PHOTOGRAPH / VETTA; GETTY IMAGES

IN DEFENSE OF SNOW DAYS

STUDENTS WHO STAY HOME WHEN SCHOOL IS IN SESSION ARE A MUCH LARGER PROBLEM

In snowy climes, school superintendents must frequently decide whether an impending storm warrants closing schools for the day. Concerns about student and teacher safety must be weighed against the loss of student learning time, along with state requirements for days of instruction and the cost and inconvenience of extending the school year into the summer. This calculus assumes, based on evidence of various kinds, that school hours lost to snow days equal lost student learning. Studies show that highly effective charter schools, for instance, tend to have longer school days and years than traditional public schools, and that increased instructional time is correlated with higher school effectiveness even within the charter sector. Other studies have shown that schools fare worse on state tests in years in which they experience more weather-related school closings, seemingly providing direct evidence that closings reduce student learning (see "Time for School," *research,* Winter 2010).

Discussion of instructional time loss, however, has rarely focused on individual student attendance, a surprising omission given that the average American student misses more than two weeks of school every year. While most absences are the result of illness or disengagement from school, some reflect the decision to stay home when the weather is bad, even though schools remain open. In addition to reducing instructional time, student absences may impede the learning process by forcing teachers to split their time between students who have and have not missed the previous day's lessons.

This study provides a fresh look at the impact of instructional time lost due to weather-related student absences, as well as to school closings. Using student-level data from Massachusetts, I find that each one-day increase in the student absence rate driven by bad weather reduces math achievement by up to 5 percent of a standard deviation, suggesting that differences in average student attendance may account for as much as one-quarter of the income-based achievement gap in the state. Conversely, instructional time lost to weather-related school closings has no impact on student test scores.

What could explain these apparently conflicting results? It appears that teachers and schools are well prepared to deal with coordinated disruptions of instructional time like snow days but not with absences of different students at different times. In short, individual absences and not school closings are responsible for the achievement impacts of bad weather.

Studying Instructional Disruptions

The major challenge of studying the effect of disruptions to instructional time on student achievement is that students and schools with high absence and closing rates are likely to differ in unobserved ways from those with low absence and closing rates. Simply comparing the test scores of students who are absent more and less often, for example, would ignore factors such as students' health or family background that affect both academic

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performance and attendance rates. In the same way, school districts that close school more often may have other policies in place that would lead to performance differences.

One way to overcome this challenge is to take advantage of weather patterns that affect instructional time. Although students have been known to pray for snow days, the amount of snow that falls in a given time and place is outside of their control. It is of course possible that regions that consistently receive more snow than others may differ in unobserved ways that are related to their achievement. Yet the amount of snow a given school experiences often varies a great deal from one year to the next. This makes it possible to compare the performance of individual schools in years they experience an unusually large amount of snow to their performance in years they experience very little.

This is the strategy I implement, using data from Massachusetts spanning the years 2003 to 2010. In particular, I compare how students in a particular grade in a particular school fared on the state tests in years when winter weather resulted in numerous student absences and school cancellations to the test results for students in that same grade and school in years when the winter was milder and resulted in fewer absences and cancellations.

Massachusetts is an ideal state to conduct a study of weather-related absences and school closings as the amount of snowfall varies widely from year to year and across the state. Indeed, the average number of days with more than four inches of snowfall experienced by schools in the state during the study period ranged from just a single day in 2007 to nearly five days in 2005. In some years, the Boston area was hardest hit, while in others more snow fell in the Berkshire Mountains to the west.

As in most states, school closings in Massachusetts are at the discretion of the superintendent, who generally consults the weather forecast, neighboring superintendents, and other local officials before making a decision. Superintendents are typically reluctant to call a snow day for a number of reasons. Parents of school-age children may struggle to make child-care arrangements when schools close unexpectedly. Massachusetts law requires all schools to provide 180 days of instruction. When schools close too often during the winter, instructional days must be added to the calendar in June. Because the state's standardized tests are administered in the spring, snow days also reduce the amount of instructional time that schools have to prepare students for the tests.

Data

Because the Massachusetts Department of Elementary and Secondary Education does not collect information on school closings, I solicited it from the state's roughly 350 school districts individually, by e-mail and phone, with priority given to collecting data from the largest districts. I was ultimately able to obtain annual data on the number of school closings between 2003 and 2010 from districts serving more than half the students in the state.

Snowfall data come from the National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online. NOAA records daily weather data, including snowfall, rainfall, and minimum and maximum temperatures, all of which are captured by dozens of sensors scattered across the state. By mapping schools' latitude and longitude, I assigned each to its closest weather sensor. This allowed the construction of annual measures of snowfall that are specific to each school.

My main analysis sample includes all students in Massachusetts public schools from 2003 to 2010 with valid state test scores in math or English language arts (ELA) from districts that reported a complete annual history of school closings. Student-level data on demographics, attendance, and achievement come from the Massachusetts Department of Elementary and Secondary Education. Specifically, the data include student gender, race/ethnicity, family income as indicated by free or reduced-price

Substantial gains in instructional time may be made by simply improving school attendance.

PHOTOGRAPHS / SHUTTERSTOCK *(LEFT)*; MICHAEL LLOYD, THE OREGONIAN *(RIGHT)*

Snowy days affect instructional time through two channels. Some result in school closings, in which all students miss school. On other, less snowy days, schools typically remain open but a subset of students remains home.

lunch eligibility, special education status, and current grade. A little more than one-third of the students are from low-income families. More than two-thirds are white, while 11 percent are black, 14 percent are Hispanic, and 6 percent are Asian.

I calculate student absences as the difference between the number of days a student was enrolled in school and the number of days a student actually attended school. The data do not include specific dates of student absences, so daily weather patterns cannot be linked to daily attendance. All analysis is therefore done at the annual level.

The data include students' scores on the Massachusetts Comprehensive Assessment System (MCAS), which is given annually in grades 3 through 8 and in grade 10 in mathematics and ELA. The ELA tests are typically administered during a two-week window in late March to early April and the math tests in mid- to late May. Although my annual measure of absences may therefore overstate the number of absences that could affect test performance, the weather-related absences that are the focus of the analysis almost always occur prior to these test-administration windows.

A Blizzard of Absences

The average Massachusetts student is absent 8 school days per year, but student absences vary by poverty status, grade, and race. In the sample of students used in my analysis, poor students are absent 10 days per year on average, 3 days more than nonpoor students. There are also striking differences by race in the average number of absences. Black and Hispanic students are absent 9 and 10 school days a year, respectively, compared to 5 days for Asian and about 8 days for white students.

In contrast, the average student misses just two days a year due to weather-related closings, a figure which does not differ notably across student groups. For most students, then, the amount of instruction time lost to absences dwarfs that lost to closings (see Figure 1).

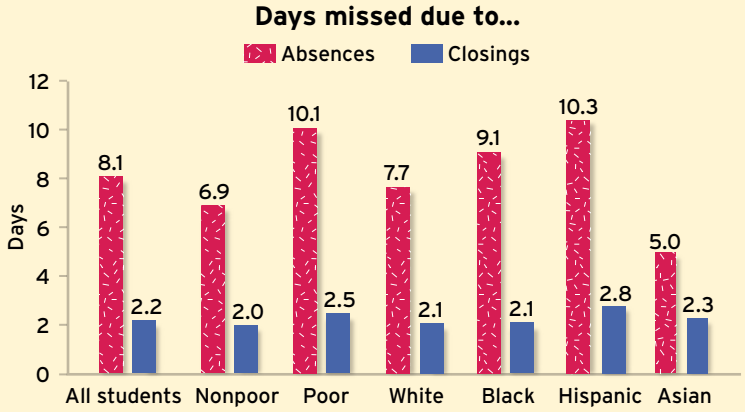
The first step in my analysis is to determine how both student absences and school closings are affected by snowfall. In doing so, I distinguish between moderately snowy days, in which a school received at least 4 but fewer than 10 inches of snow, and days when more than 10 inches fell. To discern the effects of both kinds of days, I compare students attending the same school and grade in different years and adjust for the average amount of snow experienced in a given year statewide.

I find that each extra day with at least 4 but fewer than 10 inches of snow leads to just .04 additional school closings but .08 additional student absences (see Figure 2). The size of the latter effect implies that, for a classroom of 25 students, each additional moderately snowy day would result in about two students more being absent. Each day with snowfall of 10 inches or more, in contrast, leads to .51 additional closings. Controlling for the number of moderately snowy days, however, heavy snow leaves student absences unaffected, since all students are generally out of school.

Snowy days thus affect instructional time through two

Why Kids Miss School (Figure 1)

Students miss many more days due to absences than to closings, and poor and minority students tend to be absent most often.



NOTES: Based on all students with valid Massachusetts Comprehensive Assessment System scores whose school districts reported school closings for years 2003-2010. Poor students are those participating in the free or reduced-price lunch program.

SOURCE: Author's calculations based on data from Massachusetts school districts and the Massachusetts Department of Elementary and Secondary Education

When the average student is absent one additional day over the course of a year, math achievement falls by 5 percent of a standard deviation, a large effect.

channels. Some result in school closings, in which all students miss school. On other, less snowy days, schools typically remain open but a subset of students remains home. With information on the number of moderate and heavy snow days that schools experience each year, it is possible to disentangle the effects of absences and closings on student achievement.

Absences, Closings, and Student Achievement

I find that absences cause sharp reductions in math achievement. When the average student in a given grade and school is absent one additional day over the course of a year, average math achievement in that grade falls by 5 percent of a standard deviation, a large effect, roughly equivalent to 6 percent of the gap in math performance between low-income and nonpoor students in Massachusetts. Given that the typical low-income student is absent three more days each year than a nonpoor student, this result suggests that student absences could account for as much as one-quarter of the income-based achievement gap in the state. The estimated impact on ELA performance, while negative, is smaller and statistically insignificant (see Figure 3).

The larger impact of absences on math performance may be because in math, much more so than in ELA, understanding the current topic depends on having understood prior topics. Teachers may feel more obligated during math instructional time to try to catch up students who have been absent, thus depriving the rest of the class of instructional time. If teachers don't review for those students, their days missed may have long-run effects, as they lose mastery of both the material presented in their absence and the material presented subsequently. Missing an ELA lesson may not have as deep an impact on a student's ability to learn from subsequent lessons.

Because my analysis relates average achievement levels in a given school and grade to overall absence rates, the effects of absences on math achievement could be driven by students' own absences or those of their peers. I suspect that both factors are important. In a separate analysis of the same achievement data, I compare the test scores of specific students to their own test scores in years in which they and their peers were absent more often. I find that student learning in math is equally affected by one's own lost instructional time and the time lost by one's peers. This pattern provides a first suggestion that the harm caused by student absences may stem as much from the challenges frequent absences pose for teachers as from the instructional time lost by the specific students missing class.

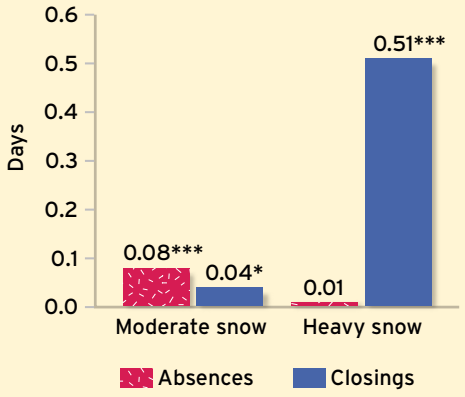
School closings, in contrast, have no effect at all on student achievement for the sample as a whole, in either math or ELA. I find that school closings do appear to reduce performance in both subjects in schools serving predominantly low-income students, but the effect is smaller than .02 standard deviations for each day lost. In the main, then, it appears that individual student absences and not school closings are responsible for the achievement impacts of bad weather and that the magnitude of the estimated impact of absences on math achievement is substantial.

These findings, that weather-related school closings have little

It's the Amount of Snow That Counts

(Figure 2)

Moderate snowfall rarely causes schools to close but has a noticeable effect on absence rates. Heavy snow leads to school closings but leaves absences unaffected.



* indicates statistical significance at the 90 percent confidence level

*** indicates statistical significance at the 99 percent confidence level

NOTES: Figure shows instructional time loss caused by each additional day with 4+ inches of snow. Moderate snowfall is defined as at least 4 but fewer than 10 inches of snow, and heavy snowfall is defined as more than 10 inches of snow.

SOURCE: Author's calculations based on data from Massachusetts school districts, the Massachusetts Department of Elementary and Secondary Education, and the National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online

impact on student achievement, appear to conflict with those of a number of previous studies, which may have painted an incomplete picture of the relationship between bad weather, lost instructional time, and achievement. Finding a correlation between bad weather and declines in student achievement, prior researchers assumed that the effect runs through school closings. This analysis distinguishes between the effects of school closings and of individual student absences and finds the latter to be the culprit in lowering student test scores.

the bulk of the evidence suggests it does. A more likely explanation is that schools and teachers are well prepared to deal with the coordinated disruptions caused by snow days—much more so than they are to handle the less dramatic but more frequent disruptions caused by poor student attendance.

This result may seem intuitive to teachers, who are familiar with the management challenges of instructing students at different levels of preparation. When a few students miss a day or more of instruction, the teacher can review the recently presented material for those students who missed it, in which case the absent students' peers lose out on valuable instructional time, or she may move forward with new material and risk having the absent students fall behind.

School closings, conversely, present no such coordination challenge. All students miss the exact same lesson, allowing the teacher to easily plan for ways to compensate. The lost time will have no effect on students' standardized test scores so long as the teacher redirects time from nontested subjects or material to compensate for the missed lesson on tested material. If lessons on nontested material can be postponed, compressed, or eliminated altogether, school closings will not affect student test scores.

The fact that changes in student absence rates are strongly associated with changes in student achievement demonstrates that instructional time lost to these student-level disruptions matters for student learning. Increasing instructional time does not necessarily require lengthening the school day or year. Substantial gains may be made by simply improving student attendance.

The negative achievement impacts associated with student absences imply that schools and teachers are not well prepared to deal with the more frequent disruptions caused by poor student attendance. Schools and teachers may benefit from investing in strategies to compensate for these disruptions, including the use of self-paced learning technologies that shift the classroom model to one in which all students need not learn the same lesson at the same time.

In the meantime, superintendents watching the weather forecast should consider erring on the side of cancellation when an impending storm is likely to be severe enough to substantially disrupt student attendance. Their decisions may not please working parents scrambling to arrange child care. (As a Boston-area parent, I speak from experience.) But closing school for everyone appears to be better for student learning than adding to the challenges posed by American students' already low attendance rates.

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School closings have no effect at all on student achievement for the sample as a whole, in either math or ELA.

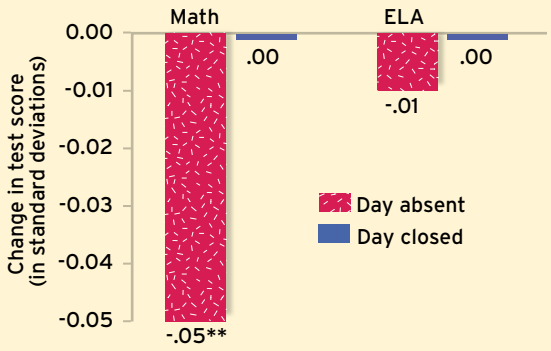
Conclusion

In short, the impact of lost instructional time depends on the particular form of the time lost. Student absences sharply reduce student achievement, particularly in math, but school closings appear to have little impact. These findings should not be taken to mean that instructional time does not matter for student learning;

Absences Make the Scores Go Wander

(Figure 3)

Absences caused by snowy weather sharply reduce student achievement in math. In contrast, closings have no effect on learning in either math or English language arts.



** indicates statistical significance at the 95 percent confidence level

NOTE: Figure shows the estimated effect of each additional snow-induced absence or closing on math and English language arts (ELA) scores from the Massachusetts Comprehensive Assessment System (MCAS).

SOURCE: Author's calculations based on data from Massachusetts school districts, the Massachusetts Department of Elementary and Secondary Education, and the National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online