning for most weeks in the school year. About half the schools in the sample were remote for at least some part of the year, but no schools were remote for the entire school year. Few schools were ever in-person, but the schools that were ever in-person tended to be in-person for most of the school year.

Figure A23. Distribution of weeks in each learning modality in 2020/21 school year by school
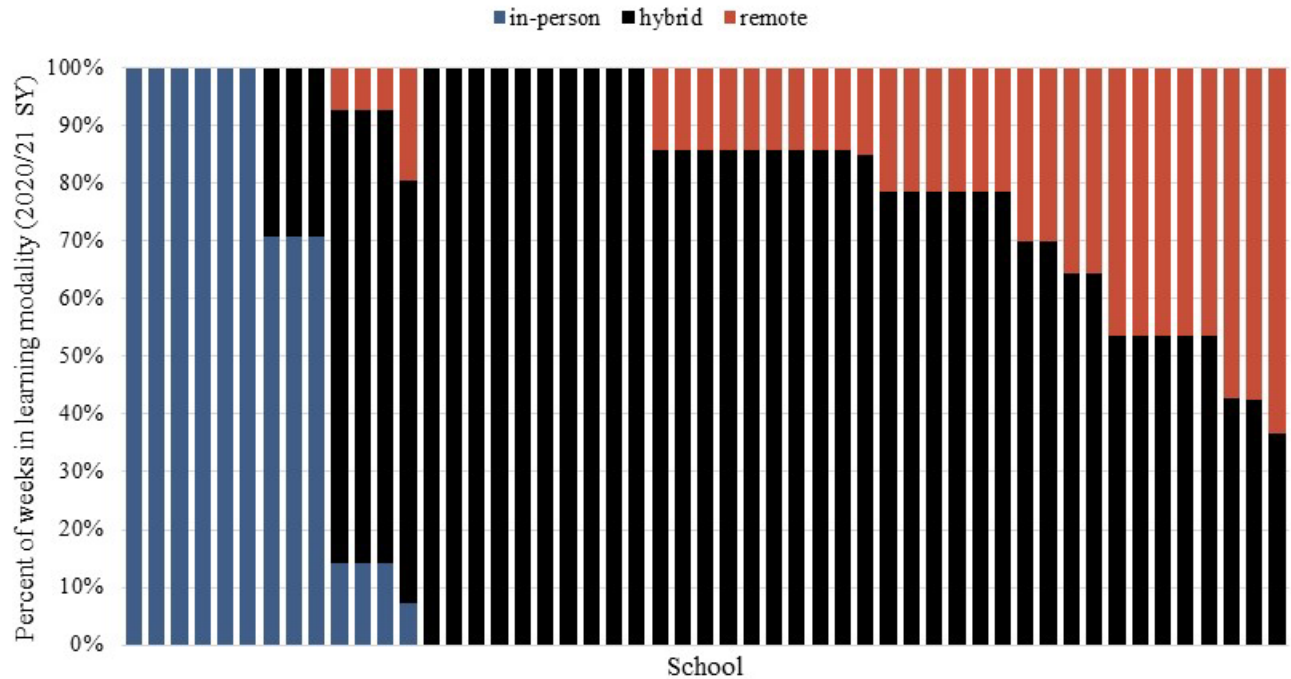
SY is school year.
Note: Stacked bars sum to 100. Each bar represents a single school and displays the percentage of weeks in the 2020/21 school year in which they used a given learning modality. Return to Learn Tracker data are at the school district level, and the district level data were extended to schools within the district's jurisdiction.
Source: Return to Learn Tracker data, 2021/22.

To estimate the relationship between learning modality and school climate in 2021/22, the study team used a district-level regression to account for the fact that learning modality only varies at the district level. (The error terms would be correlated in a school-level regression.) Using the set of schools in the sample, the team calculated a district average score for each school climate measure in 2021/22 and in 2018/19 for all schools that were in the same district. We then estimated the relationship at the district level between the percentage of weeks a district used a given learning modality in 2020/21 and school climate in 2021/22 using a series of regression models, controlling for pre-COVID school climate (2018/19). These models were as follows:

- Model 1 (remote learning): $y_d = \phi + R_d\theta_1 + C_d\gamma + \epsilon_d$

- Model 2 (in-person learning): $y_d = \phi + P_d\theta_2 + C_d\gamma + \epsilon_d$

- Model 3 (remote and hybrid learning): $y_d = \phi + R_d\theta_1 + H_d\theta_3 + C_d\gamma + \epsilon_d$

where y_d is school climate score in the 2021/22 school year in district d; R_d is the percentage of remote instruction in 2020/21 in district d; H_d is the percentage of hybrid instruction in 2020/21 in district d; P_d is the percentage of in-person instruction in 2020/21 in district d; C_d is the school climate from the 2018/19 school year in district d; ϵ_d is the error term; and ϕ, θ_1, θ_2, θ_3, and γ are parameters to be estimated. We also use

heteroskedastic robust standard errors, which provide unbiased standard errors in the presence of heteroskedasticity. (The homoskedasticity assumption may be violated in this case due to differences in the number of schools contributing to the means for each district.) This analysis enables us to describe how the percentage of the 2020/21 school year spent with a specific learning modality explains deviations from the predicted school climate in 2021/22, where the prediction is based on the 2018/19 school climate score. Models 1–3 compare the percentage of weeks spent in the listed modality to either of the excluded modalities. For example, model 1 compares the percentage of the weeks spent in remote learning to the time spent either in in-person or hybrid instruction. In comparison, model 4 includes both the percentage of weeks in hybrid learning and the percentage of weeks in remote learning in the model, which implies the comparison group for both is in-person learning.

References

Amos, L., and Xue, Y. (2021). Development of Pennsylvania Department of Education School Climate Index summary. Regional Educational Laboratory Mid-Atlantic. https://ies.ed.gov/ncee/edlabs/regions/midatlantic/pdf/REL_MA_5.2.5_School_Climate_memo_508c.pdf

American Institutes for Research. (2011). *2011 School Climate and Connectedness Survey: Statewide report*.

Bear, G., Yang, C., Mantz, L., Pasipanodya, E., Hearn, S., and Boyer, D. (2014). *Technical manual for Delaware School Survey: Scales of school climate, bullying victimization, student engagement, and positive, punitive, and social emotional learning techniques*. Delaware Positive Behavior Support (DE-PBS) and School Climate Transformation Projects.

Bentler, P.M. (1990). Fit indexes, lagrange multipliers, constraint changes and incomplete data in structural models. *Multivariate Behavioral Research*, *25*(2), 163–172. https://www.ncbi.nlm.nih.gov/pubmed/26794478

Brown, T.A. (2015). *Confirmatory factor analysis for applied research*. Guilford Publications.

Fischer, G.H. and Molenaar, I.W. (1995). *Rasch Models: Foundations, Recent Developments and Applications*. Springer.

Henseler J., Ringle C. M., Sarstedt M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135.

Kline R.B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). Guilford.

MacCallum, R.C., Browne, M.W., & Sugawara, H.M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, *1*, 130–149.

Steiger, J.H., and Lind, J.C. (1980). *Statistically based tests for the number of common factors* [Paper presentation]. Annual spring meeting of the Psychometric Society, Iowa City, IA.

Stevens, J.P. (2012). *Applied multivariate statistics for the social sciences*. Routledge.

Tucker, L.R., and Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika*, *38*(1), 1–10. https://eric.ed.gov/?id=EJ075116

Appendix B. Supporting analysis

Research question 1. Did pandemic-related disruptions affect the validity of the school climate survey?

The COVID-19 pandemic did not change the psychometric properties of the school climate surveys for students and teachers. Based on the results of the confirmatory factor analysis for the revised/final models across all respondents (tables A12 to A15), we did not observe any survey items only performing poorly during both COVID-affected years (2020/21 and 2021/22). However, for the 2020/21 COVID-affected year, the year with the most hybrid or remote instruction, we observed two items from the safe and respectful school climate domain that performed poorly for the noninstructional staff survey only. (These items were related to safety in the school building and the surrounding neighborhood and may have been affected by COVID disruptions.) We removed these items from the noninstructional staff revised/final models across all years and re-ran the models. In the final models, items included in each domain were the same in every year. As presented in table A11, final models demonstrated acceptable model fit across years. CFI and TLI estimates were at or above the acceptable limit of 0.90 (except a small number of TLI statistics falling very slightly under the cutoff of 0.90), and all RMSEA estimates were at less than 0.08. As presented in tables A17 to A21, correlations between latent factors provided evidence of discriminant validity. For a few years, the safe and respectful school climate domain on the teacher and non-instructional staff surveys was highly correlated (>0.85) with another domain, but the pattern was not consistent across all years and varied by domain.

Research question 2. Did school climate scores change from before the pandemic to the years during the pandemic?

Results from these analyses for students, teachers, and adults are reported below. Tables B1 to B3 show descriptive statistics, including the average school climate index and domain scores for students, teachers, and adults by year, as well as the 25th and 75th percentiles of the school distribution. Table B1 presents this information for a sample of schools that had responses in 2018/19, 2020/21, and 2021/22. Table B2 presents this information for a sample of schools that had responses in 2016/17, 2017/18, and 2018/19. Finally, table B3 presents this information for a sample of schools that had responses in both 2018/19 and 2021/22.

Table B1. Descriptive statistics for students, teachers, and adult respondents for schools that participated in the survey in all of the following school years: 2018/19, 2020/21, and 2021/22

Analytic group	Students (N = 18)			Teachers (N = 28)			Adults (N = 28)		
	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile
Overall school climate									
2018/19	33.7	20.0	46.3	47.6	35.3	57.9	47.6	36.2	57.8
2020/21	43.1	27.8	53.3	57.1	45.7	66.9	56.8	45.6	66.0
2021/22	33.4	22.8	38.5	51.4	37.0	59.8	51.3	39.1	60.0
Social-emotional learning									
2018/19	19.7	4.1	35.2	25.1	16.8	33.9	25.7	17.8	34.0
2020/21	28.6	12.8	40.1	35.7	21.6	47.3	36.0	21.5	47.1
2021/22	19.3	5.5	25.9	29.5	13.3	43.5	30.2	15.0	43.4
Safe and respectful school climate									
2018/19	41.9	23.4	57.8	59.5	46.6	70.0	59.5	47.5	69.9
2020/21	54.1	41.5	69.1	72.5	60.1	82.6	71.9	59.9	81.5
2021/22	39.9	24.2	43.8	64.6	50.8	75.6	64.2	51.3	75.3
Student support and academic engagement									
2018/19	40.1	32.4	49.0	58.2	43.8	67.1	57.9	43.7	67.9
2020/21	46.7	34.4	52.2	62.6	50.3	71.0	62.2	50.4	71.2
2021/22	41.7	34.4	45.9	59.7	48.8	66.7	59.4	48.9	65.6

Note: Adults refers to both teachers and noninstructional staff. Eighteen schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years: 2018/19, 2020/21, and 2021/22), and 28 schools are included in the teacher sample (schools with at least 5 responses to the teacher survey in each of the years: 2018/19, 2020/21, and 2021/22). All schools in the teacher sample also had staff respondents. School climate scores are on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups.
Source: Pennsylvania School Climate Survey, 2018/19, 2020/21, and 2021/22.

Table B2. Descriptive statistics for students, teachers, and adult respondents for schools that participated in the survey in all of the following school years: 2016/17, 2017/18, and 2018/19

Analytic group	Students (N = 29)			Teachers (N = 28)			Adults (N = 28)		
	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile
Overall school climate									
2016/17	33.8	25.7	43.4	39.0	30.7	46.8	39.4	30.6	46.9
2017/18	31.8	21.6	42.4	41.6	34.4	51.6	41.9	34.3	51.3
2018/19	31.3	22.1	43.5	38.5	28.1	48.3	38.9	29.7	48.9
Social-emotional learning									
2016/17	21.3	10.5	34.3	17.4	7.1	24.2	18.3	9.2	24.8
2017/18	19.0	8.8	32.5	17.5	9.0	23.6	18.2	10.0	24.1
2018/19	17.9	6.6	29.8	15.1	3.5	24.2	15.9	5.3	26.0
Safe and respectful school climate									
2016/17	39.6	26.2	51.2	50.9	43.6	61.6	51.2	44.7	61.5
2017/18	37.8	24.2	45.2	54.3	46.2	64.5	54.1	46.8	63.7
2018/19	37.7	24.1	51.7	51.7	40.3	61.7	52.0	41.1	62.5
Student support and academic engagement									
2016/17	40.6	32.5	49.5	49.4	40.4	57.2	49.4	40.3	57.1
2017/18	38.8	31.6	46.5	53.8	45.4	61.8	54.0	44.7	59.9
2018/19	38.5	34.0	46.6	50.1	42.1	59.6	50.0	40.5	58.1

Note: Adults refers to both teachers and noninstructional staff. Twenty-nine schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years: 2016/17, 2017/18, and 2018/19), and 28 schools are included in the teacher and adult samples (schools with at least 5 responses to the teacher survey in each of the years: 2016/17, 2017/18, and 2018/19). School climate scores are on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, and 2018/19.

Table B3. Descriptive statistics for students, teachers, and adult respondents for schools that participated in the survey in both of the following school years: 2018/19 and 2021/22

Analytic group	Students (N = 30)			Teachers (N = 52)			Adults (N = 52)		
	Mean	25th percentile	Mean	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile
Overall school climate									
2018/19	31.1	20.7	43.7	44.4	34.0	53.7	44.7	34.8	53.5
2021/22	32.0	22.8	36.7	47.6	36.0	57.9	47.7	36.3	58.8
Social-emotional learning									
2018/19	17.6	6.8	29.8	21.7	8.5	32.5	22.4	9.2	32.2
2021/22	18.5	7.2	25.3	25.5	11.4	41.4	26.2	13.8	41.8
Safe and respectful school climate									
2018/19	37.9	23.2	52.9	56.9	46.2	67.6	57.1	46.7	66.1
2021/22	38.4	25.2	44.6	61.3	49.4	75.2	61.3	50.1	75.3
Student support and academic engagement									
2018/19	38.1	30.4	45.2	55.0	43.8	63.9	55.0	43.8	64.0
2021/22	39.8	32.6	45.3	56.2	46.9	63.2	56.2	46.4	62.6

Note: Adults refers to both teachers and noninstructional staff. Thirty schools are included in the student sample (schools with at least 25 responses to the student survey in the years 2018/19 and 2021/22), and 52 schools are included in the teacher and adult samples (schools with at least 5 responses to the teacher survey in the years 2018/19 and 2021/22). School climate scores are on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups.
Source: Pennsylvania School Climate Survey, 2018/19 and 2021/22.

The findings from the RM ANOVA to test differences in school climate across school years are reported below in tables B4–B6. A difference in school climate scores was detected for all aspects of school climate for students in the main analysis sample, which compared the 2018/19, 2020/21, and 2021/22 school years (Table B4). Differences were detected for teachers' and adults' perceptions of overall school climate, social-emotional learning, and safe and respectful school climate, but not for perceptions of student support and academic engagement. No differences across years for students, teachers, or adults in most aspects of school climate were detected for the pre-COVID sample (Table B5). However, there were three cases in which school climate differed across school years: students' perceptions of social-emotional learning, teachers' perceptions of student support and academic engagement, and adults' perceptions of student support and academic engagement. The alternative sample that compared 2018/19 to 2021/22 showed no differences for students in any school climate domain, but there were differences for teachers and adults in the social emotional learning and safe and respectful school climate domains (Table B6).

Table B4. ANOVA table for test 1 (changes across 2018/19, 2020/21, and 2021/22 school years)

Outcome	df (numerator)	df (denominator)	F	p-value	Effect size (η^2)
Students					
Overall school climate	2	34	7.88	0.002	0.08
Social-emotional learning	2	34	5.68	0.007	0.06
Safe and respectful school climate	2	34	7.90	0.002	0.10
Student support and academic engagement	2	34	8.46	0.001	0.05
Teachers					
Overall school climate	2	54	8.57	0.001	0.06
Social-emotional learning	2	54	12.61	< 0.001	0.07
Safe and respectful school climate	2	54	14.35	< 0.001	0.09
Student support and academic engagement	2	54	1.08	0.348	0.01
Adults					
Overall school climate	2	54	9.46	< 0.001	0.06
Social-emotional learning	2	54	15.04	< 0.001	0.07
Safe and respectful school climate	2	54	15.94	< 0.001	0.09
Student support and academic engagement	2	54	1.21	0.305	0.01

ANOVA is analysis of variance. Df is degrees of freedom.

Note: Eighteen schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years 2018/19, 2020/21, and 2021/22), and 28 schools are included in the teacher and adult samples (schools with at least 5 responses to the teacher survey in each of the years 2018/19, 2020/21, and 2021/22). School climate scores were derived from Rasch models and scaled to 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups. Evidence for a difference in school climate among the reference school years indicated by a p-value < .05.
Source: Pennsylvania School Climate Survey, 2018/19, 2020/21, and 2021/22.

Table B5. ANOVA table for test 2 (changes across 2016/17, 2017/18, and 2018/19 school years)

Outcome	df (numerator)	df (denominator)	F	p-value	Effect size (η2)
Students					
Overall school climate	2	56	2.44	0.097	0.01
Social-emotional learning	2	56	3.83	0.028	0.01
Safe and respectful school climate	2	56	1.03	0.363	0.00
Student support and academic engagement	2	56	2.03	0.141	0.01
Teachers					
Overall school climate	2	54	3.06	0.055	0.01
Social-emotional learning	2	54	2.09	0.133	0.01
Safe and respectful school climate	2	54	2.64	0.080	0.01
Student support and academic engagement	2	54	3.70	0.031	0.03
Adults					
Overall school climate	2	54	3.15	0.051	0.01
Social-emotional learning	2	54	2.35	0.105	0.01
Safe and respectful school climate	2	54	2.20	0.120	0.01
Student support and academic engagement	2	54	4.47	0.016	0.03

ANOVA is analysis of variance. Df is degrees of freedom.

Note: Twenty-nine schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years 2016/17, 2017/18, and 2018/19), and 28 schools are included in the teacher and adult samples (schools with at least 5 responses to the teacher survey in each of the years 2016/17, 2017/18, and 2018/19). School climate scores were derived from Rasch models and scaled to 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups. Evidence for a difference in school climate among the reference school years indicated by a p-value < .05.
Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, and 2018/19.

Table B6. ANOVA table for test 3 (changes across 2018/19 and 2021/22 school years)

Outcome	df (numerator)	df (denominator)	F	p-value	Effect size (η2)
Students					
Overall school climate	1	29	0.17	0.681	0.00
Social-emotional learning	1	29	0.15	0.705	0.00
Safe and respectful school climate	1	29	0.02	0.887	0.00
Student support and academic engagement	1	29	2.04	0.164	0.01
Teachers					
Overall school climate	1	51	3.90	0.054	0.01
Social-emotional learning	1	51	6.61	0.013	0.01
Safe and respectful school climate	1	51	5.91	0.019	0.01
Student support and academic engagement	1	51	0.38	0.538	0.00
Adults					
Overall school climate	1	51	3.86	0.055	0.01
Social-emotional learning	1	51	8.41	0.005	0.02
Safe and respectful school climate	1	51	5.95	0.018	0.01
Student support and academic engagement	1	51	0.34	0.565	0.00

ANOVA is analysis of variance. Df is degrees of freedom.

While findings from an ANOVA can tell us whether *any* statistical difference is present among the years tested, it does not tell us which years are different than other years. Therefore, to test which school years were statistically different, a series of post-hoc tests using a Tukey's HSD (honestly significant difference) test were conducted. [4] The findings from these post-hoc tests are reported in tables B7 – B9 below.

The post-hoc comparisons for the main analysis sample showed evidence of change for students, teachers, and adults in most aspects of school climate. Students reported more favorable perceptions of school climate (overall index and all three domains) in 2020/21 compared to 2018/19 and 2021/22 (Table B7). Similarly, teachers reported more favorable perceptions of school climate for overall school climate, social-emotional learning, and safe and respectful school climate in 2020/21 compared to 2018/19 and 2021/22. There was no evidence of differences across school years for teachers' perceptions of student support and academic engagement. Adults reported more favorable perceptions of school climate for overall school climate, social-emotional learning, and safe and respectful school climate in 2020/21 compared to 2018/19 and 2021/22. In the social-emotional learning domain, adult respondents reported more positive perceptions in 2021/22 compared to 2018/19. There was no evidence of difference across school years for teachers' perceptions of student support and academic engagement.

The post-hoc comparisons for the pre-COVID sample showed minimal evidence of changes in students' or teachers' school climate perceptions (Table B8). Students' perceptions of social-emotional learning were more favorable in 2016/17 compared to 2018/19. In addition, teachers' perceptions of student support and academic engagement were more favorable in 2017/18 compared to 2016/17. Like teachers, adults' perceptions of student support and academic engagement were more favorable in 2017/18 compared to 2016/17. Adults' perceptions of student support and academic engagement were also more favorable in 2017/18 compared to 2018/19. No other evidence of differences was found for the pre-COVID sample.

The post-hoc comparisons for the alternative main analysis sample showed no evidence of changes in students' perceptions of school climate and evidence of changes for teachers and adults' perceptions of school climate (Table B9). There was no evidence of changes in students' perceptions of school climate between the 2018/19 and 2021/22 school years for any aspect of school climate (that is, overall or individual domains). However, teachers and adults reported more favorable perceptions of overall school climate, social-emotional learning, and safe and respectful school climate in 2021/22 compared to 2018/19.

Table B7. Post-hoc table comparing changes in scores across pairs of years in the main analysis sample (2018/19, 2020/21, and 2021/22 school years)

Outcome	Comparison		Mean difference	SD	t	p-value
	SY 1	SY 2				
Students						
Overall school climate	2020/21	2018/19	9.46	2.79	3.39	0.002
Overall school climate	2021/22	2018/19	-0.27	2.79	-0.10	0.995
Overall school climate	2021/22	2020/21	-9.73	2.79	-3.49	0.002
Social-emotional learning	2020/21	2018/19	8.95	3.13	2.86	0.012
Social-emotional learning	2021/22	2018/19	-0.35	3.13	-0.11	0.993
Social-emotional learning	2021/22	2020/21	-9.30	3.13	-2.97	0.008
Safe and respectful school climate	2020/21	2018/19	12.23	3.87	3.16	0.004

---

[4] Tukey's HSD test adjusts standard t-tests to correct for the family-wise error rate. This is recommended when making multiple comparisons to control for type I error (identifying a relationship when there actually is not one, also called a false positive). As we compared every pairing of school years within a single ANOVA, we need to make adjustments to account for these multiple comparisons' potential to inflate type I error.

Outcome	Comparison SY 1	SY 2	Mean difference	SD	t	p-value
Safe and respectful school climate	2021/22	2018/19	-1.99	3.87	-0.51	0.864
Safe and respectful school climate	2021/22	2020/21	-14.23	3.87	-3.67	0.001
Student support and academic engagement	2020/21	2018/19	6.61	1.68	3.93	< 0.001
Student support and academic engagement	2021/22	2018/19	1.55	1.68	0.92	0.625
Student support and academic engagement	2021/22	2020/21	-5.06	1.68	-3.01	0.007
Teachers						
Overall school climate	2020/21	2018/19	9.50	2.31	4.12	< 0.001
Overall school climate	2021/22	2018/19	3.86	2.31	1.67	0.215
Overall school climate	2021/22	2020/21	-5.64	2.31	-2.44	0.039
Social-emotional learning	2020/21	2018/19	10.59	2.12	5.00	< 0.001
Social-emotional learning	2021/22	2018/19	4.39	2.12	2.07	0.096
Social-emotional learning	2021/22	2020/21	-6.21	2.12	-2.93	0.010
Safe and respectful school climate	2020/21	2018/19	12.98	2.44	5.32	< 0.001
Safe and respectful school climate	2021/22	2018/19	5.13	2.44	2.10	0.090
Safe and respectful school climate	2021/22	2020/21	-7.85	2.44	-3.22	0.004
Student support and academic engagement	2020/21	2018/19	4.37	3.03	1.44	0.319
Student support and academic engagement	2021/22	2018/19	1.49	3.03	0.49	0.875
Student support and academic engagement	2021/22	2020/21	-2.88	3.03	-0.95	0.609
Adults						
Overall school climate	2020/21	2018/19	9.15	2.12	4.32	< 0.001
Overall school climate	2021/22	2018/19	3.70	2.12	1.75	0.187
Overall school climate	2021/22	2020/21	-5.44	2.12	-2.57	0.027
Social-emotional learning	2020/21	2018/19	10.29	1.88	5.47	< 0.001
Social-emotional learning	2021/22	2018/19	4.55	1.88	2.42	0.041
Social-emotional learning	2021/22	2020/21	-5.74	1.88	-3.05	0.006
Safe and respectful school climate	2020/21	2018/19	12.40	2.22	5.59	< 0.001
Safe and respectful school climate	2021/22	2018/19	4.74	2.22	2.14	0.083
Safe and respectful school climate	2021/22	2020/21	-7.66	2.22	-3.46	0.002
Student support and academic engagement	2020/21	2018/19	4.34	2.83	1.53	0.275
Student support and academic engagement	2021/22	2018/19	1.49	2.83	0.53	0.858
Student support and academic engagement	2021/22	2020/21	-2.85	2.83	-1.01	0.573

SY is school year. SD is standard deviation.

Note: Eighteen schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years 2018/19, 2020/21, and 2021/22), and 28 schools are included in the teacher sample (schools with at least 5 responses to the teacher survey in each of the years 2018/19, 2020/21, and 2021/22). School climate scores were on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores for students were weighted to account for nonresponse bias. Evidence for a difference in school climate among the reference school years indicated by a p-value < .05. Comparisons used Tukey's HSD (honestly significant difference) to adjust for multiple comparisons.

Source: Pennsylvania School Climate Survey, 2018/19, 2020/21, and 2021/22.

Table B8. Post-hoc table comparing changes in scores across pairs of years in the pre-COVID sample (2016/17, 2017/18, and 2018/19 school years)

Outcome	Comparison SY 1	SY 2	Mean difference	SD	*t*	*p*-value
Students						
Overall school climate	2017/18	2016/17	-1.96	1.18	-1.66	0.219
Overall school climate	2018/19	2016/17	-2.46	1.18	-2.09	0.092
Overall school climate	2018/19	2017/18	-0.50	1.18	-0.42	0.906
Social-emotional learning	2017/18	2016/17	-2.27	1.27	-1.79	0.174
Social-emotional learning	2018/19	2016/17	-3.46	1.27	-2.72	0.018
Social-emotional learning	2018/19	2017/18	-1.19	1.27	-0.93	0.619
Safe and respectful school climate	2017/18	2016/17	-1.86	1.51	-1.23	0.433
Safe and respectful school climate	2018/19	2016/17	-1.89	1.51	-1.25	0.421
Safe and respectful school climate	2018/19	2017/18	-0.03	1.51	-0.02	1.000
Student support and academic engagement	2017/18	2016/17	-1.79	1.12	-1.61	0.243
Student support and academic engagement	2018/19	2016/17	-2.07	1.12	-1.86	0.151
Student support and academic engagement	2018/19	2017/18	-0.28	1.12	-0.25	0.966
Teachers						
Overall school climate	2017/18	2016/17	2.62	1.35	1.94	0.127
Overall school climate	2018/19	2016/17	-0.48	1.35	-0.35	0.933
Overall school climate	2018/19	2017/18	-3.10	1.35	-2.30	0.056
Social-emotional learning	2017/18	2016/17	0.07	1.33	0.06	0.998
Social-emotional learning	2018/19	2016/17	-2.32	1.33	-1.74	0.189
Social-emotional learning	2018/19	2017/18	-2.39	1.33	-1.80	0.170
Safe and respectful school climate	2017/18	2016/17	3.32	1.51	2.20	0.072
Safe and respectful school climate	2018/19	2016/17	0.77	1.51	0.51	0.867
Safe and respectful school climate	2018/19	2017/18	-2.55	1.51	-1.69	0.210
Student support and academic engagement	2017/18	2016/17	4.40	1.74	2.53	0.030
Student support and academic engagement	2018/19	2016/17	0.72	1.74	0.41	0.910
Student support and academic engagement	2018/19	2017/18	-3.68	1.74	-2.12	0.086
Adults						
Overall school climate	2017/18	2016/17	2.51	1.29	1.95	0.125
Overall school climate	2018/19	2016/17	-0.51	1.29	-0.40	0.917
Overall school climate	2018/19	2017/18	-3.01	1.29	-2.34	0.050
Social-emotional learning	2017/18	2016/17	-0.04	1.26	-0.03	0.999
Social-emotional learning	2018/19	2016/17	-2.38	1.26	-1.89	0.141
Social-emotional learning	2018/19	2017/18	-2.34	1.26	-1.86	0.150
Safe and respectful school climate	2017/18	2016/17	2.85	1.41	2.02	0.107
Safe and respectful school climate	2018/19	2016/17	0.75	1.41	0.53	0.857
Safe and respectful school climate	2018/19	2017/18	-2.11	1.41	-1.49	0.294
Student support and academic engagement	2017/18	2016/17	4.60	1.66	2.77	0.016
Student support and academic engagement	2018/19	2016/17	0.66	1.66	0.40	0.917
Student support and academic engagement	2018/19	2017/18	-3.94	1.66	-2.37	0.047

SY is school year. SD is standard deviation.

Note: Twenty-nine schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years 2016/17, 2017/18, and 2018/19), and 28 schools are included in the teacher sample (schools with at least 5 responses to the teacher survey in each of the years 2016/17, 2017/18, and 2018/19). School climate scores were on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores for students were weighted to account for nonresponse bias. Evidence for a difference in school climate among the reference school years indicated by a *p*-value < .05. Comparisons used Tukey's HSD (honestly significant difference) to adjust for multiple comparisons.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, and 2018/19.

Table B9 Post-hoc table comparing changes in scores across pairs of years in the alternative main analysis sample (2018/19 and 2021/22 school years)

Outcome	Comparison SY 1	SY 2	Mean difference	SD	*t*	*p*-value
Students						
Overall school climate	2021/22	2018/19	0.87	2.10	0.42	0.678
Social-emotional learning	2021/22	2018/19	0.89	2.34	0.38	0.703
Safe and respectful school climate	2021/22	2018/19	0.43	2.98	0.14	0.886
Student support and academic engagement	2021/22	2018/19	1.67	1.17	1.43	0.154
Teachers						
Overall school climate	2021/22	2018/19	3.24	1.64	1.97	0.048
Social-emotional learning	2021/22	2018/19	3.80	1.48	2.57	0.010
Safe and respectful school climate	2021/22	2018/19	4.46	1.84	2.43	0.015
Student support and academic engagement	2021/22	2018/19	1.29	2.08	0.62	0.535
Adults						
Overall school climate	2021/22	2018/19	3.04	1.55	1.96	0.050
Social-emotional learning	2021/22	2018/19	3.86	1.33	2.90	0.004
Safe and respectful school climate	2021/22	2018/19	4.18	1.71	2.44	0.015
Student support and academic engagement	2021/22	2018/19	1.15	1.98	0.58	0.562

SY is school year. SD is standard deviation.

Note: Thirty schools are included in the student sample (schools with at least 25 responses to the student survey in each of the years 2018/19 and 2021/22), and 52 schools are included in the teacher and adult samples (schools with at least 5 responses to the teacher survey in each of the years 2018/19 and 2021/22). School climate scores were derived from Rasch models and scaled to 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. School climate scores were weighted to account for imbalances between respondents and the population of intersectional race by gender groups. Evidence for a difference in school climate among the reference school years indicated by a *p*-value < .05. Comparisons used Tukey's HSD (honestly significant difference) to adjust for multiple comparisons.

Source: Pennsylvania School Climate Survey, 2016/17, 2017/18, and 2018/19.

Research question 3. Did school climate scores in 2021/22 vary according to the amount of virtual and hybrid instruction used during the 2020/21 school year?

Table B10 shows the results of a regression of school climate in 2021/22 on the percentage of the previous year spent in each listed learning modality, controlling for 2018/19 school climate, for students and teachers. We find no evidence of a relationship between learning modalities in 2020/21 and school climate in 2021/22. This was the case for both students and teachers and for all three modality types (in-person, hybrid, remote). However, the small sample size in this analysis makes it difficult to detect anything but a very strong relationship. The analysis can rule out the existence of a large association between learning modality and school climate scores but cannot rule out a small or moderate relationship.

Table B10. Results of regression models showing relationship between the change in school climate score between 2018/19 and 2021/22 and percentage of weeks in each learning modality in 2020/21

Dependent variable	Percent hybrid			Percent remote			Percent in-person		
	Coefficient	SE	*p*-value	Coefficient	SE	*p*-value	Coefficient	SE	*p*-value
Model 1: Percent remote									
Student school climate index	--	--	--	-0.08	0.14	0.56	--	--	--
Students' perceptions of social-emotional learning	--	--	--	-0.03	0.15	0.85	--	--	--
Students' perceptions of safe and respectful school climate	--	--	--	-0.10	0.19	0.62	--	--	--
Students' perceptions of student support and academic engagement	--	--	--	-0.06	0.07	0.43	--	--	--
Teacher school climate index	--	--	--	0.03	0.11	0.83	--	--	--
Teachers' perceptions of social-emotional learning	--	--	--	0.02	0.07	0.74	--	--	--
Teachers' perceptions of safe and respectful school climate	--	--	--	0.00	0.15	1.00	--	--	--
Teachers' perceptions of student support and academic engagement	--	--	--	0.01	0.11	0.92	--	--	--
Adult school climate index	--	--	--	0.03	0.12	0.80	--	--	--
Adults' perceptions of social-emotional learning	--	--	--	0.05	0.08	0.56	--	--	--
Adults' perceptions of safe and respectful school climate	--	--	--	0.00	0.16	1.00	--	--	--
Adults' perceptions of student support and academic engagement	--	--	--	0.02	0.11	0.86	--	--	--
Model 2: Percent in-person									
Student school climate index	--	--	--	--	--	--	0.05	0.10	0.62
Students' perceptions of social-emotional learning	--	--	--	--	--	--	0.01	0.09	0.94
Students' perceptions of safe and respectful school climate	--	--	--	--	--	--	0.12	0.19	0.54
Students' perceptions of student support and academic engagement	--	--	--	--	--	--	0.02	0.03	0.44
Teacher school climate index	--	--	--	--	--	--	0.00	0.05	0.93
Teachers' perceptions of social-emotional learning	--	--	--	--	--	--	0.04	0.05	0.44
Teachers' perceptions of safe and respectful school climate	--	--	--	--	--	--	-0.04	0.04	0.39
Teachers' perceptions of student support and academic engagement	--	--	--	--	--	--	0.00	0.05	0.93
Adult school climate index	--	--	--	--	--	--	-0.01	0.04	0.82
Adults' perceptions of social-emotional learning	--	--	--	--	--	--	0.02	0.05	0.64
Adults' perceptions of safe and respectful school climate	--	--	--	--	--	--	-0.04	0.04	0.36
Adults' perceptions of student support and academic engagement	--	--	--	--	--	--	-0.01	0.04	0.83
Model 3: Percent hybrid and percent remote									
Student school climate index	-0.04	0.11	0.74	-0.10	0.16	0.54	--	--	--
Students' perceptions of social-emotional learning	0.00	0.10	1.00	-0.03	0.16	0.87	--	--	--

Dependent variable	Percent hybrid			Percent remote			Percent in-person		
	Coefficient	SE	*p*-value	Coefficient	SE	*p*-value	Coefficient	SE	*p*-value
Students' perceptions of safe and respectful school climate	-0.11	0.20	0.58	-0.15	0.24	0.54	--	--	--
Students' perceptions of student support and academic engagement	-0.01	0.04	0.90	-0.06	0.06	0.37	--	--	--
Teacher school climate index	0.00	0.05	0.99	0.02	0.11	0.83	--	--	--
Teachers' perceptions of social-emotional learning	-0.05	0.05	0.36	0.00	0.08	0.99	--	--	--
Teachers' perceptions of safe and respectful school climate	0.04	0.05	0.47	0.02	0.14	0.89	--	--	--
Teachers' perceptions of student support and academic engagement	0.00	0.05	0.96	0.01	0.11	0.92	--	--	--
Adult school climate index	0.00	0.05	0.93	0.03	0.12	0.77	--	--	--
Adults' perceptions of social-emotional learning	-0.04	0.05	0.48	0.03	0.08	0.73	--	--	--
Adults' perceptions of safe and respectful school climate	0.04	0.06	0.46	0.02	0.15	0.89	--	--	--
Adults' perceptions of student support and academic engagement	0.01	0.05	0.89	0.02	0.11	0.84	--	--	--

SE is standard error.

Note: Fifteen districts are included in the student sample (districts with at least one school that has enough respondents (at least 25) to the student survey in each of the years 2018/19 and 2021/22 as well as Return to Learn Tracker data), and 18 districts are included in the teacher sample (districts with at least one school that has enough respondents (at least 5) to the teacher survey in each of the years 2018/19 and 2021/22 as well as Return to Learn Tracker data). School climate scores were on a scale from 1–99. In all domains, 1 = most negative perceptions of school climate and 99 = most positive perceptions of school climate. When constructing school climate scores for students, the team weighted to account for nonresponse bias. Evidence for a difference in school climate among the reference school years is indicated by a *p*-value < .05. Regressions tested whether the percentage of a learning modality used in 2020/21 was associated with 2021/22 school climate (overall and domain), controlling for 2018/19 school climate. The 2018/19 covariate matched the outcome; for example, if the outcome was 2021/22 social-emotional learning, the model included a control for 2018/19 social-emotional learning. '--' refers to cells that are not applicable to the model.

Source: Pennsylvania School Climate Survey, 2018/19, 2020/21, and 2021/22.

References

Bacher-Hicks, A., Goodman, J., Grief Green, J., and Holt, M. (2022). The COVID-19 Pandemic Disrupted Both School Bullying and Cyberbullying. *AER: Insights*, 4(3): 353–370.

CDC Foundation (2021). Mental Health Impact of the COVID-19 Pandemic on Teachers and Parents of K-12 Students. Available at: https://www.cdcfoundation.org/mental-health-triangulated-report?inline

Hansen, B., Sabia, J. J., & Schaller, J. (2022). In-Person Schooling and Youth Suicide: Evidence from School Calendars and Pandemic School Closures (No. w30795). National Bureau of Economic Research.

Vaillancourt, T., Brittain, H., Krygsman, A., Farrell, A. H., Landon, S., & Pepler, D. (2021). School bullying before and during COVID-19: Results from a population-based randomized design. *Aggressive behavior,* 47(5), 557-569.

Welsh, R. O. (2022). School discipline in the age of COVID-19: Exploring patterns, policy, and practice considerations. *Peabody Journal of Education*, 97(3), 291-308.

Appendix C. Nonresponse bias analysis

This appendix provides a detailed description of response rates and the nonresponse bias analysis.

Analyzing response rates

For the Pennsylvania School Climate Survey, not all respondents eligible to take the surveys took them. If those who responded to the survey had responses that were not representative of their school, the school-level averages of school climate could be misleading. For example, if White students were more likely to respond to the survey than Black students (and thus were overrepresented among survey respondents) and White students score their schools higher on student support than other students, then the school-level score for the student support domain may appear higher than it would be if all students had responded (Voight et al., 2015). To address this, the study examined response rates, checked for evidence of nonresponse bias, and applied weights to adjust for nonresponse, as needed.

Response rates. We calculated response rates for the student and teacher samples of the Pennsylvania School Climate Survey (table C1). To count as a respondent, individuals had to answer all items in the survey. The response rate is the number of respondents divided by the number of people eligible to take the survey. For each school year, we report the average response rate for schools in the sample as well as the 25th, 50th, and 75th percentiles of the school distributions to describe the variation in response rates across schools (table C1).

To identify the set of students eligible to take the survey, the team used student counts from Common Core of Data (CCD) for each school in a given year. To identify the teachers eligible to take the survey, the team used counts of classroom teachers for each school, pulled from the Pennsylvania Department of Education (PDE) Professional Personnel Individual Staff Reports for a given year. We could not calculate response rates for noninstructional staff because we did not have information about the eligible populations of this group. Specifically, we could not identify all potential respondents from the noninstructional staff group because of a misalignment between PDE's professional staff definition under the "Other Certified Staff" category and the school climate survey's staff definitions. PDE's staff category of "Other Certified Staff" excludes noncertified staff, whereas staff respondents include noncertified personnel like janitors.

In addition, response rates were only calculated for schools that were included in analyses for research questions 2 and 3, as these were the analyses that used school climate scores. We did not calculate response rates for technical centers (technical centers are categorized as vocational schools in CCD) due to a mismatch between enrollment data from CCD and the students who took the survey. Specifically, we observe many more students taking the survey at a technical center than the enrollment data from CCD indicated would be possible. This may be due to differences in how enrollment is calculated for students who take courses both at a technical center and a high school. This resulted in the team dropping five technical centers (21 school/year pairings) from the response rate analysis.

The response rates for students and teachers across the 2016/17 to 2021/22 school years are reported in table C1.

Table C1. Pennsylvania School Climate Survey response rates

Measure	Mean	25th percentile	50th percentile	75th percentile	Observations
Student response rate					
2016/17	0.62	0.34	0.73	0.78	19
2017/18	0.66	0.62	0.73	0.77	22
2018/19	0.67	0.57	0.71	0.78	42
2020/21	0.60	0.51	0.71	0.74	14
2021/22	0.58	0.48	0.64	0.72	23
Classroom teacher response rate					
2016/17	0.68	0.52	0.67	0.84	19
2017/18	0.64	0.49	0.70	0.73	22
2018/19	0.63	0.42	0.62	0.80	42
2020/21	0.62	0.47	0.60	0.76	14
2021/22	0.66	0.56	0.68	0.78	23

Note: The table shows the response rates of students and teachers to the Pennsylvania School Climate Survey for each school year used in the study (described in appendix B). The 2019/20 school year is not included because it is not used in any analyses.

Response rates were calculated for a subset of schools that took the Pennsylvania School Climate Survey. Schools included those in the sample for research questions 2 or 3. In addition, technical centers were dropped due to lack of comprehensive enrollment data in Common Core of Data (21 school/year pairings across 5 schools were dropped from the response rate analysis).

Source: Authors' analyses based on administrative data from the Pennsylvania Department of Education Professional Personnel Individual Staff Reports and Common Core of Data, 2016/17 to 2021/22 (excluding 2019/20).

Nonresponse bias analysis

Because overall response rates were less than 85 percent (the standard set by the National Center for Education Statistics, 2012), the study team conducted a nonresponse bias analysis to examine the potential for nonresponse bias to affect the results. CCD provides detailed demographic information for students but does not provide this information for teachers or noninstructional staff. Therefore, the nonresponse bias analyses could only be conducted for students.

The analysis is composed of two parts. First, we examine how the characteristics of students who responded to the survey differ from the characteristics of all eligible students within a school in each year. The student characteristics available for these analyses include gender and race/ethnicity. For the Pennsylvania School Climate Survey, less than 5 percent of students across all years are missing any of these variables.

Second, the study team calculated the differences in student characteristics in standard deviation units between students who responded to the survey and students in the total eligible sample (table C2). The average absolute value of the differences was greater than 0.05 for many years for the intersectional categories of gender (female, male) and race/ethnicity (Asian/Pacific Islander, American Indian/Alaska Native, Black, Hispanic/Latino/a/x, multiracial, and White). The percentage of schools in a given year with standardized differences exceeding the 0.05 threshold ranged from 18 percent to 85 percent across demographic groups in the first two years (2016/17 and 2017/18) but improved in later years. For example, in 2020/21, this ranged from 9 percent to 21 percent across demographic groups.

Given that the differences between the student characteristics of the sample of eligible students and students who responded to the Pennsylvania School Climate Survey were frequently larger than 0.05 standard deviations, it is necessary to adjust for nonresponse on the survey in schools that have low response rates, according to National Center for Education Statistics guidance.

Table C2. Differences between student respondents and the eligible sample of students

Covariates and units	Average |standardized difference|	Percentage of schools with listed group overrepresented (standardized difference > .05)	Percentage of schools with listed group underrepresented (standardized difference < -.05)	Percentage of schools with imbalance (|standardized difference| > .05)	Percentage of schools without imbalance (|standardized difference| < .05)
2016/17 (n = 30)					
Asian American/Pacific Islander females	0.04	3.3	16.7	20.0	80.0
Asian American/Pacific Islander males	0.04	10.0	16.7	26.7	73.3
American Indian/Alaska Native females	0.13	0.0	60.0	60.0	40.0
American Indian/Alaska Native males	0.22	0.0	73.3	73.3	26.7
Black females	0.06	26.7	10.0	36.7	63.3
Black males	0.06	20.0	16.7	36.7	63.3
Hispanic females	0.07	33.3	10.0	43.3	56.7
Hispanic males	0.08	46.7	13.3	60.0	40.0
Multiracial females	0.35	0.0	76.7	76.7	23.3
Multiracial males	0.40	3.3	80.0	83.3	16.7
White females	0.08	26.7	16.7	43.3	56.7
White males	0.13	63.3	13.3	76.7	23.3
2017/18 (n = 33)					
Asian American/Pacific Islander females	0.06	9.1	24.2	33.3	66.7
Asian American/Pacific Islander males	0.05	3.0	30.3	33.3	66.7
American Indian/Alaska Native females	0.13	0.0	63.6	63.6	36.4
American Indian/Alaska Native males	0.29	0.0	69.7	69.7	30.3
Black females	0.05	21.2	12.1	33.3	66.7
Black males	0.06	6.1	30.3	36.4	63.6
Hispanic females	0.04	12.1	6.1	18.2	81.8
Hispanic males	0.07	33.3	18.2	51.5	48.5
Multiracial females	0.33	3.0	81.8	84.8	15.2
Multiracial males	0.38	3.0	81.8	84.8	15.2
White females	0.08	33.3	18.2	51.5	48.5
White males	0.11	54.5	9.1	63.6	36.4
2018/19 (n = 71)					
Asian American/Pacific Islander females	0.04	1.4	18.3	19.7	80.3
Asian American/Pacific Islander males	0.05	7.0	16.9	23.9	76.1
American Indian/Alaska Native females	0.21	1.4	45.1	46.5	53.5
American Indian/Alaska Native males	0.22	0.0	53.5	53.5	46.5
Black females	0.06	16.9	11.3	28.2	71.8
Black males	0.07	12.7	21.1	33.8	66.2
Hispanic females	0.04	19.7	7.0	26.8	73.2
Hispanic males	0.08	26.8	9.9	36.6	63.4
Multiracial females	0.32	1.4	56.3	57.7	42.3
Multiracial males	0.38	1.4	59.2	60.6	39.4
White females	0.07	26.8	9.9	36.6	63.4
White males	0.13	49.3	5.6	54.9	45.1

Covariates and units	Average |standardized difference|	Percentage of schools with listed group overrepresented (standardized difference > .05)	Percentage of schools with listed group underrepresented (standardized difference < -.05)	Percentage of schools with imbalance (|standardized difference| > .05)	Percentage of schools without imbalance (|standardized difference| < .05)
2020/21 (n = 30)					
Asian American/Pacific Islander females	0.04	0.0	8.5	8.5	91.5
Asian American/Pacific Islander males	0.08	7.0	8.5	15.5	84.5
American Indian/Alaska Native females	0.40	0.0	21.1	21.1	78.9
American Indian/Alaska Native males	0.28	0.0	19.7	19.7	80.3
Black females	0.08	9.9	5.6	15.5	84.5
Black males	0.07	7.0	9.9	16.9	83.1
Hispanic females	0.07	11.3	1.4	12.7	87.3
Hispanic males	0.05	9.9	2.8	12.7	87.3
Multiracial females	0.24	0.0	19.7	19.7	80.3
Multiracial males	0.25	0.0	19.7	19.7	80.3
White females	0.12	8.5	5.6	14.1	85.9
White males	0.14	16.9	2.8	19.7	80.3
2021/22 (n = 50)					
Asian American/Pacific Islander females	0.07	1.4	12.7	14.1	85.9
Asian American/Pacific Islander males	0.05	5.6	14.1	19.7	80.3
American Indian/Alaska Native females	0.13	0.0	32.4	32.4	67.6
American Indian/Alaska Native males	0.39	0.0	38.0	38.0	62.0
Black females	0.05	5.6	8.5	14.1	85.9
Black males	0.06	12.7	11.3	23.9	76.1
Hispanic females	0.06	22.5	0.0	22.5	77.5
Hispanic males	0.07	23.9	1.4	25.4	74.6
Multiracial females	0.25	2.8	35.2	38.0	62.0
Multiracial males	0.28	2.8	35.2	38.0	62.0
White females	0.11	23.9	9.9	33.8	66.2
White males	0.11	28.2	2.8	31.0	69.0

Note: The first column of the table shows the average of the absolute value of the standardized difference in mean student characteristics between students who responded to the Pennsylvania School Climate Survey in each year and those who were eligible to respond to the survey in each school. The second and third columns show the percentage of schools with a standardized difference greater than .05 and the percentage of schools with a standardized difference less than -.05, respectively. The fourth column shows the percentage of schools that have an imbalance, meaning the absolute value of the standardized difference is greater than .05. The fifth column shows the percentage of schools without an imbalance. The number of observations indicates how many schools are included within each school year.

Nonresponse bias was calculated for a subset of schools that took the Pennsylvania School Climate Survey. Schools included those in the sample for research questions 2 or 3. In addition, technical centers were dropped due to lack of comprehensive enrollment data in Common Core of Data (21 school/year pairings across 5 schools were dropped from response rate analysis).

Source: Authors' analyses based on survey data provided by the Pennsylvania Department of Education and administrative data from Common Core of Data.

Nonresponse weights

Given the possibility of nonresponse bias on the Pennsylvania School Climate Survey, the study team created nonresponse weights for schools with low response rates (less than 0.85). Nonresponse weights help to make school average scores more representative of the eligible population of students in a school by giving more weight to responding students who are part of a group that is less likely to have responded to the survey. Because we use school-level averages of the survey measures in this report, we construct the nonresponse weights within schools using a weighting class approach described below.

1. We first identify the student characteristics that are imbalanced between the group of eligible students and the group of responding students (those with standardized differences greater than .05). For example, a school may have an imbalance among White females, Black females, and Asian females but have no other imbalances.

2. For each group with an imbalance in each school, we calculate nonresponse weights equal to the number of group members in the eligible population of students in the school over the number who responded to the survey. In the example above, we would construct weights for these three groups (White females, Black females, Asian females) and a weight for all other students. This approach enabled us to create weights to adjust for the specific groups of students that have imbalances in response rates within a given school-year pairing.

We then applied nonresponse weights for students in schools with low response rates when constructing school-level averages of the school climate indices and domain scores.

References

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2012). *2012 revision of NCES statistical standards: Final.* (NCES 2014-097). Author. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2014097

Voight, A., Hanson, T., O'Malley, M., & Adekanye, L. (2015). The racial school climate gap: Within-school disparities in students' experiences of safety, support, and connectedness. *American Journal of Community Psychology*, *56*, 252–267.