Educational Rights and Wrongs: How COVID-Related Student Math Achievement Losses Distributed and Implications for Equal Educational Opportunity

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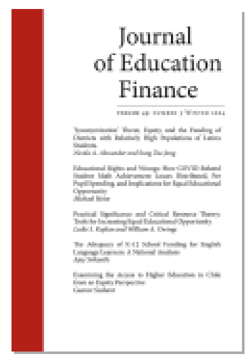

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ABSTRACT

Comparing changes to school districts' mean math achievement from 2019 to 2022 across 5,696 public school districts and 39 states provides critical information on how historic student achievement losses attributable to disruptions imposed by the COVID-19 pandemic distributed. Core findings emphasize that while increased student access to in-person schooling during the 2020-2021 school year systematically corresponds with smaller student math achievement losses, per pupil spending variation does not. Student achievement losses were larger in school district's with comparatively higher percentages of URM, IDEA-eligible, and low-income students, as well as in larger districts and districts that experienced enrollment turbulence. Student achievement decay's uneven distribution raises equal educational opportunity concerns that are as troubling as they are obvious.

INTRODUCTION

Despite the equal educational opportunity doctrine's enduring salience, what the doctrine means in practice remains contested (Peterson & Woessmann, 2007; Salomone, 1986). Good faith contestations aside, however, few dispute that striving toward increased equal educational opportunity remains a lodestar in the United States. At the same time, few also dispute that the COVID-19 pandemic, particularly its profound disruptions to the nation's schools and student learning, has "laid bare the equal educational opportunity doctrine's fragility with 'new and alarming clarity'" (Moran, 2021, p.590) and, in turn, has propelled calls for increased judicial intervention (Crow, 2022).

As the pandemic abruptly altered life and prompted virtually all schools to close in spring 2020, the potential implications for children—and their educational progress—were understood in real-time. Fears of critical student learning losses only compounded during the 2020-2021 school year as student access to in-person schooling in public schools varied considerably across the

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nation. And this variation was non-random. For example, scholars note that while school districts with Republican governors and in rural areas provided comparably more in-person schooling, school districts with higher enrollments and higher percentages of URM students provided less (Heise, 2023).

Emerging student achievement data make clear that many of the earlier worries about student learning losses attributable to pandemic-related school disruptions were well-founded. The term "learning losses" refers to students' lost opportunities to study and learn during the pandemic. These lost opportunities, in turn, fueled less student learning than prior student cohorts at the same grade levels. While many expected that some students would suffer some level of academic decay, the scope and magnitude of the student achievement losses were not expected. As the full scale of the unprecedented student learning losses comes into greater focus, scholarly attention has already turned to explanations for these learning losses as well for how these losses distribute.

The SEDA 2020 2.0 data set (Reardon et al., 2023) used in this study facilitates comparing student math achievement changes between 2019 and 2022 across a nationally-representative sample of 5,586 public school districts in 39 states. Levering these data provides critical information on how student learning losses that correspond with various school disruptions imposed by the COVID-19 pandemic distribute across school districts.

Rather than assessing the wide sweep of varied, nuanced, and complex factors that inform student academic achievement more generally, this study instead focuses on how various district-level mechanisms map onto the student learning losses, with an emphasis on student access to in-person instruction for the 2020-2021 school year and per pupil spending. Such an emphasis is warranted as school districts largely controlled their learning mode decisions during the 2020-2021 school year and typically set per pupil spending levels. In addition, many generally assumed that variation in these two particular variables would inform how student learning losses distributed. Finally, and unsurprisingly, recent calls to extend and, as well, increase, various sources of supplemental educational funding have emerged as one path forward to help address the student learning deficits attributed to the pandemic (Fahle et al., 2023a).

Key to this study's research design is that the two district-level math achievement data points, drawn from 2019 and 2022, surround the entire 2020-2021 school year and that the initial math achievement tests (in 2019) were administered prior to the pandemic's emergence (in 2020). This study exploits, among other variables, variation in student access to in-person instruction and per pupil spending across 5,586 public districts during the intervening 2020-2021 school year to help explain changes in student math achievement between 2019 and 2022. Core findings from this study provide mixed support for *ex ante* expectations, largely comport with existing research, and make clear that while increased student access to in-person schooling during the 2020-2021 school year corresponds with decreased student math achievement losses, per pupil spending variation does not. At the same time, correlates of increased student achievement losses also include a school district's percentage of URM, IDEA-eligible, and low-income students, as well as larger school districts and districts noted for turbulent enrollment changes between 2019-2022.

These findings implicate multi-generational efforts seeking progress on the nation's implied fundamental promise for greater equal educational opportunity. Progress on this front has been met, at best, with mixed success during the seven decades since the Supreme Court's *Brown* (1954) decision. Scholars have already observed how various political, economic, geographic, and student race factors influenced student access to in-person education during the 2020–21 school year (*e.g.*, Heise, 2023; Moran, 2021). What is only now coming into greater focus is how the uneven distribution of student access to in-person education, in turn, exacerbated uneven distributions of student achievement losses attributable to the pandemic. Consequently, the pandemic's deleterious consequences for students, schools, and learning remind anew that troubling distributional issues persist when it comes to equal educational opportunity in the United States.

BACKGROUND AND LITERATURE REVIEW

Widely feared in real-time was that the pandemic's disruptions to the educational system would impose learning losses upon students. Emerging data, scholarship, and research reports document that such fears were not only realized but, if anything, underestimated the severity of the student learning losses. Aside from one recent research report (Fahle et al., 2023a), non-nationally representative samples limit most of the existing empirical studies (*e.g.*, Bielinski et al., 2021; Domingue et al., 2022; Goldhaber et al., 2022a; Goldhaber et al., 2022b; Kuhfeld et al., 2022; Lewis et al., 2021; Locke et al., 2021). Results from other assessments derive from case studies limited to specific states (*e.g.*, Jack et al., 2022; Kogan & Lavertu, 2022; Pier et al., 2021).

Research design limitations aside, existing research on pandemic-related student learning losses converges on a few core findings. One is that the student learning losses are "historic" in their scale, breadth, and scope (Fahle et al., 2023a, p.24). For example, National Assessment of Educational Progress ("NAEP") test data reveal student achievement declines not seen in decades (Meckler, 2022; Mervosh, 2022; NCES, 2022). Moreover, non-NAEP student test data point in a similar direction (Kuhfeld et al., 2020). Finally, learning losses are not limited to U.S. students. Engzell et al. (2021), for example, report that while Dutch primary schools were exclusively remote for a relatively brief period of time (approximately eight weeks), students nonetheless lost academic ground. As well, recent international data from the Programme for International Student Assessment (PISA) document much of the same and note a "record drop" in terms of students' mathematics performance between 2018 and 2022 across OECD nations (OECD, 2023, p.28).

A second shared finding is that these historic student learning losses distribute unevenly across the nation's school districts. Specifically, student learning losses are typically larger in school districts that serve comparatively higher percentages of low-income students as well as students from traditionally marginalized subgroups (Fahle et al., 2023a; Kuhfeld et al., 2022).

While Fahle et al. (2023a) exploit the data set used in this study, their research scope is at once broader and narrower. Notably, their research interests extend beyond exploring school district- (and community-) level mechanisms as they also assess possible household-level mechanisms as well. One of their most intriguing findings is that mechanisms helping to account for student learning loss variation operated "at the district and/or community level—not within districts" (p.20). Despite their study's generally broader research focus, Fahle et al.'s (2023a) study does not account for per pupil spending variation across school districts. Insofar as the Fahle et al. (2023a) study concludes with an emphasis on and calls for increased educational funding as one way to try to off-set student learning losses (pp.24-27), their report paradoxically, if only implicitly, underscores the salience of per pupil spending in this research context.

Prompted by Fahle et al.'s (2023a) recent findings and motivated to both expand and narrow their models, this study departs from and advances the current scholarly literature in two important ways. First, Fahle et al. (2023a) emphasize "contextualizing" student learning losses by emphasizing a dependent variable that reflects a differential change in school district mean math achievement between 2019 and 2022, after subtracting out district mean math achievement score changes between 2016 and 2019.[1] Partly owing to the cross-sectional nature of the data, this study, by contrast, includes a more straightforward measure of pandemic-related student learning losses: school district-level mean math achievement changes between 2019 and 2022. Second, to better bridge emerging research on student learning losses attributable to the pandemic to adjacent research on school districts' educational mode decisions for the 2020-2021 school year (*e.g.*, Heise, 2023; Oster et al., 2021; DeAngelis & Makridis, 2021) as well as the much broader and more developed school finance literature, this study includes district-level per pupil spending data.

1. Fahle et al. (2023a) report results from changes between 2019 and 2022 as a robustness checks in their report's appendices.

DATA AND EMPIRICAL STRATEGY

Data

Analyses in this study feature data draw from two main data sets. First, the SEDA 2022 2.0 data set provides mean NAEP-scaled math test score estimates from 5,696 districts across 39 states (Reardon et al., 2023). The test score estimates derive from state accountability test data and were then scaled to the NAEP to facilitate comparability across states, grades, and time (Reardon et al., 2023, p.9). Second, these district-level math achievement data were matched to information from the COVID-19 School Data Hub data set ("CSDH"), one the nation's most comprehensive repositories of public school district-level information on the percentage of in-person learning offered during the 2020–2021 school year (CSDH, 2023).

Stored at the Stanford Education Data Archive (SEDA), the SEDA 2022 2.0 data set (Reardon et al., 2023) includes mean school district student achievement estimates, scaled to NAEP scores, that permit comparisons, at the school district-level, of student math achievement in 2022, two years after the onset of the COVID-19 pandemic, with student math achievement in 2019, one year prior to the pandemic's emergence. The data set pools test scores across third through eighth grades to calculate a simple difference in every school district's average math achievement score from 2019 to 2022. The term "student learning loss" in this Article refers to those school districts where the 2022 mean math achievement score fell below the district's mean 2019 score.

The SEDA 2022 2.0 data set benefits from notable and deserved prominence among researchers, particularly for its effort to locate estimates of local school district test scores on the more common NAEP scale (Ho, 2020). As the degree of difficulty of such a technical task is considerable, that the SEDA data set contains important limitations warrants attention. One concern relates to SEDA achievement estimates' stability and validity. While Kuhfeld et al. (2019) note a "very strong convergence" overall between SEDA and, for example, MAP Growth district estimates, they also note that the convergence is not exact and some degree of error likely lurks (p.14).

This study focuses on student math achievement because prior research has found it to be more correlated with earnings than reading achievement or vocabulary (Murnane et al, 1995). Since the data set provides group achievement means—rather than individual student-level data—the data will yield valid estimates of gap closure trends conditioned on the assumption that underlying changes in student cohort composition are unrelated to achievement patterns. Finally, for privacy reasons, the data set suppresses data where the number of participating students in any sub-group fell below a certain threshold (*e.g.*, 20 students), state test participation rate fell below 95 percent, or where a state did not report sufficient data (Fahle et al., 2023b).

A second key source of data for this study draws from the CSDH (2023) data set, a leading source of public school district-level information on the percentage of in-person learning offered by U.S. public school districts during the 2020–2021 school year. In response to the COVID-19 pandemic, virtually all public school districts across the United States abruptly transitioned to a remote instructional mode in the spring of 2020. For the 2020–2021 school year, however, educators, policymakers, and students and their parents confronted an exceptionally difficult set of choices, including how they would deliver and receive educational instruction (*i.e.*, in-person, hybrid, or remote, or some combination of these three instructional modes).

While alternative school district instructional mode data sets exist, their overlap with the CSDH (2023) data set is considerable (though not exact). Studies that lever various combinations of instructional mode data sets (*e.g.*, Fahle et al., 2023a) report that the CSDH (2023) data set is among the more "straightforward" and that, in any event, their core results remain largely undisturbed by the selection of school district instructional mode data.

While both the SEDA 2022 2.0 (Reardon et al., 2023) and CSDH (2023) data sets are important in their own right, matching these two data sets, at the school district-level, permits analyses of the degree to which variation in student access to in-person schooling helps explain changes in a district's average math achievement between 2019 and 2022. After matching, the resultant data set includes information on 5,603 regular public school districts across 39 states.

The matched data set was further supplemented in important ways to better reflect an array of additional variables, all drawn from traditional public data sources (including the National Center for Education Statistics and the U.S. Census Bureau), which plausible inform student math achievement. For example, school district-level data on current per pupil spending for the 2019–20 school year, drawn from the U.S. Census Bureau's survey of public education and secondary schools (U.S. Dept. of Comm., 2020a), facilitates analyses of how variation in financial investments and school district fiscal health and capacity may have influenced student achievement decay. These per pupil spending data were adjusted with recent Comparable Wage Index data to account for cost-of-living variations across the nation's public school districts (NCES, 2021b; Taylor & Fowler, 2006). Similarly, other data sets, including the National Center for Education Statistics' ("NCES") Common Core data set, supply salient district-level student enrollment information and additional standard student demographic data (NCES, 2021a; U.S. Dept. of Comm., 2021) as well as county-level reported COVID-19 case data (New York Times, 2023).

As this Article explores correlates of student academic achievement decay between the 2019 and 2022 school years, the use of 2019–2020 current per pupil spending and enrollment data warrants brief discussion. With respect to per pupil spending, the student achievement benchmark data draw from 2019 (pre-pandemic) and per pupil spending data from the 2019–20 school year reflect school districts' budget decisions made prior to the emergence of the COVID pandemic. Beginning with and during the 2020-2021 school year, many school district budgets were supplemented in various—and often complex—ways to help off-set reflect pandemic-related expenses (Robinson, 2022).

Public school district student enrollments for the 2020–2021 school year were also likely implicated by the pandemic. Specifically, unlike the 2019–20 student enrollment data used in this study, 2020–2021 enrollment data were assuredly influenced by school districts' initial learning mode decisions in the fall of 2020. Indeed, Dee et al. (2021) find that remote-only instruction reduced student enrollment by a statistically significant 2.4 percent relative to in-person instruction while hybrid instruction had smaller and statistically insignificant effects.

To better align with prior related research, analyses exclude school districts that the NCES classifies as anything other than "regular." Likewise, "outlier" school districts, such as those that enrolled fewer than ten students and those where per pupil spending exceeded three standard deviations from the mean (plus or minus), were also excluded (Morgan & Amerikaner, 2018b). After filtering, the resultant data set in this study includes usable information on 5,586 regular public school districts from 39 states.

Finally, the study's unit of analysis—the public school district—possesses important analytical strengths. First, a school district is the legal entity that typically establishes and implements core policies for schools within the district, including decisions about learning modes for the 2020–2021 school year. Accordingly, school districts play a key role in the distribution of federal and state school revenue (Roza, 2010). District-level decisions determine, in large part, how both financial and other resources (such as experienced teachers) are distributed among schools, potentially contributing to within-district, between-school inequality in opportunity (Atteberry et al., 2021; Sosina & Weathers, 2019). School district-level decisions and policies also affect many types of resources that shape student performance, including local funding initiatives, class sizes, staffing decisions, curricular foci, and course offerings (Blazar & Schueler, 2022; Roza, 2010). That is not to say that individual school-level practices and decisions play no role, but only that the context in which school leaders operate is largely shaped by district-level jurisdiction and actions. As a result, insofar as school districts are a consequential unit of interest in examining student achievement and disparity trends, the school district remains a dominant unit of analysis in an array of related research literatures. Finally, practical concerns play a role as well as various demographic measures (*e.g.*, students eligible for free- and reduced-price lunch programs) are often more comprehensively measured at the district- than the individual school-level (Greenberg et al., 2019).

Second, school districts are comparably more stable units of analysis than individual schools. Individual school attendance zone boundaries, by contrast, change with greater regularity. Even when they do not, student assignment policies and changes in school programs (such as the availability of gifted/talented programs) may alter the mix of students attending a given school within a district. As well, between-district student moves and transfers are much rarer than between-school, within-district student transfers (Reardon et al., 2019). The mix of students in a district also may change over time due to local demographic changes or changes in private school enrollment patterns. As the math achievement data in this study span between 2019 and 2022, changes to a school district's student composition during these years remain a concern as any material student compositional changes risk confounding the measurement of district-level trends in average student academic achievement. To help manage this concern, the models include a dummy variable signaling those districts where enrollment or enrollment composition significantly changed between 2019 and 2022 (Reardon et al., 2023).

Third, in their analyses of student learning losses, Fahle et al. (2023a) emphasize the salience of mechanisms operating at the district- and community-levels, rather than at the student household-level. What this means is that while student learning losses vary considerably *across* the nation's public school districts, learning losses distribute more evenly across students *within* school districts. Intriguingly, and surprisingly, this implies that when it came to student learning losses fueled by the pandemic variation across school districts mattered more than variation across individual student households within a school district.

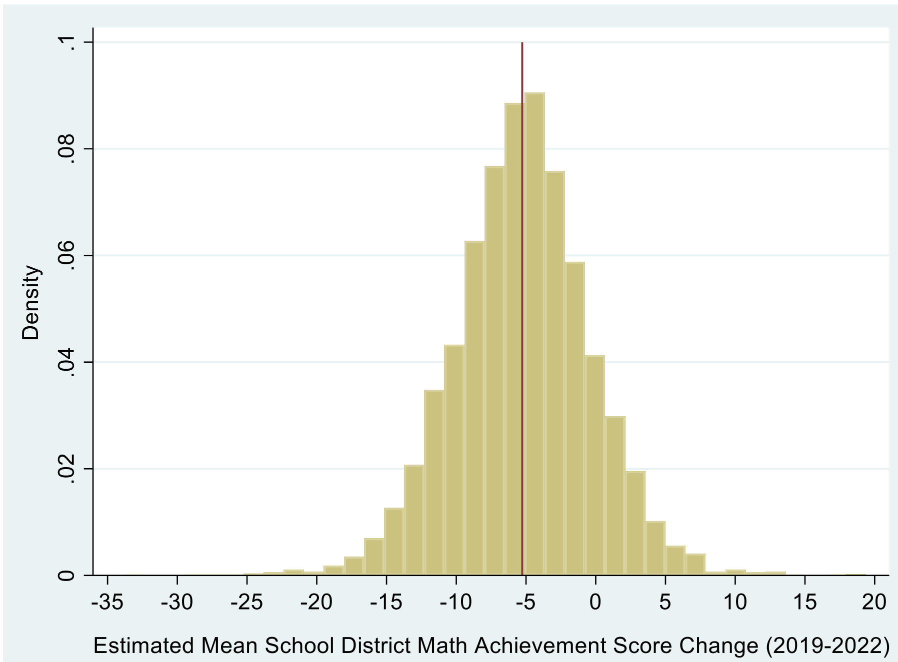
Dependent Variable

This study examines changes in estimated school districts' mean math achievement scores from 2019 and 2022. A negative math achievement score change indicates a decline in a school district's math achievement between 2019 and 2022; a positive score indicates that a district's score increased (Reardon et al., 2023). Figure 1 visually depicts how the dependent variable distributes and indicates that, across all sampled school districts, the average school district student math achievement declined by 5.27 NAEP-scaled points.

Key Independent Variables

A brief description of all independent variables used in the analyses, summarized

Figure 1. Estimated Mean School District Math Achievement Score Change (2019-2022)



Note: As indicated by the vertical red line, mean estimated school district student math achievement scores declined by 5.27 NAEP-scaled points from 2019 and 2022; (N=5,586). Source: Reardon et al. (2023)[SEDA 2022 2.0]; (N=5,586).

in Table 1, follows. Key independent variables include school districts' percentage of in-person schooling offered during the 2020-2021 school year and mean per pupil spending.

In-person schooling

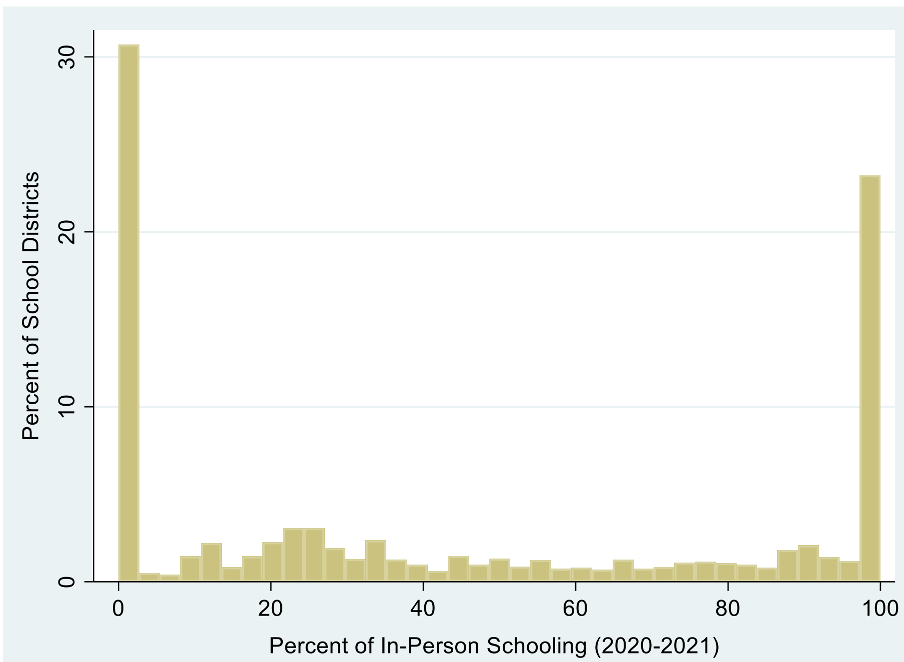
The CSDH (2023) data set includes information on the percentage of student instruction across all three main student learning modes (in-person, hybrid, and remote) offered during the 2020–2021 school year for virtually all U.S. public school districts. Prior research emphasizes that increases in a district's percentage of in-person schooling systematically correspond with decreases in student learning losses (Fahle, et al., 2023a).

While Table 1 indicates that the mean school district provided 44.94 percent of its instruction in-person during the 2020-2021 school year, far more important, and as Figure 2 makes clear, is that student access to in-person schooling distributed in a distinctive manner across school districts. Specifically, Figure 2 identifies one distinct cluster of school districts (29.4 percent) that provided no in-person schooling; another notable cluster of districts (21.6 percent) provided only in-person schooling. The percentage of in-person schooling provided by the remaining 49 percent of school districts ranged from 1 to 99 percent.

District current per pupil spending

An enormous (and still growing) research literature explores how funding

Figure 2. School Districts' Percent of In-Person Schooling (2020-2021)



SOURCE: CSDH (2023); (N=5,586).

variation correlates with student academic achievement variation across districts, schools, and students. District per pupil spending's hypothesized influence on student academic achievement—reflected in school finance litigation and emerging calls for increased public education spending to help off-set the substantial student learning losses attributable to the pandemic (*e.g.*, Fahle et al., 2023)—implicitly assumes a positive relation between school district spending and student academic achievement. To be sure, social science evidence on one basic underlying research question—"*Does Money Matter?*"—is as enduring as it is complex and contested (*e.g.*, Rothstein & Schanzenbach, 2022; Jackson et al., 2016; Kahlenberg, 2001; Hanushek, 1996).

Despite enduring uncertainty about precisely how per pupil spending informs student learning and achievement, as a variable student spending variation likely captures, at the very least, important unobservables that differentiate school districts (Sohn et al., 2023). Yet here, as well, some level of uncertainty exists. For example, while evidence of per pupil spending progressivity exists at the state-level (Shores et al., 2022), national-level data, by contrast, imply a positive association between increased per pupil spending and higher household socioeconomic status (Shores et al., 2022).

Assessing how student-level investments distribute across school districts requires consensus on how to best measure student investments. While the school finance research literature features a handful of standard measures, this study draws on one common metric: school district mean current per pupil spending (U.S. Dept. Comm., 2020), adjusted for cost of living variation across districts (NCES, 2021b; Taylor & Fowler, 2006). Table 1 indicates that the adjusted mean current per pupil spending across all districts exceeded $11,970 for the 2019–2020 school year.

Given the significant and sudden external economic shocks to school districts' budgets beginning with the 2020-2021 school year imposed by various staffing, technological, and other related costs attributable to the pandemic, a school district's financial condition assuredly influenced districts' ability to serve its students. Although the enormous and various financial impacts on school districts attributable to COVID-19 were blunted, in varying degrees, during the 2020-2021 school year (and beyond) with supplemental federal, state, and local funds (Robinson, 2022), including federal Education Stabilization Funds incident to the Coronavirus Aid, Relief, and Economic Security Act (2020), these supplemental funds did not distort 2019-2020 school district budgets or the per pupil spending variable used in this study.

Control Variables

While correlates of student academic achievement decay between the 2019 and 2022 school years serve as this study's principal focus, isolating the specific influences of student access to in-person schooling and per pupil spending requires specifications that include necessary control variables. The suite of control variables includes those that speak to traditional distributional concerns.

URM students: Complaints that underrepresented minority ("URM") students remain systematically disadvantaged when it comes to accessing educational assets endure and fuel troubling concerns about persistent student achievement gaps (Moran, 2021). Moreover, initial research (*e.g.*, Fahle et al., 2023a) notes that pandemic-related student learning losses were larger in school districts serving comparatively higher percentages of URM students. Such a result will unlikely surprise many, especially as researchers have already documented that student access to in-person schooling during the 2020–2021 school year varied across racial lines (*e.g.*, Heise, 2023; Oster et al., 2021; Camp & Zamarro, 2021). To assess possible distributional concerns relating to student achievement decay between 2019 and 2022, this study includes a school district's percentage of URM students. For the narrow purposes of these analyses, URM students include Black, Hispanic, and Native American students (NCES, 2021a).

Student poverty: The myriad of ways in which poverty can impede and complicate student academic achievement are well-understood and documented. Indeed, Fahle et al. (2023a) detect greater learning losses in low-income school districts. Such a finding is unsurprising as the various disruptions to schooling imposed by the pandemic almost assuredly reverberated more acutely in school districts serving a higher percentage of students from low-income households. For example, remote and hybrid learning mode options necessarily assume student access to the requisite technology, especially laptops and stable wi-fi access. During the pandemic, many schools serving the most economically disadvantaged students confronted new demands and struggled to "ensure connectivity, to put together online learning platforms, to make certain that students were academically engaged, and to track students who simply disappeared from classes during the pandemic" (Moran, 2021, p.606). Similarly, sustained and reliable access to an adult present in a household during regular school hours assuredly varied between low- and high-income households. Households lacking the necessary technology or those in which the head(s) of households needed to work outside of the home during the pandemic were comparably less well-positioned to monitor their children's academic progress.

To account for the possible influence of a district's percentage of students in poverty on student learning losses, this study includes school districts' percentage of students who come from households that fall below the federally defined poverty rate (U.S. Dept. Comm., 2021; Morgan & Amerikaner, 2018a; DeLuca, 2018). While no student poverty measure is perfect, the U.S. Census Bureau's SAIPE estimate levers school district Title I eligibility in the service of estimating the number of children, ages 5-17, in each district coming from families in poverty. Contributing to possible measurement error, however, is that this variable does not adjust for a school district's children in poverty who may have attended non-public schools (U.S. Dept. Comm., 2021).

IDEA-eligible students: It is likely that some Individuals With Disabilities Education Act ("IDEA") beneficiaries bring various learning challenges to schools, including learning challenges that were exacerbated during the pandemic (Hill, 2022; Troxler, 2021). Certain student learning challenges and differences plausibly influence math achievement. This is especially true where IDEA-eligible students' needs benefitted from (or even required) access to in-person schooling. To account for this possibility, the models include each district's percentage of IDEA-eligible students (NCES, 2021a).

Female students: As prior research on student math performance detects slight, if unstable, gender gaps (*e.g.*, McGraw et al., 2006), this study controls for districts' student gender composition by including each district's percentage of female students (NCES, 2021a).

Urbanicity: Initial studies of school districts' responses to COVID-19 (*e.g.*, Camp & Zamarro, 2021; Haderlein et al., 2021) note various urban/rural school district differences. To account for this aspect's potential salience as it relates to student learning losses during the pandemic, specifications in this study, drawing from the NCES's 12-point school district locale classification scale (Geverdt, 2019), include a dummy variable that identifies urban (or "city") school districts (NCES, 2021a).

Student enrollment & material enrollment changes: This study accounts for student enrollment issues in two separate ways. First, policymakers continue to search for ways to reduce the scale of schools as research implies that student achievement in math and reading declines as school size increases (Egalite & Kisida, 2016). Consistent with prior research (*e.g.*, DeLuca, 2018; Andrews et al., 2002), a district's raw student enrollment (NCES, 2021a) was first squared and then expressed as its natural log.

Second, as the key math achievement data in this study span three school years, any material enrollment or compositional changes in school districts during these years raise methodological concerns. Indeed, early research implies that public school districts' instructional mode decisions for the 2020-2021 school year stimulated student enrollment shifts from public schools to private schools, home-schooling, or various informal private 'education pods' (Dee et al., 2021). To adjust for the possible changes in a school's district's enrollment and related racial and economic compositions, following Fahle et al. (2023a, p.3) a dummy variable identifies the approximately 15 percent of school districts that experienced "significant" enrollment or compositional changes between 2019-2022 (Reardon et al., 2023). An enrollment or compositional change is defined as "significant" if a school district's overall enrollment shifted by 20 percent or more or if any student racial enrollment changed by 5 percent or more between 2019 and 2022 (Fahle et al., 2023a, pp.10-11).

Reported county-level COVID-19 case rate: In an effort to control (albeit crudely) for school districts' perception of COVID severity, the models include county-level information on reported COVID-19 infection rates (per 100,000) as of December 31, 2020. These data, drawn from the Centers for Disease Control and Prevention ("CDC") as well as Johns Hopkins University, were gathered by and archived with the *New York Times* (New York Times, 2023). While reported infection rate data assuredly undercount the actual number of positive COVID-19 infections since some unknown number of people with the COVID-19 virus may not have been tested, reported COVID-19 infection rate data nonetheless remain a useful indicator that plausibly influenced school district instructional mode decisions.

Despite lingering uncertainty about what county-level reported COVID infection rates might imply for student academic achievement, existing research typically includes such a control. As well, increased infection rates quite plausible may inform student anxiety levels. Whatever this variable may capture, a few anomalies warrant discussion. First, although the dependent variable draws data that span from 2019 to 2022, the model's single reported COVID-19 case report rate measure draws from county counts as of December 31, 2020, which is the approximate mid-point of the 2020-2021 school year. Second, the COVID-19 case report rates are aggregated at the county-level in contrast with other school district-level variables in the models. Because public school district boundaries do not necessarily align with county boundaries, this study analyzes information from 5,586 school districts located in 2,094 different counties.

State/local revenue ratio: As states' influence over local education policy has generally increased in important ways since the 1980s, states' relative and absolute contributions to local school district budgets have similarly evolved over time. The degree to which a state has centralized local school funding (and, by implication, other district-level policies) may inform various school district-level policies that, in turn, influence student achievement outcomes. It

Table 1. Descriptive Statistics

	Mean	*SD*	*N*
Change in Mean School Dist. Math Achieve. Score (2019-22)	-5.27	4.91	5,586
In-person schooling (2020-21) (%)	44.94	40.89	5,586
Current per pupil spend. (2019 $)	11,978	4,537	5,586
(*Distributional controls*:)			
URM (%)	30.00	27.77	5,586
Poverty (%)	15.43	10.03	5,586
IDEA (%)	14.97	3.94	5,586
Female students (%)	48.50	1.20	5,586
(*Other controls*:)			
Urban school dist. (1=yes)	0.11	0.31	5,586
Student enrollment^2 (nlog)	16.29	1.98	5,586
Enroll. change (2019-22) (1=yes)	0.15	0.35	5,586
Reported COVID case rate (cty, 100K)	0.06	0.02	5,586
State/local revenue ratio	1.24	0.55	5,586

SOURCES: CSDH (2023); NCES (2021a, 2021b, 2020a, 2020b); New York Times (2023); U.S. Dept. Comm. (2021, 2020a, 2020b).

is also possible that a district's comparatively higher state contribution reflects more generally that district's financial comparative disadvantage. To account for this possible dynamic, the models include a state/local revenue ratio variable that signals the relative percentage of the state contribution vis-à-vis a district's local financial contribution (U.S. Dept. Commerce, 2020a). A higher ratio signals a comparatively higher state financial contribution (and greater funding centralization) relative to the local contribution. Table 1 presents a descriptive summary of the variables included in the analyses.

EMPIRICAL STRATEGY

Critical to this paper's research design is that the two math NAEP-scaled achievement data points surround the entire 2020-2021 school year and that the initial math achievement tests (in 2019) were administered prior to the pandemic's emergence (in 2020). As such, evidence of student learning losses in math, based on comparing 2019 and 2022 school district test score changes, provides critical information on how school disruptions incident to the pandemic informed student learning losses. Regression models (with and without state fixed effects) were estimated as individual school districts administratively and legally and administratively nest within states. Finally, following Abadie et al. (2023) and because there is no state-level sampling, robust standard errors are not clustered at the state level.[2]

RESULTS AND DISCUSSION

Overall, results from this study provide mixed support for the key independent variables of interest and related hypotheses, largely comport with existing research, and coalesce around three broad themes. First, the findings emphasize that increased student access to in-person schooling during the 2020-2021 school year corresponds with reduced student math achievement losses. Second, and somewhat surprisingly, the expectation that more per pupil spending would correspond with systematically less student learning loss does not find support in the results. Third, student math achievement losses distribute unevenly across various student subgroups, including some of the traditionally more vulnerable student subgroups.

Descriptive Results

Before turning to results from more sophisticated student learning loss regression models, descriptive results relating to how the two key independent variables

2. Results from unreported alternative multilevel mixed-effects models specifications do not materially disturb the core reported results reported in Table 2. Similarly, clustering standard errors at the state level does not meaningfully disturb the core results reported in Table 2.

of interest—student access to in-person schooling and per pupil spending—correlate with the student math losses warrant brief discussion.

As it relates to in-person schooling, as expected, increases in a school district's percentage of in-person schooling correspond with decreases in the magnitude of the district's mean math achievement loss. The relation between school district per pupil spending and student learning losses, by contrast, conflicts with *ex ante* expectations as school district increases in per pupil spending map onto greater mean math achievement losses. Explanations for why per pupil spending and student learning losses negatively correlate are not obvious.

One complicating factor is that what per pupil spending captures as a variable may not be entirely clear and, in any event, has likely evolved over time. One consequence of decades of school finance (as well as school desegregation) litigation is that the relation between per pupil spending and student socio-economic status and race has become even more complex and nuanced over time. In this study, for example, while mean school district per pupil spending correlates negatively (-0.20) with the districts' percentage of students from low-income households, the relation is positive (0.11) for districts' percentage of URM students. That is to say, while increases in a school district's percentage of students from poverty correspond with per pupil spending decreases, increases in a district's percentage of URM students, in contrast, correspond with increased per pupil spending.

Regression and Fixed-Effects Models' Results

This part explores whether the initial descriptive results survive more sophisticated modeling and specifications that simultaneously account for multiple factors at once. In Table 2, Model 1, the naïve model includes only the two key hypothesized independent variables of interest. Models 2 and 3 introduce a suite of local school district-level (and one county-level) control variables. Model 3 incorporates state fixed-effects.

Overall, results in Table 2 provide mixed support for the influence of the two key independent variables of interest as well as related hypotheses. On the one hand, the findings emphasize that, as expected, increased student access to in-person schooling during the 2020-2021 school year corresponds with decreased student math achievement losses. And this finding persists across all three specifications in Table 2. On the other hand, per pupil spending variation generally does not systematically correspond with student math achievement loss variation in any of the specifications.

In addition, other important results in Table 2 (specifically, Models 2 and 3) make clear that student learning losses distribute unevenly across various student subgroups, including some of the traditionally more vulnerable student subgroups, as well as in larger districts and districts that experienced turbulent enrollment shifts between 2019 and 2022. Curiously, the county-level COVID-19 case rate variable achieves statistical significance, but the coefficient is positive. Finally, core findings in Table 2 convey notable robustness and stability across all three specifications and remain largely unchanged with the inclusion of state fixed-effects (Model 3).

Student Access to In-Person Schooling

Results in Table 2 clearly and consistently illustrate that when it comes to explaining how student math learning losses between 2019 and 2022 distributed, student access to in-person schooling during the 2020-2021 school year played an important role. This finding replicates similar findings from virtually every other published study. Fahle et al. (2023a), for example, conclude that "[u]ndoubtedly, in-person learning is important for student achievement" (p.24). They note that not only were student learning losses larger for students relegated to remote and hybrid schooling environments, but that a lack of student access to in-person schooling was especially damaging for low-income and high minority districts. Goldhaber et al. (2022a, p.21) similarly find that "[i]n districts that went remote, achievement growth was lower for all subgroups, but especially for students attending high-poverty schools. In areas that remained in-person, there were still modest losses in achievement, but there was no widening of gaps between high and low-poverty schools in math (and less widening in reading)." Notably, U.S. Secretary of Education Miguel Cardona expressly attributed student achievement losses to "the lack of in-person classroom education during the Covid-19 pandemic" (Hassan et al., 2022).

It is, of course, important to remain mindful that the pandemic and related disruptions unleashed an almost infinite array of complex factors that surely influenced student academic decay. The pandemic disrupted students' lives, routines, mental health, and family and social support networks in important ways that extend far beyond school district decisions on instructional modes. Thus, and this point bears emphasis, when it comes to student learning losses, "many" other potential mechanisms were also at work (Fahle et al. 2023a, p.24; Domina et al., 2022).

To observe that other potential mechanisms contributed to student learning losses does not, however, dislodge the point that emerging research consistently identifies school districts' instructional mode decisions as an important factor contributing to the extraordinary student learning losses suffered during the pandemic. From a policy perspective, what distinguishes school districts' learning mode decisions for the 2020-2021 school year from other potential mechanisms is the degree to which districts controlled their learning mode decisions. Indeed, the politically uncomfortable juxtapositions between public school districts that offered either remote or hybrid schooling while geographically proximate private schools operated in-person during the 2020-2021 school year surely help explain some of public school disenrollment that Dee et al. (2021) find.

In addition to influencing student learning losses in important ways, school districts' learning mode decisions themselves distributed in non-random ways. For example, analyses of how student access to in-person schooling distributed in 2020-2021consistently find that school districts in states with Republican governors (Heise, 2023; DeAngelis & Makridis, 2021; Grossman et al., 2021; Harris & Oliver, 2021) and more rural districts (Heise, 2023; Camp & Zamarro, 2021; Haderlein et al., 2021) provided comparably more in-person schooling. Conversely, school districts with larger enrollments and higher percentages of URM and IDEA-eligible students (Heise, 2023; DeAngelis & Makridis, 2021; Moran, 2021; Oster et al., 2021) provided less. Curiously, state-level COVID-19-related death rates and the likelihood of in-person schooling were positively related (Heise, 2023).

District Mean Per Pupil Spending

The expectation that more per pupil spending would correspond with systematically less student learning loss does not find support from the results in Table 2. The null results for the school districts' per pupil spending variable, consistent across all three models in Table 2, are unexpected if one assumes that, as a general matter, comparably wealthier school districts (as construed by per pupil spending) typically outperform their less financially well-off counterparts academically (*e.g.*, Lafortune et al., 2018; Card & Payne, 2002). Of course, one hint of this potentially anomalous finding includes a negative correlation between school district per pupil spending and student math achievement score changes.

While a closer examination of the relation between schools districts' per pupil spending and percentage in-person schooling does not eliminate lingering uncertainty, it does provide some helpful clues. First, prior research modeling school districts' percentage of in-person instruction for the 2020-2021 school year finds similarly null results for the schools districts' per pupil spending variable (*e.g.*, Heise, 2023; DeAngelis & Makridis, 2021). Second, as Figure 3 illustrates, increases in the percentage of school districts' in-person instruction negatively correlate (-0.33) with variation in school district per pupil spending. That is, on average *higher* per pupil spending school districts were *less* inclined to deliver in-person academic instruction. Third, as results in Table 2 also make quite clear, variation in school districts' in-person schooling emerges as a strong predictor—across all three models—of changes in school districts' math

Table 2. Regression and Fixed-Effects Models of Change in School District Mean Math Achievement Score from 2019 to 2022

	(1)	*(2)*	*(3)*
In-Person schooling (2020-21) (%)	0.03** (0.00)	0.02** (0.00)	0.02** (0.00)
Current per pupil spend. ($; /1000)	-0.03 (0.01)	0.03 (0.02)	0.05 (0.03)
(*Distributional controls*:)			
URM (%)		-0.03** (0.00)	-0.05** (0.01)
Poverty (%)		-0.03** (0.01)	-0.04** (0.02)
IDEA (%)		-0.28** (0.02)	-0.10** (0.03)
Female students (%)		-0.12* (0.05)	-0.08 (0.07)
(*Other controls*:)			
Urban school dist. (1=yes)		-0.29 (0.22)	-0.28 (0.22)
Student enrollment^2 (nlog)		-0.19** (0.04)	-0.16* (0.06)
Enroll. chg. (2019-22) (1=yes)		-0.90** (0.18)	-0.96** (0.23)
County COVID case rate (1000)		0.02** (0.00)	0.02* (0.01)
State/local revenue ratio (%)		-0.67** (0.12)	-0.33 (0.22)
constant	-6.26** (0.22)	7.43** (2.59)	2.97 (3.98)
R^2	0.06	0.16	0.12
(*N*)	*5,586*	*5,586*	*5,586*
State fixed-effects	*N*	*N*	*Y*

Notes: The dependent variable is the change in a school district's mean math achievement score from 2019 to 2022. A dependent variable greater than 0.0 indicates that a school district's mean math achievement score increased from 2019 to 2022. * p<0.05; ** p<0.01. Robust standard errors (Models 1 and 3) in parentheses. Models 1 and 2 were estimated using the "reg" command in Stata (v.18.0). Model 3 includes state fixed-effects and was estimated using the "xtreg" command.
Sources: CSDH (2023); Reardon et al. (2023)[SEDA 2022 2.0]; New York Times (2023); U.S. Dept. Comm. (2021, 2020a, 2020b); NCES (2021a, 2021b, 2020a, 2020b).

achievement.

These clues' likely interactions imply one potential explanation for the unexpected null results for the school districts' per pupil spending variable across all three models in Table 2. Despite whatever general comparative advantages that typically attach to higher per pupil spending school districts, when it came to in-person instruction during the 2020-2021 school year higher per pupil spending school districts were systematically less likely to provide in-person instruction (Heise, 2023). Results in Table 2 make quite clear how increased student access to in-person instruction decreased student math learning losses. Consequently, a comparatively greater preference for remote and hybrid instructional mode options helps explain why higher per pupil spending districts do not fare better in terms of student math achievement.

Of course, even if the explanation for the null results for the school districts' per pupil spending variable across all three models in Table 2 is plausible, explanations for comparatively higher per pupil spending districts' instructional mode decisions are not obvious. While these data do not speak to school districts' motivations for their instructional mode decisions during the 2020-2021 school year, two potential explanations warrants brief discussion.

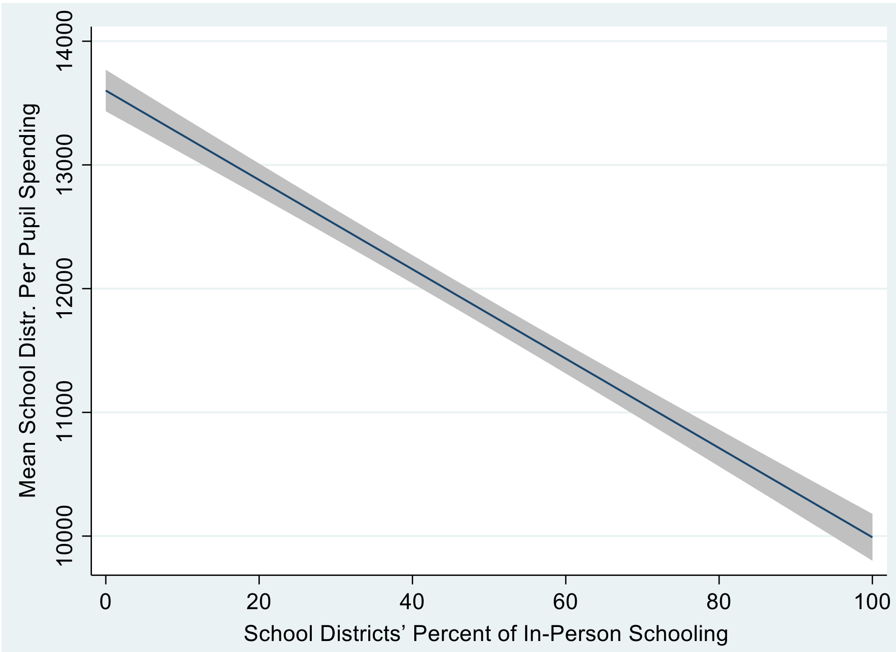
One explanation relates to political pressure. Pressure on school districts to provide in-person instruction emerged from many different—but certainly not all—directions. Although many school district constituents clamored for more in-person instruction, many public school teachers—and their unions—successfully demanded less, or no, in-person instruction (Marianno et al., 2022). And district-level variation in households' needs for childcare as well as access to non-school-based education options may also have informed school districts' instructional mode decision, even if only at the margins.

Specifically, if higher SES households enjoyed greater access to various education alternatives and childcare (*e.g.*, private family-organized education "pods," private schools providing in-person instruction, etc.) (Hartney & Finger, 2020), this could have, in turn, reduced political pressure on their comparatively higher per pupil spending public school districts to provide more in-person student instruction. At the same time, if comparatively lower SES households, owing to fewer childcare and alternative educational options, had a greater need in-person schooling, lower SES households could have imposed comparatively more political pressure on their lower per pupil spending school districts for in-person education.

A second complementary possibility is economic, and pivots on the possibility that comparatively higher per pupil spending districts were better positioned financially to fund the extraordinary costs associated with equipping schools with the technology that made remote and hybrid instructional options practical possibilities for school districts. By contrast, and despite the addition of new COVID-related funds (DeAngelis & Makridis, 2021), comparatively lower per pupil spending school districts may have been less financially able to implement the costly remote-learning technology and, as a consequence, had comparatively less fiscal capacity to offer alternatives to in-person instruction. While in-person schooling certainly imposed additional costs on school districts during the pandemic, for some school districts in-person instruction may have been less expensive than the remote or hybrid options. Regardless, either dynamic would have contributed to the paradoxical result of comparatively higher per pupil spending school districts levering their economic advantages in the service of an option (alternatives to in-person instruction) that correlates with, on average, increased student math decay.

The plausibility of either possibility, of course, turns on the degree to which

Figure 3. School Districts' Percent of In-Person Schooling By Mean Per Pupil Spending



Sources: Reardon et al. (2023)[SEDA 2022 2.0]; U.S. Dept. Comm. (2020a); NCES (2020b); (N=5,586).

school district mean per pupil spending persuasively proxies for school district "wealth," more broadly understood. And uncertainty persists on the proxy's efficacy as evidence of a link between per pupil spending and household SES remains contested (*see, e.g.*, Shores et al., 2022). Any uncertainly notwithstanding, the hypothesized relation between per pupil spending and math achievement does not find support in any of the models in Table 2. In the naïve model (Model 1), the coefficient is negative. Once the suite of controls are introduced into the models (Models 2 and 3), as well as state fixed-effects (Model 3), per pupil spending's coefficient, while positive, still fails to approach standard statistical significance thresholds. Despite this variable's null results, including per pupil spending controls in student academic achievement models remains warranted.

How Student Math Achievement Losses Distributed

In addition to information on the two key independent variables of interest, school districts' in-person teaching and per pupil spending, results in Table 2 also illustrate that student math achievement losses raise troubling distributional questions as well. If students and school districts struggled during the pandemic—as they surely did so mightily and in many different ways—these struggles may have been especially acute for subgroups of traditionally marginalized students, including URM students, students from low-income households, and IDEA-eligible students. And if the intensity and magnitude of COVID-19's burdens distributed unevenly across various student subgroups, one might expect, *ex ante*, that student learning losses would distribute in similarly uneven patterns. Emerging research generally comports with this expectation as, for example, Fahle et al. (2023a) find that student learning losses were "larger" in lower-income and minority districts (p.18).

Results in Table 2 largely replicate prior research findings and make clear that increases in a district's percentages of URM, IDEA-eligible, and low-income students correspond with systematic increases in student math achievement decay. Notably, results for these traditionally marginalized student subgroups achieve statistical significance after controlling for district per pupil spending and student access to in-person schooling.

URM students

Similar what to Fahle et al. (2023a) find, results in Table 2 make clear that increases in a district's percentage of URM students correspond with systematic increases in student math learning losses. Moreover, various interactions only made it more difficult for URM students. For example, while prior research notes that increases in a school district's percentage of URM students correlate with decreased access to in-person education during the 2020-2021 school year (*e.g.*, Heise, 2023), Fahle et al. (2023a, p.18) note that, in terms of explaining student learning losses, not being in-person was "differentially worse" for school districts with high concentrations of URM students. Such findings, individually and cumulatively, raise important and, indeed, troubling distributional and equal educational opportunity concerns.

Student poverty

Consistent with emerging research, results in Table 2 suggest that increases in a district's percentage of low-income students correlate with increases in student learning losses. Given the challenges that low-income school districts confront are both well-documented and well-understood (Black, 2012), this finding does not surprise. Unlike their higher-income household counterparts who benefitted from greater access to private schooling, informal parent-initiated education "pods," and the necessary technology assets at home for remote instruction (*e.g.*, laptops, reliable and stable home wi-fi access, etc.), school districts serving a higher percentage of low-income students, by contrast, may have lacked the assets necessary to off-set how poverty's various effects on student learning were exacerbated by pandemic-related disruptions. Given the additional obstacles that low-income students typically confront, that they lost comparatively more ground academically during the pandemic will, sadly, surprise few.

IDEA-eligible students

Similar to other discrete subgroups of potentially vulnerable students, Table 2 illustrates that increases in a school district's percentage of IDEA-eligible students correspond with increased student learning losses. If IDEA-eligible students present particular challenges for school districts and educators, it is possible that such challenges only increased in magnitude and scope during the pandemic, especially for those relegated to either remote or hybrid learning environments during 2021-2022 who would have benefitted from in-person instruction.

Financial and resource challenges to districts are among those posed by some IDEA-eligible students. Such challenges persist even though some IDEA-eligible students bring with them supplemental per pupil spending and other resources. While the array of accommodations required from school districts, necessary to discharge legal obligations owed to IDEA-eligible students, can vary tremendously in terms of time, money, and resources, IDEA-eligible students typically consume comparably more district resources than their non-IDEA-eligible student counterparts. The possibility that IDEA-eligible students' needs were more likely to have been unmet during the 2020-2021 school year may have contributed to their achievement losses.

The cumulative weight of the results in Table 2 germane to traditionally marginalized and vulnerable student subgroups makes clear that school districts serving comparatively higher percentages of those students most in need of quality educational services reported comparatively higher levels of student learning losses during the pandemic. To note that such findings raise troubling distributional and equal educational opportunity issues is to note the obvious.

In addition to the uncomfortable distributional concerns discussed above, findings for three additional control variables warrant brief note.

Student enrollment & material enrollment changes

Larger school districts (construed in terms of student enrollment) as well as districts that underwent material enrollment or enrollment compositional changes between 2019 and 2022 correlate with systematic increases in student learning losses. That increases in school district size correspond with increases in student learning losses generally comports with growing policy concerns relating to the possible deleterious consequences of school and school district size and scale on student achievement (Egalite & Kisida, 2016).

While a dummy variable identifies the approximately 15 percent of school districts that experienced material raw enrollment or enrollment compositional changes between 2019 and 2022 achieves statistical significance, how to interpret this finding and what this variable signals are comparatively less clear. Dee et al., (2021) find that public school districts, on net, suffered palpable student enrollment losses attributable to the pandemic. What is not known, however, is how district enrollment turbulence implicates student learning losses because it is uncertain whether students who exited public schools were systematically higher- or lower-scoring math students.

What is clear, however, is that Dee et al. (2021) suggest that some students departed public schools owing to district decisions on whether to offer in-person schooling. Moreover, those who migrated from public to private schooling alternatives (including homeschooling) may skew in terms of household income or parental employment requirements or engagement with their child's education. Similarly, it also may be that enrollment turbulence itself reflects unobserved characteristics, including, for example, students' (or their families') perceptions about a school's instructional efficaciousness or quality. While uncertainty clouds how school district enrollment turbulence implicates student learning losses, what is clear is that school district enrollment turbulence corresponds with increased student learning losses.

Reported county-level COVID-19 case rates

As Table 2 illustrates, the county-level COVID-19 case rate variable coefficient is both positive and statistically significant. That is, increases in county-level reported COVID case rates systematically correspond with decreased student learning losses. One possible explanation is that increases in COVID-19 case rate were fueled, in part, by an in-person schooling environment which itself, in turn, correlates with decreased student learning losses. On balance, this potentially curious finding likely contributes to growing uncertainty about how perceptions about COVID severity may have influenced various outcomes, including student academic achievement. Regardless, that the COVID-19 case report rate variable is aggregated at the county-level, and public school district boundaries do not match county boundaries in many instances, risks inviting some degree of measurement error.

While results for the county-level COVID-19 case report rate variable used in this study can be understood as an effort to partly replicate Fahle et al.'s (2023a) findings, their study uses a different COVID severity measure (death rates) and, in any event, they report inconsistent findings in that the direction of their county-level COVID-death rate variable's coefficient is conditioned on how they measure student learning losses. When Fahle et al. (2023a) focus more narrowly on achievement changes between 2019 and 2022, they find that increases in COVID-death rates systematically correspond with decreased student learning losses (p.21, Tbl.A7, Fig.1). When they construe student learning losses in terms of a differential change in achievement scores between 2019 and 2022, after subtracting achievement score changes between 2016 and 2019, however, they find the opposite result for their COVID death rate variable: specifically, that increases in COVID death rates systematically correspond with increased student learning losses (p.21, Tbl.6).

LIMITATIONS

Two factors limiting this study warrant emphasis. First, insofar as efforts to understand student learning (and learning losses) are fraught with complexities, studies, such as this one, exploring student learning losses ascribable to the pandemic inevitably invite even greater degrees of difficulty owing to the numerous, nuanced, and complex ways in which the pandemic interacted with student learning. While results from this study (and related studies) may identify potential mechanisms and broad trends, the specifications in this study necessarily impose an artificial level of simplicity onto a context that is anything but simple. Hopefully, future research will provide additional and helpful focus and granularity.

Second, as this study focuses on changes in estimates of school districts' mean math achievement scores between 2019 and 2022, the findings cannot speak to, for example, how learning losses varied across schools and individual students *within* a district. As previously discussed, data for this study are organized at the school district- and not at the individual student-level and a focus on school district-level data can obscure student-level implications. Similarly, this study construes student learning losses narrowly in terms of changes in school districts' mean math achievement scores. Future research may consider other dimensions of student achievement.

CONCLUSION

The global pandemic forced local public school districts across the nation to simultaneously confront an unprecedented array of challenges and decisions. These challenges and decisions, in turn, contributed to equally unprecedented levels of student learning losses. *How* school districts responded to challenges imposed by COVID-19 influenced student learning losses and their distribution. That student learning losses distribute unevenly across various student subgroups, particularly some of the traditionally more vulnerable student subgroups, in turn, raises important—and uncomfortable—equal educational opportunity questions.

Results from this study emphasize three key points. First, districts' instructional mode decisions map onto student learning losses. More specifically, decreases in school districts' in-person teaching systematically correspond with increases in the magnitude of districts' mean math achievement score losses between the 2019 and 2022 school years. Second, when it came to student learning decay, variation in how much school districts spent per pupil did not play any statistically detectable role. Third, the uneven student learning decay raises important—if uncomfortable—distributional questions. Specifically, learning losses were especially acute for traditionally marginalized student subgroups, including URM students, students from poverty, and IDEA-eligible students.

Sadly—even tragically—the pandemic's implications for student learning losses incident to the numerous and varied disruptions attributable to the pandemic partly reinforce what Gardner (2000) observed decades ago with respect to student access to equal educational opportunity more generally: "Tell me the ZIP code of a child and I will predict her chances of college completion and probable income; add the elements of family support (parental, grandparental, ethnic and religious values) and a few degrees of freedom remain, at least in our country" (p.49).

When it comes to student learning losses and how they distribute, school districts' decisions about access to in-person schooling and districts' percentage of historically marginalized students loom large. Consequently, students' proverbial (if not literal) ZIP codes, and race (and ethnicity) still weigh heavily. That evidence of Professor Gardner's alarming point raised decades ago persists and was elicited, once again, by the pandemic, should trouble anyone who harbors even a vague belief in America's ideal of equal educational opportunity.

DATA AVAILABILITY

Data for this article data draw from two main publicly-available data sets. First, the SEDA 2022 2.0 data set provides mean math test score estimates for 5,696 districts across 39 states (Reardon et al., 2023), https://doi.org/10.25740/db586ns4974. Second, the COVID-19 School Data Hub ("CSDH"), one the nation's most comprehensive repositories of public school district-level information on the percentage of in-person learning offered during the 2020–21 school year (CSDH, 2023), https://www.covidschooldatahub.com/.

REFERENCES

Abadie, A., Athey, S., Imbens, G. W., & Wooldridge, J. M. (2023). "When Should You Adjust Standard Errors for Clustering?" *The Quarterly Journal of Economics, 138*(1):1–35. https://doi.org/10.1093/qje/qjac038.

Andrews, Matthew, et al. (2002). "Revisiting Economies of Size in American Education: Are We Any Closer to a Consensus?" *Economics of Education Review, 21*(3):245-62. https://www.sciencedirect.com/science/article/pii/

S0272775701000061?via%3Dihub.

Atteberry, Allison, Kendra Bischoff & Ann Owens. (2021). "Identifying Progress Toward Ethnoracial Achievement Equity Across U.S. School Districts: A New Approach." *Journal of Research on Educational Effectiveness, 14*(2):410-41. https://doi.org/10.1080/19345747.2020.1868032.

Bielinski, J., Brown, R., & Wagner, K. (2021). "No Longer a Prediction: What New Data Tell Us About the Effects of 2020 Learning Disruptions [White paper]." Illuminate Education. https://www.illuminateed.com/wp-content/uploads/2021/06/LearningLoss_2021_Update_FB_031221.pdf

Black, Derek W. (2012). "Middle-Income Peers as Educational Resources and the Constitutional Right to Equal Access." *Boston College Law Review, 53*(2):373-442. https://heinonline.org/HOL/Page?public=true&handle=hein.journals/bclr53&div=15&start_page=373&collection=journals&set_as_cursor=1&men_tab=srchresults.

Blazar, David & Beth Schueler. (2022). "Why do school districts matter? An interdisciplinary framework and empirical review." *EdWorkingPapers*, 22(581). https://doi.org/10.26300/58M4-FS65.

Brown v Board of Education, 347 U.S. 483 (1954). https://supreme.justia.com/cases/federal/us/347/483/.

Camp, Andrew M. & Gema Zamarro. (2021). "Determinants of Ethnic Differences in School Modality Choices During the COVID-19 Crisis." *Educational Researcher, 51*(1):6-16.

Card, David & A. Abigail Payne. (2002). "School finance reform, the distribution of school spending, and the distribution of student test scores." *Journal of Public Economics 83*(1):49–82, https://doi.org/10.1016/S0047-2727(00)00177-8.

Coronavirus Aid, Relief, and Economic Security (CARES) Act, 15 U.S.C. § 9001 *et seq*. (2020).

COVID-19 School Data Hub ("CSDH"). (2023). *All School Learning Model Data* "Percentage of School Year Spent In-Person, Hybrid, or Virtual, District Overall Shares." Data Resources (Version 3/8/23). Accessed May 3, 2023. https://www.covidschooldatahub.com/data-resources.

Crow, Oliva. (2022). "Education Inequality During COVID-19: How Remote Learning Is Widening the Achievement Gap and Spurring the Need for Judicial Intervention." *Boston College Law Review, 63*(2):713-52.

DeAngelis, Corey A. & Christos A. Makridis. (2021). "Are School Reopening Decisions Related to Funding? Evidence from Over 12,000 Districts During the Covid-19 Pandemic (Version 25 Sept. 2021)." https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3799694.

Dee, Thomas, Elizabeth Huffaker, Cheryl Phillips & Eric Sagara. (2021). "The

Revealed Preferences for School Reopening: Evidence from Public-School Disenrollment." NBER Working Paper 29156. DOI 10.3386/w29156. http://www.nber.org/papers/w29156.

DeLuca, Thomas A. (2018). "Instructional Spending Metrics: A Multilevel Analysis UsingNCES

Data." *Journal of Education Finance, 44*(1):23-44. https://muse.jhu.edu/article/721594.

Domina, Thurston, Hashim, A., Kearney, C., Pham, L., & Smith, C. (2022). "COVID-19 and the System Resilience of Public Education: A View from North Carolina [Brief]." Urban Institute. https://www.urban.org/research/publication/covid-19-and-system-resilience-public-education-view-north-carolina.

Domingue, B. W., Dell, M., Lang, D., Silverman, R., Yeatman, J., & Hough, H. (2022). "The Effect of COVID on Oral Reading Fluency During the 2020–2021 Academic Year." *AERA Open, 8*, 23328584221120256. https://doi.org/10.1177/23328584221120254.

Egalite, Anna J. & Brian Kisida. (2016). "School size and student achievement: a longitudinal analysis." *School Effectiveness and School Improvement, 27*(3):406-17. DOI: 10.1080/09243453.2016.1190385.

Engzell, Per, Arun Frey & Mark D. Verhagen. (2021). "Learning loss due to school closures during the COVID-19 pandemic." *PNAS, 118*(17):e 2022376118. https://doi.org/10.1073/pnas.2022376118.

Fahle, Erin M., et al. (2023a). "School district and community factors associated with learning loss during COVID-19 pandemic" (version: May 2023). https://cepr.harvard.edu/sites/hwpi.harvard.edu/files/cepr/files/explaining_covid_losses_5.23.pdf

Fahle, Erin M., Reardon, S. F., Shear, B., Ho, A., Saliba, J., & Kalogrides, D. (2023b). "Stanford Education Data Archive Technical Documentation: SEDA2022 2.0." http://purl.stanford.edu/db586ns4974.

Gardner, Howard. (2000). "Paroxysms of Choice." *New York Review of Books*. https://www.nybooks.com/articles/2000/10/19/paroxysms-of-choice/.

Geverdt, Douglas. (2019). "Education Demographic and Geographic Estimates (EDGE) Program: Locale Boundaries File Documentation." National Center for Education Statistics. https://nces.ed.gov/programs/edge/docs/EDGE_NCES_LOCALE.pdf.

Goldhaber, D., Kane, T. J., McEachin, A., Morton, E., Patterson, T., & Staiger, D. O. (2022a). "The Consequences of Remote and Hybrid Instruction During the Pandemic" (Working Paper No. 30010). National Bureau of Economic Research. https://doi.org/10.3386/w30010.

Goldhaber, D., Kane, T. J., McEachin, A., & Morton, E. (2022b). "A Comprehensive

Picture of Achievement Across the COVID-19 Pandemic Years: Examining Variation in Test Levels and Growth Across Districts, Schools, Grades, and Students" (CALDER Working Paper No. 266–0522). CALDER. https://caldercenter.org/publications/comprehensive-picture-achievement-across-covid-19-pandemic-years-examining-variation.

Greenberg, Erica, Kristin Blagg & Macy Rainer. (2019). "Measuring Student Poverty: Developing Accurate Counts for School Funding, Accountability, and Research" (Center on Education Data and Policy) [Research Report]. Urban Institute. https://www.urban.org/research/publication/measuring-student-poverty.

Grossmann, Matt, Sarah Reckhow, Katharine Strunk & Meg Turner. (2021). "All States Close but Red Districts Reopen: The Politics of In-Person Schooling during the COVID-19 Pandemic." (EdWorkingPaper: 21-355). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/cb1f-hq66

Haderlein, Shira K., Anna Rosefsky Saavedra, Morgan S. Polikoff et al. (2021). "Disparities in Educational Access in the Time of COVID: Evidence From a Nationally Representative Panel of American Families." *AERA Open*, *7*(1):1-21. DOI: https://doi.org/10.1177/23328584211041350.

Harris, Douglas N. & Daniel M Oliver. (2021). "Why Did So Many Public Schools Stay Remote During the COVID Crisis?" (REACH Policy Brief). Retrieved from Nat'l Center for Research on Education Access and Choice: https://reachcentered.org/uploads/policybrief/20210712-Harris-Oliver-Why-Did-So-Many-Public-Schools-Stay-Remote-During-the-COVID-Crisis.pdf.

Hartney, Michael T., and Leslie K. Finger. (2020). Politics, Markets, and Pandemics: Public Education's Response to COVID-19. (EdWorkingPaper: 20-304). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/8ff8-3945.

Hassan, Carma, Deidre McPhillips, and Eric Levenson. (2022). "Student Test Scores Plummeted in Math and Reading After the Pandemic, New Assessment Finds." *CNN* (Sept. 1) https://www.cnn.com/2022/09/01/us/student-test-scores-drop/index.html.

Hanushek, Eric, A. (1996). "School Resources and Student Performance," in *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success* (Gary Burtless, ed.). Wash. D.C.: Brookings Institution.

Heise, Michael. (2023). "The distribution of in-person public K-12 education in the time of COVID: An empirical perspective." *Journal of Empirical Legal Studies, 20*(2):305-38. https://onlinelibrary.wiley.com/doi/10.1111/jels.12345.

Heise, Michael. (2006). "The Political Economy of Education Federalism." *Emory Law Journal, 56*(1):125-58. https://scholarship.law.cornell.edu/lsrp_ papers/64.

Hill, Teramie. (2022). "Equal Opportunity in Remote Learning." *Marquette Benefits & Social Welfare Law Review, 24*(1):121-56. https://scholarship.law.marquette.edu/benefits/vol24/iss1/6/.

Ho, Andrew. (2020). "What is the Stanford Education Data Archive Teaching Us About National Educational Achievement?" *AERA Open, 6*(3):1-4. https://doi.org/10.1177/2332858420939848.

Individuals with Disabilities Education Act, 20 U.S.C. § 1400 *et seq*. (1975).

Jack, R., Halloran, C., Okun, J., & Oster, E. (2022). "Pandemic Schooling Mode and Student Test Scores: Evidence from U.S. School Districts." https://emilyoster.net/wp-content/uploads/MS_Updated_Revised.pdf.

Jackson, Kirabo C., Rucker C. Johnson & Claudia Persico. (2016). "The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms." *Quarterly Journal of Economics, 131*(1):157–218. https://doi.org/10.1093/qje/qjv036.

Kahlenberg, Richard D. (2001). "Learning from James Coleman." *The Public Interest, 144*:54-72. https://www.nationalaffairs.com/storage/app/uploads/public/58e/1a4/fba/58e1a4fba1ba7477467159.pdf.

Kogan, Vladmir & Stephane Lavertu. (2022). "How the COVID-19 Pandemic Affected Student Learning in Ohio: Analysis of Spring 2021 Ohio State Tests." The Ohio State University, John Glenn College of Public Affairs. https://glenn.osu.edu/sites/default/files/2021-10/210828_KL_OST_Final_0.pdf.

Kuhfeld, Megan, Thurston Domina, & Paul Hanselman. (2019). "Validating the SEDA Measures of District Educational Opportunities via a Common Assessment." *AERA Open, 5*(2):1-18. https://doi.org/10.1177/2332858419858324.

Kuhfeld, Megan, James Soland, Kayrn Lewis. (2022). "Test Score Patterns Across Three COVID-19-Impacted School Years." *Educational Researcher, 51*(7):500–506. https://doi.org/10.3102/0013189X221109178.

Lafortune, Julien, Jesse Rothstein & Diane W. Schanzenbach. (2018). "School Finance Reform and the Distribution of Student Achievement." *American Economic Journal: Applied Economics, 10*(2):1-26.

Shores, Kenneth A., Hojung Lee & Elinor Williams. (2022). "The Distribution of School Resources in The United States: A Comparative Analysis Across Levels of Governance, Student Subgroups, And Educational Resources." (EdWorkingPaper: 21-443.) Retrieved from Annenberg Institute at Brown University, https://doi.org/10.26300/58f3-6v39.

Lewis, K., Kuhfeld, M., Ruzek, E. & McEachin, A. (2021). "Learning during COVID-19: Reading and math achievement in the 2020-21 school year" [Research brief]. NWEA. https://www.nwea.org/uploads/2021/07/Learning-during-COVID-19-Reading-and-math-achievement-in-the-2020-2021-school-year.research-brief-1.pdf.

Locke, V. N., Patarapichayatham, C. & Lewis, S. (2021). "Learning Loss in Reading and Math in U.S. Schools Due to the COVID-19 Pandemic." Istation. https://www.istation.com/hubfs/Content/downloads/studies/COVID-19_Learning_Loss_USA.pdf.

Marianno, Bradley D., Annie A. Hemphill, Ana Paula Loures-Elias, et al. (2022). Power in a Pandemic: Teachers' Unions and Their Responses to School Reopening. *AERA Open*. *8*(1):1-16. https://doi.org/10.1177/23328584221074337.

McGraw, Rebecca et al. (2006). "A Closer Look at Gender in NAEP Mathematics Achievement and Affect Data: Intersections with Achievement, Race/Ethnicity, and Socioeconomic Status." *Journal for Research in Mathematics Education, 37*(2):129-50. https://www.jstor.org/stable/30034845.

Meckler, Laura. (2022). "Scores Fall Coast to Coast, Especially in Math, Under Pandemic's Toll." *The Washington Post*, Oct. 24. https://www.washingtonpost.com/education/2022/10/24/pandemic-learning-loss-naep-tests/.

Mervosh, Sarah. (2022). "The Pandemic Erased Two Decades of Progress in Math and Reading." *New York Times*, Sept. 1. https://www.nytimes.com/2022/09/01/us/national-test-scores-math-reading-pandemic.html.

Moran, Rachel F. (2021). "Persistent Inequalities, the Pandemic, and the Opportunity to Compete." *Washington and Lee Journal of Civil Rights and Social Justice*, *27*(2):589-645. https://scholarlycommons.law.wlu.edu/crsj/vol27/iss2/9/.

Morgan, Ivy & Ary Amerikaner. (2018a). "Funding Gaps 2018: An Analysis of School Funding Equity Across The U.S. and Within Each State." https://edtrust.org/wpcontent/uploads/2014/09/FundingGapReport_2018_FINAL.pdf.

Morgan, Ivy & Ary Amerikaner. (2018b). "Funding Gaps 2018: Technical Appendix." https://edtrust.org/wp-content/uploads/2014/09/FundingGap_TechnicalAppendix_2018_FINAL.pdf.

Murname, Richard J., John B. Willett & Frank Levy. (1995). "The Growing Importance of Cognitive Skills in Wage Determination." *The Review of Economics and Statistics, 77*(2):251-266. https://doi.org/10.2307/2109863.

National Center for Education Statistics ("NCES"), U.S. Department of Education. (2022). "National Assessment of Educational Progress (NAEP) 2020 and 2022 Long-Term Trend (LTT) Reading and Mathematics Assessments [Research report]." https://www.nationsreportcard.gov/highlights/ltt/2022/#intro.

National Center for Education Statistics ("NCES"), U.S. Department of Education. (2021a). "Elementary and Secondary Information System (School District), 2019-20 [CCD data]." https://nces.ed.gov/ccd/elsi/default.aspx?agree=0 (last visited 8 January 2024).

National Center for Education Statistics ("NCES"), U.S. Department of Education. (2021b). "Comparable Wage Index for Teachers (CWIFT) [ACS Comparable Wage Index for Teachers data]." https://nces.ed.gov/programs/edge/Economic/TeacherWage, last visited 10 January 2024).

National Center for Education Statistics, U.S. Department of Education. (2020). "Digest of Education Statistics [HS dropout data]." https://nces.ed.gov/programs/digest/d20/tables/dt20_219.85a.asp.

New York Times. (2023). "Coronavirus in the U.S.: Latest Map and Case Count" (Updated Mar. 23, 2023) [COVID-19 case report data]. https://github.com/nytimes/covid-19-data (last visited: 23 August 2023).

OECD. (2023). "PISA 2022 Results (Volume II): Learning During – and From – Disruption." PISA, OECD Publishing, Paris, https://doi.org/10.1787/a97db61c-en.

Oster, Emily, Rebecca Jack, Clare Halloran, et al. (2021). "Disparities in Learning Mode Access Among K–12 Students During the COVID-19 Pandemic, by Race/Ethnicity, Geography, and Grade Level — United States, September 2020–April 2021." *Morbidity and Mortality Wkly. Rep. 70*(26):953–58. PMID: 34197363. DOI: 10.15585/mmwr.mm7026e2, http://dx.doi.org/10.15585/mmwr.mm7026e2,

Peterson, Paul E. & Ludger Woessmann. (2007). Introduction: Schools and the Equal Opportunity Problem, *in Schools and the Equal Opportunity Problem* (Paul E. Peterson & Ludger Woessmann, eds.). Cambridge, MA: MIT Press.

Pier, L., Christian, M., Tymeson, H. & Meyer, R. H. (2021). "COVID-19 Impacts on Student Learning: Evidence from Interim Assessments in California." https://edpolicyinca.org/sites/default/files/2021-06/r_pier_jun2021.pdf.

Reardon, Sean F. et al. (2023). "Stanford Education Data Archive" (Version SEDA 2022 2.0). Retrieved from http://purl.stanford.edu/dt080zr0625 (version date: 11-22-2023).

Reardon, Sean F. et al. (2019). "Can Repeated Aggregate Cross-Sectional Data Be Used To Measure Average Student Learning Rates? A Validation Study of Learning Rate Measures in the Stanford Education Data Archive" (No. 19–08; CEPA Working Paper). Stanford Center for Education Policy Analysis. https://cepa.stanford.edu/content/can-repeated-aggregate-cross-sectional-data-be-used-measure-average-student-learning-rates-validation-study-learning-rate-measures-stanford-education-data-archive.

Robinson, Kimberly J. (2022). "Strengthening the Federal Approach to Educational Equity During the Pandemic." *Harvard Journal on Legislation, 59*(1):35-100. https://harvardjol.com/wp-content/uploads/sites/17/2022/03/102_Robinson.pdf.

Rothstein, Jesse & Diane W. Schanzenbach. (2022). "Does Money Still Matter? Attainment and Earnings Effects of Post-1990 School Finance Reforms." *Journal of Labor Economics, 40*(S1):S141-S178, https://doi.org/10.1086/717934.

Roza, Marguerite. (2010). *Educational Economics: Where do School Funds Go?* Wash. D.C.: Urban Institute Press.

Salomone, Rosemary C. (1986). *Equal Education Under Law*. New York: St. Martin's Press.

Sohn, Hosung, Heeran Park & Haeil Jung. (2023). "The Effect of Extra School Funding on Students' Academic Achievements under a Centralized School Financing System." *Education Finance and Policy, 18*(1):1–24. https://doi.org/10.1162/edfp_a_00375.

Sosina, Victoria E. & Ericka S Weathers. (2019). "Pathways to Inequality: Between-District Segregation and Racial Disparities in School District Expenditures." *AERA Open, 5*(3)1-15. https://doi.org/10.1177/2332858419872445.

Taylor, Lori L. & William J. Fowler, Jr. (2006). "A Comparable Wage Approach to Geographic Cost Adjustment." https://nces.ed.gov/pubs2006/2006321.pdf.

Troxler, McKala. (2021). "Evaluating the Impact of the COVID-19 Pandemic on Students with Disabilities." *Journal of Law & Education, 50*(2):362-89. https://sc.edu/study/colleges_schools/law/student_life/journals/jled/editions/_documents/2021_50_2/troxler-evaluating_the_impact_of_the_covid-19_pandemic_on_students_with_disabilities.pdf.

U.S. Dept. Commerce, Bureau of the Census. (2021). "SAIPE School District Estimates for 2020" [Student household poverty data]. https://www.census.gov/data/datasets/2020/demo/saipe/2020-school-districts.html.

U.S. Dept. Commerce, Bureau of the Census. (2020a). "2020 Public Elementary-Secondary Education Finance Data" [Per pupil spending data]. https://www.census.gov/data/tables/2020/econ/school-finances/secondary-education-finance.html.

U.S Dept. Commerce, Bureau of Economic Analysis. (2020b). "Per Capita Real Gross Domestic Product (GDP) of the United States in 2019, by state" (in chained 2012 U.S. dollars) [GDP data]. https://www.statista.com/statistics/248063/per-capita-us-real-gross-domestic-product-gdp-by-state/.

Zimmer, Ron & John T. Jones. (2005). "Unintended Consequence of Centralized Public School Funding in Michigan Education." *Southern Economic Journal, 71*(3):534-44. https://doi.org/10.2307/20062058.