Instructional Time in U.S. Public Schools: Wide Variation, Causal Effects, and Lost Hours

Matthew A. Kraft
Brown University

Sarah Novicoff
Stanford University

Policymakers have renewed calls for expanding instructional time in the wake of the COVID-19 pandemic. We establish a set of empirical facts about time in school, synthesize the literature on the causal effects of instructional time, and conduct a case study of time use in an urban district. On average, instructional time in U.S. public schools is comparable to most high-income countries, with longer days but shorter years. However, instructional time varies widely across U.S. public schools with a 90th-10th percentile difference of 190 total hours. Empirical literature confirms that additional time can increase student achievement, but how this time is structured matters. Our case study suggests schools might also recover substantial lost learning time within the existing school day.

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Matthew A. Kraft
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Abstract

Policymakers have renewed calls for expanding instructional time in the wake of the COVID-19 pandemic. We establish a set of empirical facts about time in school, synthesize the literature on the causal effects of instructional time, and conduct a case study of time use in an urban district. On average, instructional time in U.S. public schools is comparable to most high-income countries, with longer days but shorter years. However, instructional time varies widely across U.S. public schools with a 90^{th}-10^{th} percentile difference of 190 total hours. Empirical literature confirms that additional time can increase student achievement, but how this time is structured matters. Our case study suggests schools might also recover substantial lost learning time within the existing school day.

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1. Introduction

For decades, policymakers have argued that the American education system fails to provide the necessary instructional time for U.S. students to remain competitive in an increasingly globalized economy. In 1983, the landmark report *A Nation at Risk* warned that the "mediocre educational performance" of American students threatened the very safety and economic security of the country. The report attributed this competitive decline, in part, to the comparatively fewer hours Americans spent in school and the ineffective use of instructional time (Gardner et al., 1983). Ten years later, the National Education Commission on Time and Learning characterized the American school system as "a prisoner of time" (Kane, 1994). President Obama echoed these sentiments in 2009, arguing that the American school calendar "puts us at a competitive disadvantage" and that "the challenges of a new century demand more time in the classroom" (Martin, 2009).

These oft-repeated assertions that America's public schools and economic competitiveness suffer from a lack of instructional time rest on several key assumptions. First, they assume that students in the United States spend less time in school than their peers in other countries. Second, they assume that spending more time in school would increase academic achievement. Third, they assume that expanding the number of total hours in the school year is the optimal way to increase instructional time. However, longstanding debates about time in school often fail to recognize these assumptions or attempt to address them with incomplete and imprecise information.

Most recently, policymakers have argued for expanding instructional time as a response to the loss of in-person learning time caused by the COVID-19 pandemic (Perez, 2021). Some states and districts are moving in this direction with the support of federal dollars from the

Elementary and Secondary School Emergency Relief Fund. For example, the Dallas Independent School District extended the school year at 46 elementary and middle schools in the fall of 2021, affecting more than 20,000 students (Little, 2022). In the country's second largest school district, Los Angeles Unified, school board members recently voted to add seven optional days to the calendar for 2022-23: four days for extra academic support and three for teacher professional development (Sequeira, 2022). At the same time, some rural districts have recently reduced total instructional time by moving to a four-day week to address staffing challenges and budget constraints (Thompson, Gunter, et al., 2021).

In this paper, we aim to inform the ongoing national dialogue about expanding instructional time in U.S. public schools by establishing a set of core empirical facts. We focus our analyses on three questions, each of which interrogates a key assumption underlying proposals to expand learning time: 1) How much time do U.S. students actually spend in school?, 2) Would increasing instructional time in school raise student achievement?, and 3) How much can schools increase actual learning time within the existing school day by reducing the amount of lost learning time? We answer these questions based on descriptive analyses of national and international datasets, a synthesis of the causal research on instructional time, and a case study of time use in an urban district.

Drawing on several data sources, we show that U.S. public schools offer a similar amount of total instructional time as other high-income countries, with longer school days but shorter school years. However, these international comparisons mask substantial variation in the total number of hours individual public schools are in session in the U.S. Using nationally representative data, we find that the decentralized education system in the U.S. has resulted in large differences in learning time, with differences of almost 200 total hours (roughly equivalent to five and a half weeks) between schools at the 90th percentile of the distribution of learning time and those at the 10th percentile.

We next synthesize the causal research literature on the effects of learning time on academic achievement. As a whole, the research provides compelling evidence that increasing instructional time leads to gains in academic achievement, the magnitude of which depends on how time is increased and what the time is used for. Research suggests that extending the school year is a relatively more effective method of improving academic outcomes compared to extending the school day, especially in contexts such as the U.S. where students already attend school for a full-day. Studies also demonstrate that extended learning time is often effective when bundled with other reforms aimed at enhancing instructional quality or offering more personalized instruction (e.g. Kraft, 2015).

Finally, we present a case study of the Providence Public School District (PPSD) to quantify the scope of lost learning time during the existing school day in one setting. To accomplish this, we combine administrative data on student absences, suspensions, and tardies with teacher absences and field-based estimates of time lost from outside interruptions to classroom instruction. Making conservative assumptions about time loss, we estimate that students in PPSD lose between 16 and 25 percent of their allocated instructional time to these factors. Total instructional time loss is likely even higher given that our estimates do not incorporate time lost due to off-task student behavior or transitions between activities.

While empirical evidence provides little support for claims that the U.S. education system has been left behind by instructional time increases in other countries, the wide variation in instructional time across U.S. public schools is concerning. Districts could provide more equitable learning opportunities to students by expanding instructional time in many U.S. public schools that operate with relatively low levels of learning time. States might also move to raise and more closely align minimum learning time requirements.

Research on the causal effect of time in school on academic achievement suggests that increasing learning time in schools could be beneficial for students if that time is used well. These increases could be especially beneficial in environments where students currently experience low levels of time. Research also suggests that expanded instructional time has the potential to accelerate student learning in the wake of large COVID-19 learning losses, (Kuhfeld & Lewis, 2022; Mervosh, 2022), but that it is not a silver bullet. At the same time, our case study illustrates how considerable inefficiencies in time use can undercut the added value of additional time. There exist real opportunities to increase the actual amount of instructional time students receive by better utilizing the allocated time schools have in their current schedules.

2. How Much Time do U.S. Students Spend in School?

2.1 International Comparisons

We draw on data collected by the Organization for Economic Co-operation and Development (OECD) to compare the length of the school year across countries.[1] These data from 2017-18 are statistics provided by ministries and federal departments of education. According to the OECD data, lower secondary schools in the United States are in session an average of 180 days per year, several days below the sample mean of 184.4 days per year. School year length varies substantially within the sample's 41 reporting countries, ranging from 160 days in the Flemish Community of Belgium to 209 days in Israel (σ=12.1 days). Within this distribution of 41 countries, the U.S. is tied for 23rd with Hungary, Austria, and Turkey.

[1] We include in our sample current OECD countries, countries that were or are in OECD ascension discussions, and key partners.

Both the OECD and the Program for International Student Assessment (PISA) collect international data on instructional hours spent in lower secondary schools. The OECD data capture the total *intended* instructional hours, while the PISA data reflect 15-year-old students' estimates of the number of minutes of learning time per week.[2] Based on the OECD data, the average instruction per day in U.S. schools is 5.7 hours, well above the sample average of 5.1 hours. The PISA data estimate a slightly lower average for the U.S., 5.5 hours, just above the sample average of 5.4 hours. The U.S. ranks 8th among the 36 countries with available data on instructional hours from the OECD and 23rd among the 61 countries with available data from PISA. These differences across datasets are a function of different measurement approaches and samples of countries included in each dataset.

We combine statistics on the average length of the school day and year to compare total instructional hours per school year across countries. In Figure 1, we plot the number of hours in a school day against the number of days in a school year for a subset of countries which have data for both measures. Overlaid "Isoquant" curves highlight how countries achieve similar total instructional hours per year through different combinations of the length of the school day and year. As shown in Figure 1, the U.S. ranks near the top of this distribution: 8th among the 37 countries using only OECD data (Panel A) and 16th out of 41 countries based on OECD and PISA data (Panel B).[3] Both distributions of total instructional hours are skewed to the right, with

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[2] The PISA survey is administered to a representative sample of schools in each country. All data is scaled to hours per day for consistency.

[3] Several countries have particularly large differences in the estimated number of hours per day across OECD and PISA data. For countries like France and Greece, the OECD data reflect intended instructional hours that include time spent on elective subjects, such as additional foreign languages, that schools are expected to offer but students are not required to take. For France and Greece, these non-compulsory hours constitute 17 and 24 percent of their total intended instructional hours, respectively. PISA estimates for these countries are notably lower given that not all students enroll in these non-compulsory elective subjects. For countries such as Korea, Japan, and Israel, the opposite pattern occurs where OECD estimates are notably lower than those from PISA. This pattern likely reflects the fact that the minimum total compulsory instructional time for these countries reported by the OECD is the same

four and seven countries that have at least 100 hours more total instructional time than the U.S., respectively.

2.2 The Decentralized Education System in the United States

Unlike most countries where a central ministry of education sets national education policies, the U.S. system of government delegates authority over education to individual states. States set the minimum length of the school year, the minimum amount of total instructional hours, and/or the minimum number of hours in a school day. A database maintained by the Education Commission of the States shows that, in January 2020, 15 states mandated both the length of the school year and the amount of total instructional hours, while 12 states gave districts the freedom to meet either a minimum number of days or total hours requirement (Brixey, 2020). Eleven states require only a minimum number of days, and 12 states only set a minimum requirement for the number of total instructional hours.

This patchwork system results in markedly different minimum learning time requirements for U.S. students depending on where they live. Among the 38 states that identify a minimum number of days per year, the majority (28) set the minimum at 180 days. Seven set their minimum number of days below 180. Minimums range from a low of 160 in Colorado to a high of 186 in Kansas.[4]

Thirty-eight states specify a minimum total number of hours per year, with high school hours ranging between 720 hours in Arizona to 1,260 hours in Texas. Even setting these two outliers aside, there exist large differences across states. High school students in Alaska, Florida, and Connecticut are only required to have 900 hours of school per year, while high school

as the intended instructional hours. In practice, students in these countries report being in school many more hours, likely due to extended and supplemental education programs.

[4] Kansas requires 186 days for grades K-11 and 181 days for grade 12.

students in Maryland are required to have 1,170 hours (Brixey, 2020). Graduating seniors in Maryland will have been required to attend high school for 30 percent longer – approximately 160 more days – than students in Alaska, Florida, and Connecticut.

2.3 School Hours across U.S. Public Schools

While there exist stark differences in the minimum number of hours and days across states, districts maintain the autonomy to increase time requirements so long as their budgets can cover the expansion. We draw upon the 2015-16 National Teacher and Principal Survey (NTPS) to quantify the actual number of school days and total hours students spend in U.S. public schools. The NTPS is a nationally representative survey of K-12 public schools, including both traditional and charter schools. We exclude from our sample a small fraction of schools that provide alternative or nontraditional education (6 percent), specialized schools with a targeted emphasis in a given subject such as STEM or performing arts (4 percent), special education schools (2 percent), and career/technical/vocational schools (2 percent) and apply appropriate population weights.

We estimate that the typical K-12 public school in the U.S. is in session for 6.87 hours per day and 178.71 days per school year, on average, for a total of 1,227 hours per year. These estimates are notably higher than those based on the OECD and PISA data because our international comparisons focused more narrowly on instructional time whereas the NTPS measures the total length of the school day. In Table 1 and Figure 2, we describe the wide variation in the number of school hours per day, days per year, and hours per year. Students attending schools at the 90th percentile of the distribution of the number of hours per day are in school more than an hour longer each day than those at the 10th percentile (7.42 vs. 6.33 hours). Similarly, schools at the 90th percentile of the distribution of the number of days per year are in session nine days more than schools at the 10^{th} percentile (183 vs. 174 days). Cumulatively, the total number of school hours per year differs by almost 200 hours between schools at the 90^{th} and 10^{th} percentiles (1,323 vs. 1,134 hours). This gap equates to a difference of approximately five and half weeks of schooling. This variation in instructional time in the U.S. also dwarfs that of other countries, including those that also allow for sub-national variation in schooling laws such as Belgium, Canada, and the United Kingdom (OECD 2018).

We further explore the variation in the total number of hours in a school year by plotting the full population-weighted sample of schools in Figure 3. This scatterplot illustrates the wide variation in the total number of hours per school year. We find a small negative correlation between the number of school days and the length of the school day (r=-0.15). This pattern is exemplified by the outlying cluster in the upper left quadrant, which represents schools that are in session only four days a week (~ 150 days a year) for upwards of eight total hours a day. Although these schools achieve a similar number of hours as many schools that are in session the standard five days a week, research described below suggests that the number of days per week and hours per day are not perfect substitutes in the extremes.

2.4 Variation across States and Districts

We next explore the degree to which systematic differences across states and districts account for the variation in learning time across individual U.S. public schools described above. We estimate that 29 percent of the variation in total school hours is accounted for by differences across states.[5] Differences in the number of hours in a day appear to contribute most to this variation relative to differences in the length of the school year. Thirty-six percent of the

[5] The NTPS sampling design limits the precision of these analyses given that schools are sampled to provide nationally representative estimates, but not representative estimates at the state level. While we recognize these limitations, the NTPS are still the best available data to inform this question given that they include an average of 500 traditional and charter public schools per state.

variation in hours per day is explained by states compared to only 23 percent of the variation in the number of days per year. We further find that schools with relatively low amounts of total time (less than 1,200 hours; the 37th percentile in the national distribution) are disproportionately concentrated in some states. Our estimates suggest that in nine states over 70 percent of schools are in session fewer than 1,200 total hours, whereas in another nine states fewer than 5 percent of schools have fewer than 1,200 hours.

We complement the analyses above with district-level data collected by the National Council on Teacher Quality (NCTQ) on the number of school days per year in 2018-19. NCTQ maintains a database on 145 districts that includes the 100 largest districts in the country, the largest district in each state, and member districts of the Council of Great City Schools. There exists meaningful variation in the number of days in a school year even among this pool of predominantly large urban schools with a mode of 180 and a standard deviation of 3.26 days.

2.5 Variation by School Type and Location

We examine heterogeneity in school hours by school type using the NTPS data and find that, on average, primary schools are in session fewer total hours (1,211 hours) than middle (1,248 hours) and high schools (1,254 hours). In fact, the full distribution of hours for elementary schools is shifted leftward, indicating that secondary schools are typically in session longer at each percentile of the distribution. We also find that charter public schools are likely to be in session for more total hours than traditional public schools. The average charter public school has 74 more hours per year (1,297 vs 1,223) and ranks at the 86th percentile among non-charters. The distribution of charter schools has a thick upper tail consisting of predominantly urban charter schools that have notably extended the length of the school day and/or year.

The total number of hours per school year also varies by schools' locations. Suburban schools are in session the least (1,209 hours on average), whereas schools in rural areas (1,239 hours) and towns (1,243 hours) have the longest average time in school. There is considerably more variation in the total hours among schools in cities, and schools in the upper range of the distribution are much more likely to be in cities than elsewhere.

2.6 Variation by Student Characteristics

The composition of students attending schools with more total hours differs from schools with fewer hours. In Table 2, we present average student characteristics among schools grouped by quintiles of total hours per year. We find that African-American students disproportionately attend schools with more total hours (r=0.17). African-Americans represent 20 percent of students at schools in the top quintile of time, but less than 11 percent in the bottom quintile. This is partially due to the fact that, nationally, African-American students are twice as likely to attend a charter school as a traditional public school (26 vs. 13 percent). Asian students follow an opposite trend, disproportionately attending schools in the bottom quintile (r=-0.14). Hispanic students show a bimodal distribution, clustering at the bottom and top quintiles, while white students cluster in the middle of the distribution.

Similar to African-American students, students eligible for free- or reduced-price lunch disproportionately attend schools in the top quintile of time (r=0.12). Students from low-income families comprise 64 percent of the student body in top quintile schools, but only 54 percent in bottom quintile schools. Low-income communities may be more supportive of longer school hours because these hours provide a subsidy to parents in the form of childcare (Gelbach, 2002). Together, these patterns suggest that districts may take a compensatory approach when determining the length of the school day and year.

3. Would Increasing Learning Time Raise Student Achievement?

Prior reviews have relied largely on case studies and correlational evidence, and have found small positive relationships between time in school and achievement (Aronson et al., 1998; Patall et al., 2010). In the last decade, social scientists have produced a large body of empirical evidence on the causal effects of learning time on achievement, which we synthesize below. We organize the literature into four broad categories: 1) studies of bundled educational interventions that include additional learning time, 2) studies of extending the school year, 3) studies of extending the school day, and 4) studies of how time is organized in schools with a focus on four-day weeks and school start times. We focus our review on studies that examine instructional time during the traditional school day and exclude literature on after-school and summer programs which have been surveyed extensively in other reviews (e.g. McCombs et al., 2019; Zief et al., 2006).[6] We also distinguish between studies that identify effects from natural experiments that caused instructional time to vary across students in a quasi-random way and program evaluations of policies intended to explicitly increase learning time. While both types of studies leverage exogenous variation in extended learning time, studies of purposeful interventions have greater external validity given that they reflect the inherent implementation challenges of education policy reforms.

3.1 Search Procedures

We conducted a systematic review of the literature using a three-part process. First, we identified articles using five search engines (Google Scholar, JSTOR, ERIC, NBER, and

[6] We recognize that the line between an afterschool program and an extended day program can be subjective, as can be the line between a summer program and an extended year program. We focus on traditional extended day and extended year programs whenever possible.

EconLit) and an iteratively developed set of search terms including “length of school day[year]”, “extended school day[year]”, “extended learning time,” and “increasing time in school”. Second, we reviewed references in prior reviews of time identified above and from the studies that met our inclusion criteria to cross-check our search process. Finally, we contacted leading scholars in the field, including many authors of the articles included in this analysis, to solicit their help in identifying additional causal analyses of teacher coaching.

3.2 Inclusion Criteria and Outcomes

We also limited our search to papers written and published in English. For each search, we read the abstracts of articles and focused on those with experimental and quasi-experimental methods that produced plausibly causal conclusions about the effect of time on academic outcomes. These research designs included randomized field trials, regression discontinuity designs, difference-in-differences/event-study designs, and panel methods with high-dimensional fixed effects. We focus our synthesis on academic outcomes because these are the most common outcomes examined across studies. We emphasize, however, that learning time can have important consequences for a whole range of equally important outcomes including social-emotional skills, contact with the juvenal justice system, property values, parental employment, teacher labor markets, and more as several studies demonstrate (e.g. Clauretie & Neill, 2000; Graves et al., 2018; Ward, 2019).

Together, the literature paints a compelling picture that increasing time can increase student achievement, though the effect sizes vary depending on how time is increased and for which students.

3.3 Increased Learning Time as Part of a Package of Inputs

Studies of charter school operators such as KIPP and Promise Academy that operate schools with extended learning time, among other strategies, show positive and significant effect sizes on academic achievement as measured by test scores (Abdulkadiroglu et al., 2011; Angrist et al., 2012, 2013; Dobbie & Fryer, 2011, 2013; Hoxby & Murarka, 2009). Leveraging randomized lottery admission processes, these studies find effects as large as 0.42 standard deviations ("σ" hereafter) in middle school math per year and 0.25σ in middle school English (Abdulkadiroglu et al., 2011). However, determining the degree to which extended instructional time in these schools is responsible for driving these effects is a difficult empirical task given the inability to isolate time from other elements of the schools such as lower student-to-teacher ratios, data-driven instruction, frequent teacher observations and feedback, and health interventions, among others. Dobbie and Fryer (2013) and Hoxby and Murarka (2009) conclude that instructional time is responsible for a significant share of the total gains.

There is also evidence of traditional school districts implementing similar bundled interventions and seeing positive results. Traditional public schools in Houston that implemented a set of best practices used in high-performing charter schools including extended learning time experienced substantial gains in math and small gains in reading (Fryer, 2014). These reforms included extending the school day and year, increasing total instructional time by 21 percent in Houston, as well as incorporating high-dosage tutoring throughout the extended school day. In Lawrence, Massachusetts, the state took over the traditional public school district and instituted a series of changes, including reducing spending at the central office to increase school-level expenditures, replacing under-performing staff (including 30% of principals in the first year), and creating Acceleration Academies of extra time for underperforming students in math and English. In year two of the takeover, the district also added 200 hours to the school year for all first through eighth graders. Using a difference-in-differences approach, researchers show math scores increased by 0.30σ and ELA scores increased by 0.10σ in Lawrence relative to similarly underperforming districts (Schueler et al., 2017).

3.4 Extending the School Year

Causal evidence on the effect of additional school days often leverages plausibly exogenous increases in the number of days that students are in school before taking standardized tests and finds a small positive increase in achievement in math and English Language Arts from the addition of 10 or more extra days (Aguero et al., 2021; Aucejo & Romano, 2016; Carlsson et al., 2015; Fitzpatrick et al., 2011). Other studies examine natural variation in instructional days before a test administration and find small positive effects concentrated in math (Hansen, 2011; Sims, 2008). Purposeful policy reforms to increase time can also raise student achievement; weeklong vacation academies in Massachusetts improved math scores of struggling students by 0.07σ (Schueler, 2020). These studies illustrate that increases in the number of days in a school year can improve academic performance for students.

Leveraging snow fall, strikes, and other plausibly exogenous decreases in instructional time, research find corresponding decreases in the overall academic performance of students who experience an unscheduled loss of instructional time. Several studies using weather-related school cancellations as an instrumental variable find small negative effects of lost time on math but not ELA (Goodman, 2014; Hansen, 2011; Marcotte, 2007), while others find small declines in both math and ELA (Marcotte & Hemelt, 2008). A recent study using difference-in-differences to examine the effects of an unexpected, regulatory change in Spain that reduced the school calendar documents moderate negative effects in Spanish and English (Sanz & Tena, 2021).

Another category of research examines policy changes that induced large increases in instructional time due to extended school calendars and finds consistent patterns: increases in time improve student outcomes while decreases of time harm them. Leuven et al. (2010) uses an instrumental variables approach to study an increase of 11 weeks to the school year for four-year-olds in the Netherlands and finds small statistically significant effects for disadvantaged students on math. Parinduri (2014) uses a regression discontinuity design to show that an additional six months of learning in Indonesia increased educational attainment by almost a full year. Pischke (2007) studies a decrease of 13 weeks of school in West Germany using a difference-in-differences design and finds it increases grade repetition.

Overall, this literature shows that scheduled extensions of the school year have the potential to improve academic outcomes for students. Reductions in the length of the school year often have the opposite effect, harming student outcomes on the whole.

3.4 Extending the School Day

The causal literature on extending the school day consists primarily of international studies of policy changes using difference-in-differences, regression discontinuity, and panel data methods. Importantly, the amount of additional time added varies meaningfully across contexts and thus so did the scale of the impact. In Colombia, when the school day went from 3.5 to 7 hours per day, research with panel data finds a 0.10σ increase in overall test scores (Hincapie, 2016). In Mexico, a new program extended the school day for some students from 4.5 to 8 hours per day; research with difference-in-differences and panel data shows that it led to significant and large positive effects in math and language test scores (Cabrera-Hernandez, 2020; Padilla-Romo, 2022). Researchers saw similarly large and positive effects in math and language test scores in a Brazilian state that expanded the length of the school day from 4.5 to 8 hours

(Rosa et al., 2022). Meanwhile, in Chile, reforms increased the length of the school day from about 5.3 to 6.75 hours per day with more mixed evidence of its impact on student achievement. Across studies using difference-in-differences, one finds moderate effects in math and language (Bellei, 2009), while another finds no effect on math and a small effect on language (Barrios Fernández & Bovini, 2017) and a third study with instrumental variables shows a moderate effect on reading (Berthelon et al., 2016). A fourth study using panel data methods shows positive effects on educational attainment (Dominguez & Ruffini, 2021). In Peru, scholars find that a two-hour increase in the length of the day increased math test scores by 0.24σ and reading test scores by 0.14σ using a regression discontinuity approach (Aguero et al., 2021). In Ethiopia, a study using a difference-in-differences design shows an increase of 1-2 hours per day led to significant and large increases in numeracy and writing, though not in literacy (Orkin, 2013). The overall pattern of findings in these studies are broadly consistent with a theory of positive but marginally decreasing returns to additional learning time during the school day; larger increases in time in education systems with fewer total instructional hours demonstrate larger overall effects.

Smaller increases in the length of the school day – 90 minutes or less – also lead to positive results, albeit with smaller effect sizes. In Germany and Israel, when schools added 1-2 more hours per week, difference-in-differences and instrumental variables approaches showed small increases in achievement across multiple subjects (Huebener et al., 2017; Lavy, 2018). Work in Italy and Denmark though, where time increased by less than an hour per day, showed moderate positive effects in math but no other subjects (Battistin & Meroni, 2016; Jensen, 2013; Meroni & Abbiati, 2016). Finally, two causal studies with smaller samples conducted in Germany and the Netherlands find moderate positive, but not statistically significant, effects on academic achievement from increasing the school day by 45-60 minutes (Dahmann, 2017; Meyer & Van Klaveren, 2013).

Three studies evaluate schools that adopted extended days in the U.S. context with more mixed results. Using a comparative interrupted time series design, Checkoway et al. (2013) find that the Expanded Learning Time Initiative in Massachusetts in which 26 schools added at least 300 instructional hours to the school year had no effect on achievement in math, ELA, or science. Using a difference-in-differences design, Kraft (2015) evaluates the effect of extending the school day by two hours for tutorial classes at one Boston charter school and finds effects between 0.15σ and 0.25σ per year in ELA but no effects in math. Figlio, Holden, and Ozek (2018) use a regression discontinuity design to analyze a Florida policy that required the 100 lowest-performing elementary schools to add an additional hour of reading instruction each day; they find that the policy increased reading test scores by 0.05σ in the first year of implementation.

Three related studies leverage data collected by the Programme for International Student Assessment (PISA) to examine the effect of subject-specific instructional time (Cattaneo et al., 2017; Lavy, 2015; Rivkin & Schiman, 2015). These studies isolate within-student or within-school variation in instructional time across subjects and find small to moderate effects; a single hour of additional instruction per week in a subject increases achievement by between 0.02σ and 0.07σ. A similar study uses data from the Trends in International Mathematics and Science Study (TIMSS) and finds a 0.02σ increase in academic achievement for every additional hour in the school day (Wu, 2020). In the United States, some districts have also begun expanding instructional time in specific subjects without changing total instructional time. Using regression discontinuity and difference-in-differences designs, studies show small or moderate positive effects of double dose math classes on student achievement (Cortes et al., 2015; Cortes & Goodman, 2014; Taylor, 2014).

Full-day kindergarten offers the best example of a widescale expansion in the length of the school day for a specific subgroup of U.S. students. In the short-term, by the end of the year in kindergarten, results of full-day kindergarten are almost uniformly positive across studies using fixed effects (Lee et al., 2006; Zvoch et al., 2008), instrumental variables (Cannon et al., 2006; Warburton et al., 2012), difference-in-differences (Cannon et al., 2011), and randomized control trials (Amsden et al., 2005).[7] Studies that take a longer-term approach have been more mixed, with some finding positive effects on achievement (DeCicca, 2007; Gottfried et al., 2019; Votruba-Drzal et al., 2008) and others showing no significant improvement in academic achievement from attending a full-day kindergarten, as compared to a partial-day program (Brownell et al., 2015; Friesen et al., 2022; C. R. Gibbs, 2014).

Overall, the literature on extending the length of the school day in the international context finds consistent small and positive effect sizes on student achievement. The much smaller research base focused on the U.S. is more divided, showing positive effects in some students and no effects in others.

3.6 The Structure of School Time

In addition to lengthening the school day or school year, districts can also change the way that their existing instructional time is structured. This includes year-round calendars, block schedules, four-day weeks, and school start times. We found scant causal evidence on year-round calendars and block schedules; thus, we focus our discussion below on four-day weeks and

[7] Gibbs (2013) offers the only exception to this, showing a positive effect using an instrumental variables approach but no significant effect using a regression discontinuity.

school start times. We find that four-day weeks rarely improve student academic outcomes and often lead to decreases in performance, while altering start times can improve outcomes but do not always.

Four-Day School Weeks

Four-day weeks, with the potential to decrease heating and busing costs, are an increasingly popular tool to restructure time. These schedules are currently being used in at least 560 districts across 25 states, mostly in rural areas where transportation is a challenge (Heubeck, 2022). Most recently, twenty-seven districts in Texas adopted four-day school weeks in 2022 in response to persistent staffing challenges, joining 14 others across the state who had made the switch since 2016 (Faheid, 2022; Lopez, 2022).

When four-day weeks maintain the same total number of hours in a school year (by lengthening the day but shortening the number of days), research shows mixed effects. In Colorado, researchers found that the switch to a four-day week in small rural districts led to a small increase in math and reading test scores for upper elementary students (Anderson & Walker, 2015). Other research also using difference-in-differences in Oklahoma shows no effect on academic achievement, but does find that the shortened school week saves districts money and decreases bullying and fights among the student body (Morton, 2021, 2022).

In other states, districts have shifted to a four-day school week and also reduced the total number of hours in a school year. This is more common, with the average student in a four-day week school experiencing 85 fewer total instructional hours per school year (Thompson, Gunter, et al., 2021). Results of those programs (examined via difference-in-differences designs) are more uniformly negative, with studies showing a corresponding small to moderate decrease in math and reading test scores (Kilburn et al., 2021; Thompson, 2019, 2021; Thompson & Ward, 2022). Research across multiple districts, some of which changed total time and some of which did not, finds small decreases in math test scores (Thompson, Tomayko, et al., 2021). A recent multi-state examination of four-day week policies, some of which kept the same overall time and others of which reduced it, uses a difference-in-differences design and again found significant negative effects on math and reading gains during the school year (Morton et al., 2022).

School Start Times

In addition to restructuring time, schools also have the option to shift their start and end times, often to address concerns about student sleep schedules. These later school start times have been shown to improve health: increasing sleep, decreasing sleepiness, improving mood, improving attention, and even decreasing car accidents (e.g. Gariépy et al., 2017; Bostwick, 2018). Even in circumstances where these schedules reduced time in physical education, health outcomes did not worsen, suggesting additional sleep countered the loss in exercise (Ha et al., 2021).

Effects on student achievement are more mixed. A study using difference-in-differences methods in North Carolina shows that a one hour delay had a small increase math and reading achievement (Edwards, 2012), while another study using instrumental variables in Florida finds moderate increases in math and reading achievement (Heissel & Norris, 2019). In South Korea, research using difference-in-differences shows that a policy to move start times to 9 am (the equivalent of a one-hour push in start times for most schools) led to a statistically significant and moderate increase in math scores, but had no significant effects on test scores in Korean and English (Kim, 2022). A further study, examining ACT scores in three cities with later start times using panel data, shows no effect of the later start (Hinrichs, 2011). When a county in North

Carolina moved start times earlier, research using difference-in-differences methods showed ACT scores were not affected (Lenard et al., 2020).

3.7 Heterogeneity in the Effects of Time

Overall, empirical evidence we have reviewed establishes a direct causal link between instructional time and student achievement. However, the literature also suggests that there exist important patterns of heterogeneity by contexts, dosage, and student characteristics. Effects differ based on how time is used, with more autonomous schools experiencing the largest gains (e.g. Lavy 2015). Given theoretical and empirical evidence of diminishing returns to time (e.g. Rivkin and Schiman 2015; Aguero et al. 2021), it is unsurprising that students in developing countries moving from half-day to full-day schooling realize larger gains than students who have an existing full-day schedule extended by an additional hour. Additionally, effects vary by grade level with many studies showing younger students benefitting the most (e.g. Marcotte and Hemelt 2008).

Perhaps most importantly, the literature is divided on who benefits most from increased learning time and whether time has the potential to close existing educational opportunity gaps. Several of studies described above find that lengthening the school day increased inequality by helping high-achievers more (e.g. Bellei 2009), while others show a larger effect size for disadvantaged or struggling students (e.g. Battistin and Meroni 2016). Some studies find that additional time helps advantaged students more (e.g. Aguero et al. 2021), while others find time is compensatory resource that aids disadvantaged students more (e.g. Leuven et al. 2010). We interpret this mixed evidence as suggesting that all students can benefit from increased instructional time, but that contextual factors and how time is used can cause some students to benefit more than others.

4. How Much Learning Time is Lost?

The empirical literature reveals the importance of learning time for supporting academic achievement. This raises concerns about the stark differences in the amount of time U.S. public schools are in session. However, the number of hours in a school year, net of non-instructional activities such as lunch, only represents the total allocated amount of learning time. The amount of potential learning time is meaningfully less because it requires students and teachers to be present in class and have the potential to focus on learning without outside interruptions (Phelps et al., 2012). Enacted learning time is then the fraction of potential learning time during which students and teachers are engaged in learning (Bellei 2009).

We examine the amount of allocated instructional time lost due to a range of student, teacher, and organizational factors to better understand the magnitude of time loss in U.S. schools. We calculate the total hours lost to student absences, suspensions, and tardies as well as teacher absences and outside interruptions to estimate the potential gains from better utilizing currently allotted time.

4.1 Providence Public School District

Our case study focuses on the Providence Public School District (PPSD), a midsize urban school district in Rhode Island. PPSD operates 41 schools serving over 24,000 students. The district predominantly serves students of color from low-income families. Sixty-four percent of PPSD students are Hispanic, 17 percent are African-American, and nine percent are white. Over 85 percent of students receive free- or reduced-price lunch. One in four students is an English Language Learner, and 15 percent receive special education services.

The state of Rhode Island requires public schools to be in session at least 6 hours a day for 180 days a year, a total of 1,080 hours. PPSD exceeds these minimum requirements by lengthening the school day to 6.52 hours in elementary schools and 6.75 hours in secondary schools. Multiplying by 180 days in the PPSD academic year produces a total of 1,174 hours for elementary schools and 1,215 hours for secondary schools. This places PPSD at the 36th percentile of the national distribution for elementary schools, the 35th percentile for middle schools, and the 27th percentile for high schools.

While PPSD is not unusual in terms of total instructional time, it is an outlier in the degree to which students are absent or suspended. In 2015-16, 45 percent of PPSD high school students missed more than 18 days of school, the equivalent of 10 percent of the school year (*Rhode Island Kids Count Factbook*, 2017). This compares to 26 percent of students statewide who missed more than 18 days and less than 14 percent nationally. PPSD also suspends students at relatively high rates, issuing 21 in-school or out-of-school suspensions per every 100 students in the district compared to 17 statewide (*Rhode Island Kids Count Factbook*, 2017).

The Rhode Island Department of Education took over PPSD for a five year term starting in 2019 after the release of an independent district review documenting major concerns over low student achievement and chronic absenteeism, deteriorating buildings, unsafe learning conditions, a demoralized teaching staff, and families who felt marginalized and without a voice (Borg, 2019; *Providence Public School District: A Review*, 2019). Thus, PPSD serves as a case study of a district facing considerable challenges in supporting students' success – and an example of a district where students might greatly benefit from more effective use of existing instructional time. Although the specific results of our case study likely have limited generalizability, we believe the general lessons can be broadly informative given that the

COVID-19 pandemic increased attendance challenges nationwide (*Monitoring Who Is Missing Too Much School*, 2022).

4.2 Data and Methods

Working with PPSD, we collected data on a range of factors that reduced potential learning time during the 2016-17 school year. We use bell schedules to calculate the total number of instructional hours in each PPSD school. These estimates exclude non-instructional time such as lunch, recess, and passing periods. We then draw on detailed administrative records to estimate the amount of allocated instructional time (AT_s) in school *s* that is actually lost instructional time. Averaging within school levels, *l*, we first estimate the potential instructional time (PT_l) per school year for students at PPSD elementary, middle, and high schools as follows:

$$PT_l = \frac{1}{N_l}\sum_{s=1}^{N_l}[\underbrace{(AT_s - TAbs_s)}_{\text{Total time teacher is present}} * \underbrace{(1 - Inter_l/AT_s)}_{\text{Proportion of time that instruction is undisturbed by outside interruptions}} * \underbrace{(1 - [SAbs_s + Susp_s + Tardy_s]/AT_s)}_{\text{Proportion of time students are present in class}}]$$

The intuition behind this formula is a three-step process. First, we calculate the total amount of instructional time at a school in which regular full-time teachers are present, assuming little to no meaningful instruction occurs during absences ($TAbs_s$). We scale this measure of total instructional time with a regular full-time teacher by the proportion of time undisturbed by outside interruptions ($Inter_l$) based on estimates from a companion study which tracked interruptions during more than 60 hours of classroom observation in five PPSD schools (Kraft &

Monti-Nussbaum, 2021). Finally, we scale the remaining instructional time by the proportion of time that the average student in a given school is not absent ($SAbs_s$), suspended ($Susp_s$), or tardy ($Tardy_s$). This provides an estimate of the total potential time that both teachers and students are present and instruction goes uninterrupted by external disruptions. Appendix A provides details of the individual statistics used in the equation above.

Our approach provides a lower bound estimate of the total instructional time lost in PPSD ($AT - PT$) for several reasons. Most basically, we assume all potential learning time is actually being used for learning. This is rarely the case in schools where students can be off-task or actively disrupting instruction (which is not captured by our measure of outside interruptions), lessons may be poorly designed or delivered, or teachers may use time inefficiently with transitions that take longer than necessary. Estimates of off-task behavior and student wait-time during transitions suggest these activities erode between 10 and 30 percent of potential learning time (Godwin et al., 2016; Phelps et al., 2012; Rosenshine, 2015). A detailed study of academic time use across five district summer school programs found that between 11 and 28 percent of potential academic time was lost to classes starting late and students being off-task (Schwartz et al., 2018). Our estimates also do not reflect the potential instructional time lost to classes starting late or ending early, to transition time, or off-task behavior nor do they reflect potential time lost in the day(s) before school holidays and breaks. In some schools, teachers show movies because they are hesitant to deliver meaningful instruction when so many of their students are absent – a self-reinforcing cycle.

4.3 Findings

In Figure 4, we illustrate how time loss affects students in elementary, middle, and high schools across the district. As shown in Panel A, we estimate that the average elementary school student in PPSD loses 16 percent of allotted instructional time, while the typical middle school student loses 21 percent. High school students lose a total of 25 percent, a full fourth of their instructional time. Assuming that additional time would suffer from the same rate of loss, Providence would need to add an extra 1.85 total hours to every school day to achieve the 5.76 hours of instructional time that the district intends for its high school students.

Disaggregating our time loss estimates reveals that three factors account for the majority of lost instructional time. As shown in Figure 4 Panel B, unexcused student absences account for the largest portion – particularly in high school. Outside interruptions and teacher absences, the second and third largest contributors to lost instructional time, respectively, limit student learning in the classroom and are arguably more directly under the control of school districts. These outside interruptions to instruction include intercom announcements, calls to classroom phones, and the subsequent disruptions these interruptions cause. Notably, middle school teachers report more frequent outside interruptions than those in elementary and high schools.

Teacher absences constitute the third largest source of lost instructional time. Although it is possible that students do learn from substitute teachers, our classroom observations in PPSD suggest that substitutes are rarely successful at delivering sustained instruction and that requests for substitutes frequently go unfilled. Together, interruptions and teacher absences cost the average PPSD high school student 97.3 hours per year. Excused absences, suspensions, and tardies account for the remainder of the lost time, bringing the total instructional time lost in high schools to 258 hours per year – approximately 45 days of school.

5. Conclusion and Policy Implications

Stagnating test scores and increasing economic competition have led to repeated calls for expanding instructional time in U.S. public schools over the last several decades. The COVID-19 pandemic and resulting learning loss experienced by students have sparked renewed interest and urgency around increasing instructional time. While the U.S. education system provides a comparable amount of instructional time to most other high-income countries, on average, many U.S. students are being left behind. Over 18% of public schools are in session at least a full week less than the national median (180 days), while another 13% of public schools have school days that are shorter than the national median (6.9 hours) by 30 minutes or more. These differences represent substantial inequities in the amount of allocated learning time students are provided by schools.

Deriving a single conclusion from the causal research literature on learning time is nearly impossible because of the multiple ways in which learning time is operationalized in schools: via the length of the school day, week, and year as well as school start times. Time operates like another key resource in schools: money. Time, like money, is necessary but not sufficient for success. How we use it matters most of all. When used ineffectively, extended learning time will produce little benefits for students and can even be counterproductive if this additional time has detracted from more enriching activities. However, the preponderance of the research literature suggests that schools are often able to convert additional learning time into increased academic achievement.

Evidence of the positive effect of expanded learning time on student achievement appears strongest for extending the school year. This may be because there is little organizational or behavioral change required on the part of schools when extending the school year, whereas extending the school day is often coupled with efforts to adapt school schedules and adopt new instructional techniques. At the same time, increasing the length of the workday for teachers with increased compensation could also have unintended consequences of decreasing interest and retention in the profession given that teacher stress and burnout have become widespread during the pandemic (Jotkoff, 2022; Zamarro et al., 2022). This may be particularly true for more experienced teachers that care for their own children after school as well as teachers in schools with poor working conditions. Later start times also present opportunities to better utilize existing time without requiring substantial organizational or behavioral change.

Raising and aligning minimum learning time requirements across states to be closer to the national average would be one possible policy response to the COVID-19 pandemic. Minimum learning time requirements are blunt instruments, but they offer a feasible top-down policy reform that is within the control of policymakers and district leaders. The available evidence suggests that these efforts would benefit millions of U.S. students. Given that research suggests instructional time has diminishing marginal returns, focusing on those schools that offer the least amount of time might also produce the largest benefits.

Our case study suggests that many U.S. public schools would also benefit from concentrated efforts to utilize existing instructional time more effectively. Schools have the potential to recover substantial amounts of lost learning time without changing their schedules at all. This approach to increasing learning time is far less malleable from a top-down policy perspective, but we expect it offers far greater potential returns for many more schools. Behavioral interventions to increase student attendance, school-wide systems to reduce disciplinary incidents that remove students from class, policies that limit school intercom and phone use, and incentives to curb teacher absenteeism could all play roles in maximizing allocated instructional time.

Time use is always about tradeoffs. Activities students engage in after school or during the summer can be rich and valuable experiences that benefit students' academic development as well as their social-emotional development and mental well-being. Learning doesn't only take place in schools, and more learning time alone will not ameliorate the deep harms caused by the COVID-19 pandemic. But the clear inequities in access to learning time and new urgency to support students' academic development in the wake of the pandemic suggest that targeted efforts to expand learning time and ensure that this time is used effectively would be a step in the right direction.

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Tables

Table 1. *Variation in Total Time in a School Year across U.S. Public Schools*

	Overall		
	Hours in Day	Days in Year	Hours in Year
Percentile			
1	6.00	151.00	1,073.00
5	6.25	170.00	1,110.00
10	6.33	174.00	1,133.67
25	6.50	177.00	1,170.00
50	6.92	180.00	1,224.25
75	7.08	180.00	1,267.93
90	7.42	183.00	1,323.00
95	7.58	185.00	1,357.42
99	8.00	190.00	1,472.92
Mean	6.87	178.71	1,227.21
Std	0.44	6.00	83.45
n[a]	5,053	5,053	5,053
N[b]	78,717.77	78,717.77	78,717.77

Notes: The following types of schools are excluded from the sample: alternative schools, schools with special education emphasis, special education schools, and career/technical/vocational schools. This excludes 13% of the 2015-16 NTPS sample. Estimates are produced using inverse probability weights.

[a]This refers to the *sample* size.

[b]This refers to the *population* size.

Table 2. *Student Characteristics by Quintiles of the Total Hours in a School Year for U.S. Public Schools*

	Bottom Quintile	Second Quintile	Third Quintile	Fourth Quintile	Top Quintile	Overall
Female (%)	48.61	48.56	48.45	48.69	48.69	48.60
African-American (%)	10.68	11.41	10.53	17.19	20.32	14.02
Asian (%)	6.09	4.43	3.51	2.99	1.97	3.76
Hispanic (%)	25.64	20.98	17.01	19.35	26.85	21.88
Other (%)[a]	7.43	6.15	5.34	4.81	3.66	5.45
White (%)	50.16	57.05	63.61	55.66	47.19	54.89
Free- and reduced-price lunch (%)	56.14	52.00	52.05	56.52	64.35	56.15
Average daily attendance (%)	93.43	92.09	94.07	93.93	94.29	93.56
n[b]	723	854	1,026	1,007	1,163	4,773
N[c]	13,828.17	15,015.24	15,866.16	14,418.78	15,077.74	74,206.09

Notes: The following types of schools are excluded from the sample: alternative schools, schools with special education emphasis, special education schools, and career/technical/vocational schools. This excludes 13% of the 2015-16 NTPS sample. About 5% of the sample is excluded because of missing student demographic information.

Estimates are produced using inverse probability weights.

[a]This includes multirace, American Indian, and Hawaiian Native or Pacific Islander.

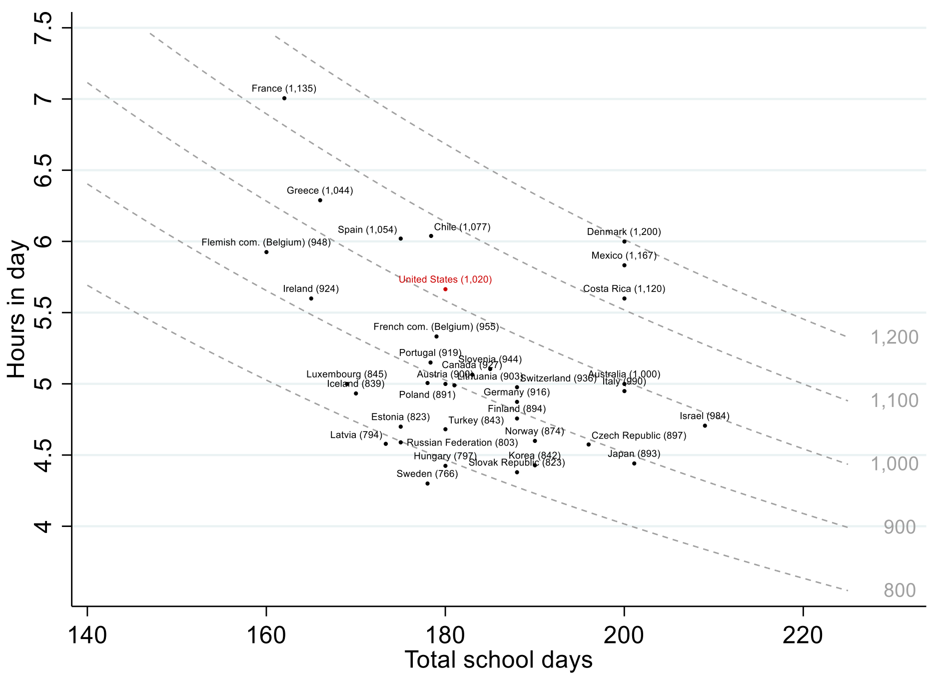
[b]This refers to the sample size.

[c]This refers to the population size.

Figures

Figure 1. Scatterplots of the instructional hours in a school day and days in a school year for lower-secondary schools across countries. Notes: OECD data represent intended instructional hours reported by government officials. PISA data represent estimated instructional hours by a large and representative sample of 15-year olds in each country.

Panel A: OECD Data



Panel B: OECD and PISA Data

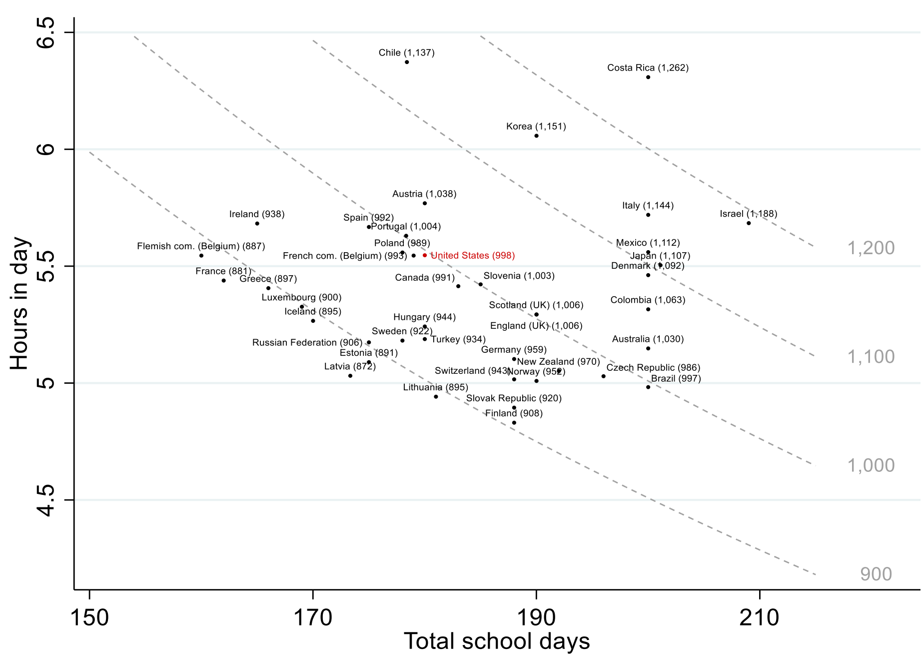
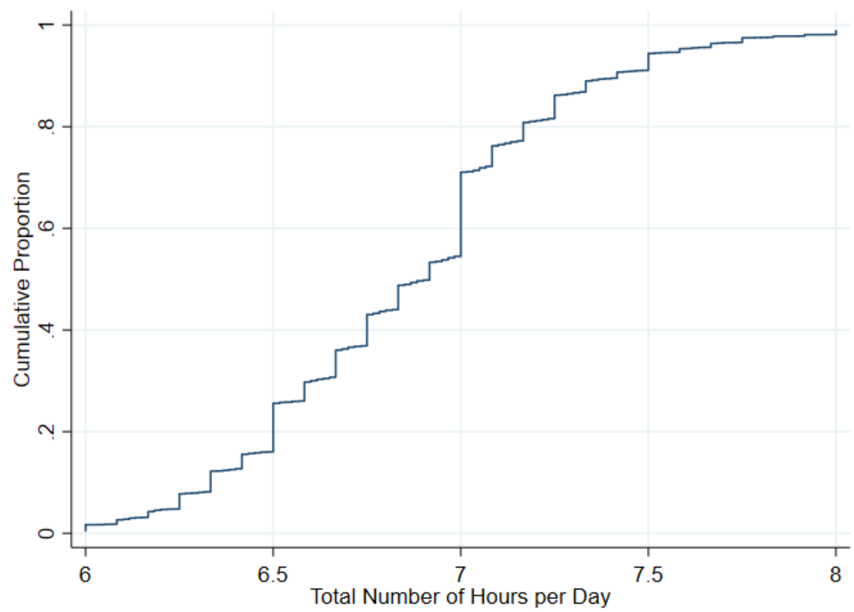
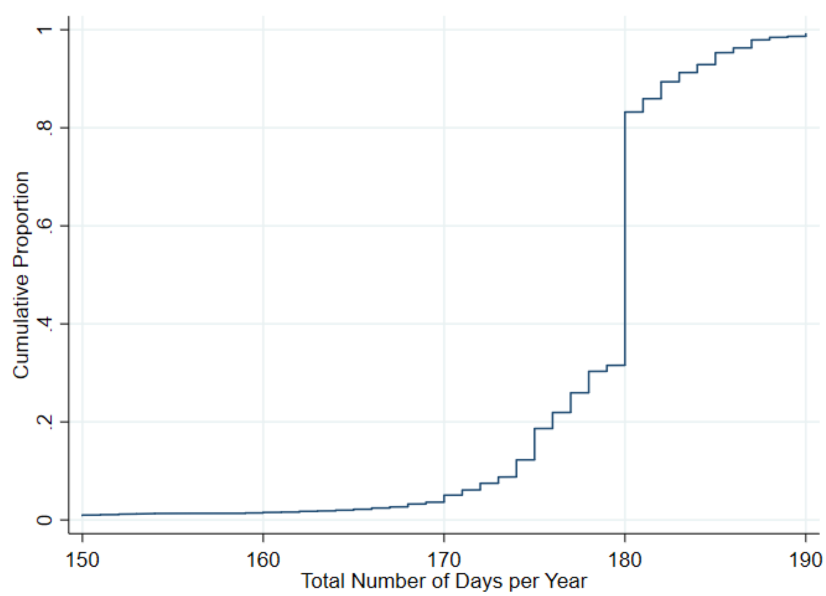


Figure 2. The cumulative distribution of learning time across U.S. Public Schools using data from the 2015-16 National Teacher and Principal Survey. Notes: Figures exclude schools below the 1st and above the 99th percentiles.

Panel A: Hours per Day



Panel B: Days per Year



Panel C: Total Hours per Year

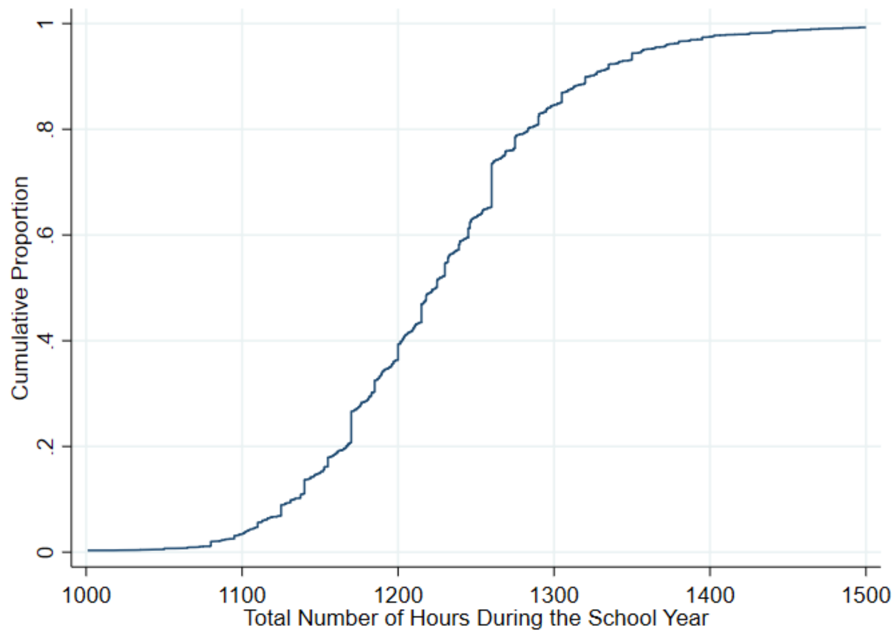


Figure 3. Scatterplot of the total hours in a school day and days in a school year for U.S. Public Schools using data from the 2015-16 National Teacher and Principal Survey.

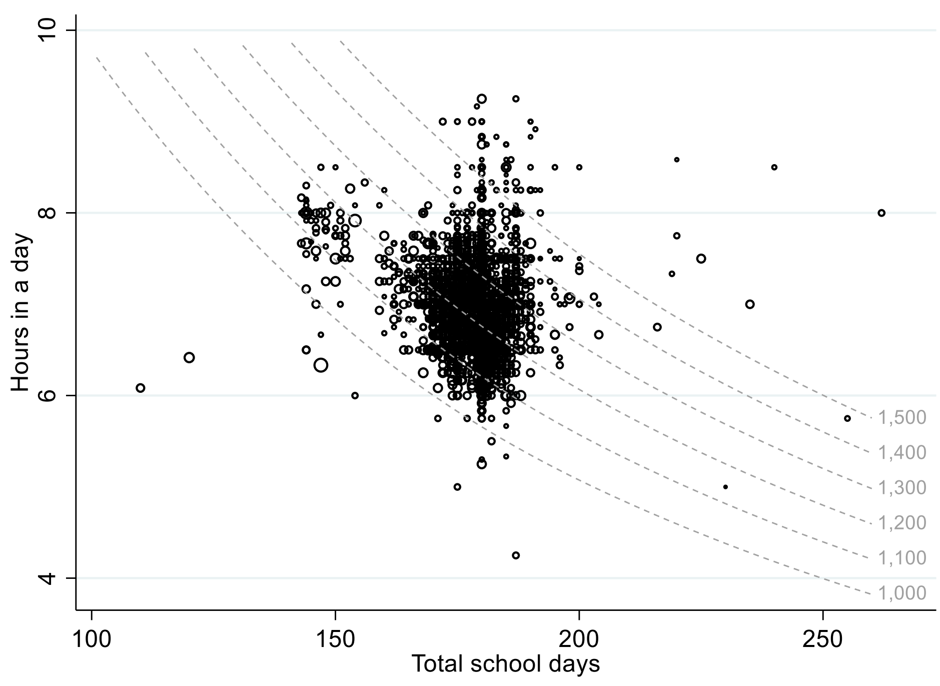
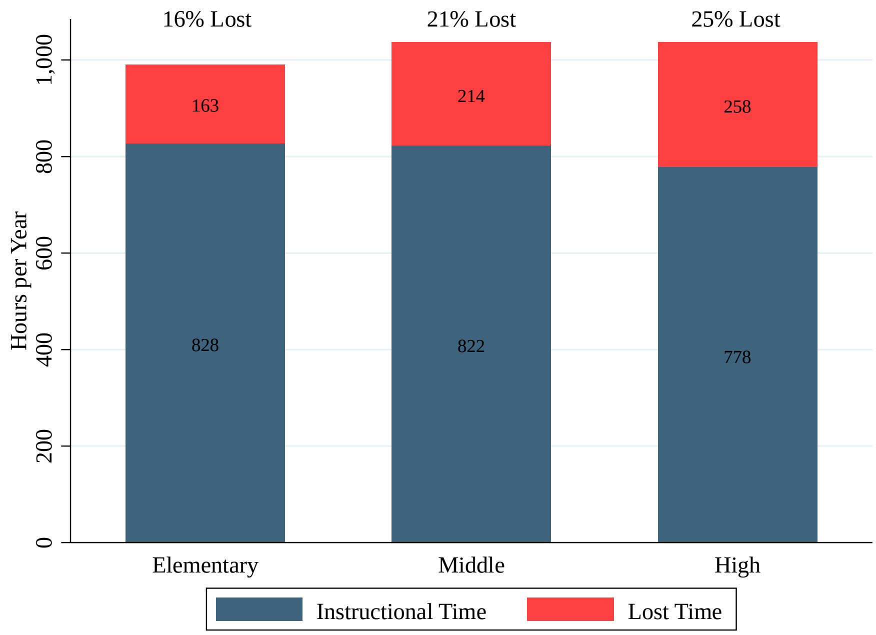
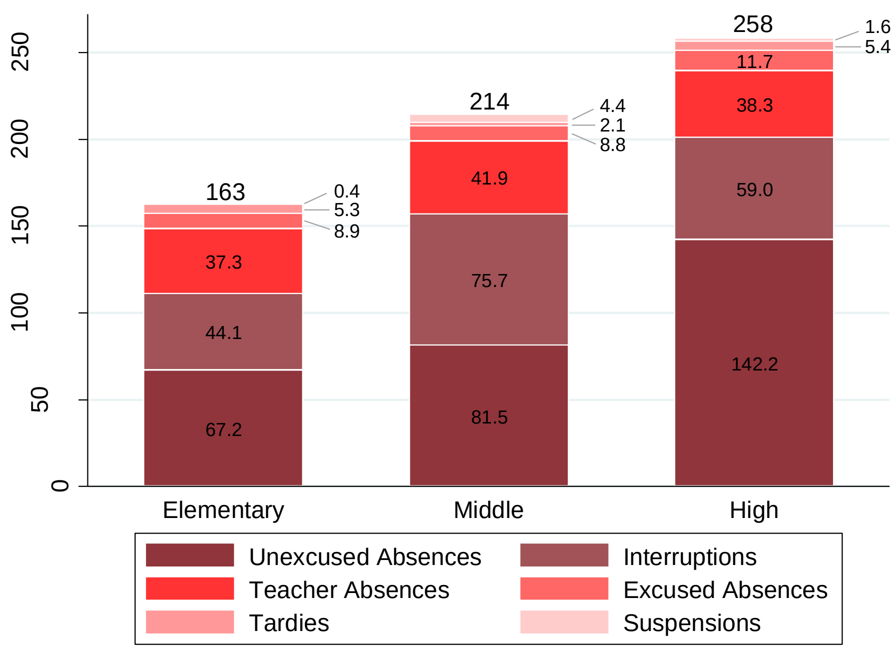


Figure 4. Instructional time loss by school level in Providence Public Schools.

Panel A: Lost instructional time



Panel B: Components of lost instructional time



Appendix A: Methods for Time Loss Calculations

In this section, we outline how each component of the lost instructional time (LT_l) equation below is calculated. All calculations draw on data from the 2016-17 academic year. As shown below, each component of time lost is calculated for each school, *s*. Next, we average these values across all schools of the same level, *l*: elementary, middle, and high school. The resulting LT_l describes the instructional time lost per student across the academic year at the average elementary, middle, or high school in PPSD.

Total Instructional Time (TT_s): To estimate the total instructional time in a school, we use data from bell schedules to calculate the average amount of instructional hours during the school year for each PPSD elementary, middle, and high school. These estimates exclude non-instructional time such as lunch, recess, and passing periods.

> *Lunch*: For each school, we divide the duration of lunch in minutes by 60 and then multiply it by 180 to calculate the total number of hours per school year spent on lunch.
>
> *Recess*: For each elementary school, we divide the duration of recess in minutes by 60 and then multiply it by 180 to calculate the total number of hours per school year spent on recess. According to bell schedules, middle and high schools do not have recess.
>
> *Passing Periods*: For each middle and high school, we divide the duration of a passing period in minutes by 60 and multiply it by one less than the number of periods per day. We then multiply this total by 180 to calculate the total number of hours per school year spent in passing periods. As a conservative approach, we assume that elementary schools do not have passing periods.

Teacher Absences ($TAbs_s$)*:* We estimate the number of instructional hours lost per student due to teacher absences in a school as follows:

$$TAbs_s = \underbrace{TotalTchAbsDays_s * (DailyInstHours_s - 1)}_{\text{Total teacher absences for a school in hours}} * \underbrace{(Stu/Tch\ Ratio_s)/TotalStus_s}_{\text{Number of students experiencing teacher absence}}$$

We first estimate the total number of teacher absences for the entire school year, including partial days, across all full-time teachers in PPSD based on detailed human resource records provided by the district. We then convert this total number of days into instructional hours by multiplying this total by the number of daily instructional hours in a school, assuming teachers have an hour-long preparation period each day. Next, we multiply the total number of teacher absence hours per year by the student-to-classroom teacher ratio in a school to scale the total number of teacher absence hours into total number of teacher absence hours experienced by students. Finally, we divide the total number of teacher absence hours students experience by the number of students in a school to estimate the average number of instructional hours that students lose over the course of a year due to teacher absences in a given school.

Interruptions ($Inter_l$)*:* To estimate the number of lost hours due to interruptions from outside of class, we draw upon original data collected by Kraft and Monti-Nussbaum (2019). The authors organized a team of researchers to observe 63 classes across five high schools in PPSD and found a typical high school class in PPSD experiences an average of 2.8 interruptions per hour for an average combined interruption and disruption length of 71 seconds (0.0197 hours). We then use these estimates to predict the number of hours lost due to interruptions at each school level. We accomplish this by leveraging teacher survey data on the frequency of interruptions per hour reported on the district teacher survey. Teachers in the participating high schools reported 4.0 interruptions per hour on average, while the average across all high school teachers was 4.3 interruptions per hour. The average frequency of interruptions reported among middle school and elementary school teachers was 5.7 and 3.4, respectively. We use these comparable measures across school levels to scale our high school estimates by the ratio of the average reported level of interruptions to the average reported level in the five participating schools for which we have observational data. Finally, we first multiply lost interruption time per hour by the number of instructional hours in a day at each school and then by the number of days in the school year to estimate the annual hours lost to interruption at each level of schooling.

$$Inter_{HS} = 2.8 * 0.0197 * \left(\frac{4.3}{4.0}\right) * DailyInstHours_s * 180\ days$$

$$Inter_{Middle} = 2.8 * 0.0197 * \left(\frac{5.7}{4.0}\right) * DailyInstHours_s * 180\ days$$

$$Inter_{Elem} = 2.8 * 0.0197 * \left(\frac{3.4}{4.0}\right) * DailyInstHours_s * 180\ days$$

Student Absences ($SAbs_s$): This gives the amount of time lost per student, per year due to excused and unexcused absences at a given school.

Unexcused Absences: We divide the total number of unexcused absences in a school for the entire year by the total number of students in that school to calculate the average number of unexcused absences per student. We assume that a student misses all the instructional time in a day when they are absent and multiply the average number of unexcused absences per student by the number of instructional hours in a day. This gives us the total amount of time lost per year per student due to unexcused absences.

Excused Absences: We calculate the total number of excused absences by totaling the number of full and partial day excused absences. Next, we perform the same calculation for all excused absences as for unexcused absences. This gives us the total amount of time lost per year per student due to excused absences.

Suspensions ($Susp_s$): We divide the total number of in-school suspensions in a school for the entire year by the total number of students in that school to calculate the average number of in-school suspensions per student. We assume that a student misses all the instructional time in a day when they are suspended and multiply the average number of in-school suspensions per student by the number of instructional hours in a day. This gives us the total amount of time lost per year per student due to in-school suspensions at a given school. We perform the same calculation for out-of-school suspensions as for in-school suspensions and add them together.

Tardies ($Tardy_s$): We divide the total number of tardies in a school for the entire year by the total number of students in that school to calculate the average number of tardies per student. In PPSD, students are marked as tardy as long as they show up before half of the school day is over. We assume that a student misses an hour of instructional time when they are tardy and multiply the average number of tardies per student by an hour. This gives us a conservative estimate of the amount of time lost per student, per year due to tardies at a given school.