Spring 5-1-2023

Zooming Out: A Retrospective Analysis of Nontraditional Learning Modes' Effect on High School Graduation and Dropout During the 2020-2021 Covid-19 School Year

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Submitted May 1, 2023

Abstract: This paper examines the impact of nontraditional learning modes, such as online education, on high school graduation and dropout rates during the 2020-2021 Covid-19 school year. Using school-level data from the Illinois Report Card for 2012-2021, a difference-in-differences framework is used to estimate the average treatment effect of two groups: schools that used virtual learning modes for only part of the year and those that used it for nearly the entire year. The study reveals that virtual learning had a negligible effect on four-year graduation rates. However, schools that used virtual learning for only part of the year witnessed a decrease in dropout rates by 0.5%, while those that used it for the entire year experienced a 1% reduction. These results suggest that virtual education and non-traditional learning modes provide greater accessibility to students, particularly during the Covid-19 pandemic, but may be less efficient than traditional in-person schooling. Overall, the study offers insights into the effects of virtual learning modes and highlights the need for further research in this area.

I. Introduction

In the spring of 2020, millions of students were sent home from school due to the Coronavirus pandemic, taking their courses online for the rest of the academic year with limited physical contact to their typical, in-person learning environment. This stark change in learning mode greatly affected students and teachers alike as curricula were altered for ease of application in a virtual setting, diminishing students' returns to class time and stretching teachers' workloads to their limit (Kaufman & Diliberti, 2021). The start of the 2020-2021 school year offered a reprieve from these learning conditions brought on by the disruptive nature of the pandemic, although many schools opted to continue instruction online as a safety measure for their students.

A school's choice of learning mode in the 2020-2021 school year has great implications on student wellbeing and academic proficiency; not only did virtual learning increase students' emotional stress due to being removed from their friends, peers, and support structures, but the altered content and vehicle of instruction had a quantitative effect in terms of students' test scores. Primarily, recent literature has attributed increased learning loss and plummeting test scores to schools' transition from in-person learning to online education during the pandemic (Halloran et al, 2021; Goldhaber et al, 2022). However, advocates of virtual instruction during this public health crisis describe online learning as a means of providing students with a more

flexible, accessible education, as graduation rates have increased since the beginning of the pandemic (Harris & Chen, 2022; Ahn et al., 2020). Nevertheless, the task of weighing the costs and benefits of nontraditional learning modes has become a divisive issue in the United States.

This paper attempts to analyze the effect of learning mode choice on overall educational outcomes such as the 4-year high school graduation rate and dropout rate in Illinois for the 2020-2021 school year, applying school level data to build on the literature that describes the impact of the pandemic-era educational system and its implications on the labor force and school completion. This study primarily differentiates itself from others as its data context allows for a school-level analysis regarding high school completion rather than relying on educationally unrelated data such as the Current Population Survey.

In the next section, this paper will explore the economics literature regarding virtual learning during the pandemic, the educational outcomes of interest, and past studies that quantify student and teacher experiences. The following sections will preview this study's theoretical and empirical framework before describing the data that is used, clarifying any assumptions and laying out the paper's experimental methods. The effect of learning mode choice on the 4-year high school graduation and dropout rates will then be analyzed in addition to clarifying this study's limitations and overall conclusions that can be found from this paper.

II. Literature Review

A. Educational Methods during the Covid-19 Pandemic

The Covid-19 pandemic was fundamentally different than prior epidemics as it forced schools around the world to vacate in-person instruction for alternative modes of education. For example, the flu epidemic in 1918 and the H1N1 epidemic in 2009 did not prompt institutions of higher education to send students home but were able to contain the viruses on campus with

classes proceeding as planned (Ronkowitz & Ronkowitz, 2021). Despite a lack of a plan prior to the pandemic, grade-school principals around the world had confidence in their teachers to use online platforms to continue education. The OECD Programme for International Student Assessment (PISA) revealed that principals in more than one-half of education systems believed that most 15-year-olds are in programs without an adequate online learning platform, trusting their teachers' pedagogical and technical ability to use various platforms effectively for digital learning (Moreno & Gortezar, 2020). However, the digital divide between affluent, urban places and poor, rural settings was a glaring weakness prior to the pandemic, as providing instruction to places without internet would be difficult.

When the pandemic eventually hit, the educational response varied across the United States. The strongest predictor for a district or school's response was the educational makeup of the adults in the area, with more educated areas expediting the transition to online learning due to the changing public health landscape. Traditional public schools were also much slower to transition to online learning than their charter and private school counterparts, although eventually arriving at the same destination (Harris et al., 2020). Economic conditions also affected school responses, as affluent communities were around twice as likely as poorer communities to expect teachers to deliver real-time lessons instead of asynchronous lecture videos (Gross, 2020).

The consensus response, shifting learning modes from in-person to virtual, hindered teachers' ability to connect with their students, as they were forced to learn new methodologies for their content. They were required to communicate constantly with their students in the absence of in-person communication, while also providing more effective individual feedback (Peña-Lévano & Melo, 2022). Teachers spent more time working outside of the classroom than before the pandemic to provide adequate instruction, despite less time in the classroom. This lead

educators, as many as 30 percent, to consider retiring or leaving the profession due to the increased expectations, fears of burnout, and the stress of potentially catching the virus (Kaufman & Diliberti, 2021; Gewertz, 2021). Furthermore, teachers felt unable to reach all of their students. According to a survey conducted by Chicago State University, 69 percent of educators felt that they were unprepared to appropriately teach students with disabilities, making educational struggles for these populations more evident (ElSaheli-Elhage, 2021).

B. Learning Loss and Virtual Learning Experiences

The shutdown of schools due to the covid-19 pandemic and the advent of widespread virtual learning and nontraditional learning modes created many roadblocks in a student's educational journey, leading to learning loss. This process, prior to the pandemic, has been known to affect students during summer breaks when they are not constantly being engaged in the classroom. Alexander et al. (2001) note that young students of lower socioeconomic status exhibit lower test scores entering first grade after kindergarten than their wealthier counterparts. Therefore, widening achievement gaps are already visible between poorer and wealthier students in the summertime due to their varying ability to access brain-stimulating programs when school is not in session. This pattern can only be expected to have been exacerbated during the coronavirus pandemic. Harmey and Moss (2021) note that sudden school closures affect students' mental health, including their ability to concentrate. This inhibits students' capacity to retain knowledge in their classes, especially those with fewer resources to aid their education. With fewer resources following the switch to virtual learning, less-fortunate students who were already at risk for learning loss have fallen even further behind their classmates: in addition to wide-scale learning losses, Black students' MAP test scores were lower by 0.119 standard deviations and

Hispanic students experienced decreased scores by 0.092 standard deviations (Leonhardt, 2022; Goldhaber et al., 2022).

The learning loss exhibited by school systems and their switch to virtual education to alleviate the social health burden of the pandemic has not been observed by all. For instance, Lewis Palmer District 83 in Monument, CO began the 2020-2021 school year with in-person learning for elementary school and special education students while middle and high school students were hybrid or virtual. Compared to the rest of the state, the district made significant gains in reading test scores and were above average for math, some of which is attributable to their different approach to the school year (Stein, 2022). Furthermore, some believed that the overall health concerns regarding Covid-19 were too intense compared to the possible risk of learning loss, as data from 47 states showed a student transmission rate of 0.13% and a staff transmission rate of 0.24% (Oster, 2020). Children who caught the virus also tended to have milder cases, giving the impression that there is lower risk with students – even though immunocompromised students would potentially be left behind if loose safety measures were enacted (Stein 2022). Therefore, opposition to virtual learning primarily cited learning loss and lack of true health concerns.

The United States also contains some schools that are online full-time, and their ability to cater to students' and parents' needs, compared to brick-and-mortar schools that were transformed into temporary institutions of online education, has been exceptional during this public health crisis. Parents of students in fully online schools were significantly more satisfied with their child's experience during the pandemic compared to parents whose children attended traditional schools before the switch to virtual learning according to surveys employed by Kingsbury (2021). Disruptions in zoom calls and difficulties with technology were more frequent

in schools that had transitioned to virtual learning while virtual institutions already had their educational infrastructure in place, limiting such disruptions.

C. The Economic Background of Graduation and Dropout Rates

The theory behind graduation rates is important to understand, as the economic conditions of the Covid-19 pandemic are influential to an individual student's decision to stay in school. Both the graduation rate and dropout rate also serve as this paper's primary outcome variables. Firstly, one of the most important drivers of the graduation and dropout rates are the credit requirements for graduation. The Carnegie Unit is the standard metric for graduation requirements, which are the number of 50-minute classes required that meet five days per week for 180 days. Increasing the required amount of Carnegie Units can increase the productivity and retention of students due to the expanded number of classes taken, but also increases the cost of education in terms of student effort and fewer courses of the student's choice (Lillard & DeCicca, 2000). Ultimately, higher Carnegie graduation requirements are positively correlated with higher dropout rates and are considered to have the largest effects on poor, minority students or those who have had their educational journey disrupted. This paper takes this relationship into account by using Illinois as a case study: graduation requirements remain constant.

In the United States, the graduation rate, which estimates the proportion of high school seniors that graduate, peaked in the 1970s at slightly greater than 80 percent (Heckman & LaFontaine, 2010). A variety of factors influence the graduation rate, including the current economic conditions, family life, and school start date (Komarek & Walker, 2020). However, graduation is not synonymous with high school completion, which includes those who complete the General Education Development test (GED), an alternative option for those who do not complete high school in a traditional sense. Although high school diplomas and GEDs signal the

same level of academic achievement, Heckman & LaFontaine (2010) purport that GEDs tend to fare worse than high school graduates in their social and economic lives.

The graduation rate's complement, the dropout rate, estimates the proportion of children who quit school every year. Dropout-prone students have similar characteristics to GED students in almost every capacity instead of academic achievement - the dropout rate is primarily composed of Black and Hispanic individuals and it is more difficult to find work for dropouts than graduates post-high school, as around 37 percent of 16–24-year-old dropouts in October of 2015 were unemployed (Rumberger, 2020). Traditionally, students are believed to drop out when their cost of education increases beyond the opportunity cost of missing out on employment opportunities. Students also drop out due to lack of involvement from their parents regarding their academic performance in addition to permissive parenting styles; laissez-faire parenting may lead to disciplinary problems, poor attendance, and high usage rates of drugs and alcohol, which heavily influence a student to drop out. More importantly, the parent rarely makes the decision for a student to drop out, though the higher degree of autonomy and lack of joint decision-making prompted by permissive parenting leads to students making the choice to quit school. (Rumberger et al., 1990).

D. Closely Related Literature

Because of its societal impact, the educational effect of the Covid-19 pandemic has been thoroughly studied by the economics community, though its literature is still emerging. One common educational outcome that was studied is the effect of the pandemic and its learning mode changes on student test scores. Halloran et al. (2021) examine the effect of different learning modes - online, hybrid, or in-person - on student test scores, finding that reading scores for third graders to eighth graders are more sensitive to instruction method than math scores.

E. Author (Date)	Title	Key Findings	Data
Halloran et al. (2021)	Pandemic Schooling Mode and Student Test Scores: Evidence from US States	Math test scores are more responsive to virtual learning modes: test score reductions are 14.2 percentage points on average compared to English and Language Arts (ELA)'s 6.3.	School-level state test scores for 12 states, focusing on students in grades 3-8 for the years 2015-2021.
Harris and Chen (2022)	How has the pandemic affected high school graduation and college entry?	High school graduation increased in 2021, though immediate transition to 4-year colleges declined by 6%. Graduation increases are prompted by reduced teacher expectations.	State-level state reported graduation rates for the years 2016-2020.
Ahn, Lee, and Winters (2020)	Employment Opportunities and High School Completion during the COVID-19 Recession	The share of HS graduates for age 18 increased from .705 in 2016-2019 to .774 in 2020, a 6.9 percentage point increase.	Individual-level data from the U.S. Current Population Survey (CPS) for the years 2016-2020 for people aged 18 and 19.
Chatterji and Li (2021)	Effects of Covid-19 on School Enrollment	The Covid-19 pandemic reduced school enrollment by around 2%, with a 2.3% drop from January/February to April 2020.	Individual-level CPS data, focusing on 16-18 year olds during non-summer months of 2010-2020.
Kingsbury (2021)	Online Learning: How do brick and mortar schools stack up to virtual schools?	Survey data shows that full-time virtual schools performed better and ensured greater parental satisfaction than brick-and-mortar schools.	Survey data at the parent-level, administered between July 30-31 2020.
Goldhaber et al. (2022)	The Consequences of Remote and Hybrid Instruction During the Pandemic	High poverty schools spent about 5.5 more weeks in remote instruction during 2020-21 than low- and mid-poverty schools. Also, 3rd to 8th grade students in the highest quartile of MAP testing scored 0.194 standard deviations lower than their expected growth would indicate. All quartiles experienced a negative deviation from their expected growth by at least 0.05.	A national sample of student-level Measures of Academic Progress (MAP) Growth assessment scores for students grades 3 through 8 for the tests administered in the Falls of 2017, 2019, and 2021.

Table 1: A summary of relevant papers that analyze the educational effects of Covid-19

According to the study, independent state-administered test scores declined by around 14.2 percentage points in math compared to reading's 6.3. Additionally, Goldhaber et al. (2022) present similar results, finding that a school's instructional mode was the primary driver of race and ethnicity achievement gaps for the national standardized MAP test. However, they note that this achievement gap is marked by schools with more Black and Hispanic students having less frequent in-person schooling, so selection is a potential limitation to studying learning mode.

Other scholars have studied Covid-19's educational impact on graduation and student enrollment rates. Although difficulties in the virtual education system have been made plain in prior paragraphs, it is possible that the change in learning modes increased high-school graduation and overall completion rates (Harris & Chen, 2022; Ahn et al., 2022). This outcome is potentially the result of relaxed standards in the classroom due to the social turmoil and stress of the pandemic. However, educational changes resulted in lower enrollment rates of around two percent, founded by reductions in kindergarten enrollment (Chatterji and Li, 2021). Thus, educational outcomes are of great interest in the economic community, with an abundance of room for literature to develop due to the recent nature of the pandemic.

F. Contribution

In my study, I employ data from Illinois to control for state-level differences in graduation requirements (Carnegie Units), as not every state has consistent requirements. For context, Illinois relaxed its graduation requirements in the 2019-2020 school year but returned to the original standards for the 2020-2021 school year, according to the Illinois General Assembly's Public Act 101-0643. Students and staff in Illinois, at the beginning of the school year, were required to always wear masks and were encouraged to socially distance if their school was in-person (Curry, 2020). A report by the Chicago Tribune's Staff in 2020 revealed that many schools attempted different plans to start the school year, with private-school enrollment increasing due to their ability to field in-person classes; public schools' health guidelines promoted virtual learning. Ultimately, this context is important to understand before the following sections, as Illinois' variation in school policy allows for a deeper analysis regarding learning modes and educational outcomes.

This paper attempts to build on an emerging literature regarding the changes to the American education system during the Covid-19 pandemic by analyzing the school-level effects of learning modes on graduation and dropout rates, specifically for the state of Illinois. As seen in Table 1, past studies have primarily used only economic and demographic data from the CPS to measure completion instead of school-level statistics (Ahn et al., 2022) or only applied school-level analyses for test scores. This study differs from the beaten path in that it exploits school-reported data for high school graduation and dropout rates, effectively applying more specific analyses to high school completion instead of only focusing on test scores and knowledge retention as educational outcomes of interest. The use of this data context ensures that educational communities are accurately represented instead of aggregating broad assumptions with economic and demographic surveys. Therefore, this approach will use data directly tied to and reported from schools to analyze high school graduation and dropout instead of using survey data and limiting educational outcomes to test scores.

III. Conceptual Framework

The conceptual framework employed in this paper stems from the Human Capital Model proposed by Ahn et al. (2022). This model follows several assumptions surrounding the choice of a student to drop out of high school or graduate by explaining the student's opportunity cost of staying in school. Naturally, completing high school is an investment in a student's human capital and should be characterized by the marginal cost and marginal benefit as any investment decision should.

Ahn et al. (2022) note that a student's marginal benefit of completing high school is characterized by several facets: the utility gained by socializing with classmates (B_S), the benefit of learning in a structured learning setting (B_L), and the expectation of higher wages in the future because of their education (B_W). In their paper, Ahn et al (2022) describe the benefit of learning

in a structured environment and socializing with peers as only one benefit of completing high school. However, as learning mode is the variable of interest in this paper, its relative importance is emphasized, resulting in its own characterization of benefit.

Conversely, a student may choose to drop out of school due to several costs. These costs which incentivize quitting school consist of financial costs, effort costs, and time costs. Financial costs (C_F) are composed of family expenditures on school supplies and required materials. Effort costs (C_E) characterize the difficult nature of assignments that are unappealing for students to complete. Time costs (C_T) are more abstract because they identify the opportunity costs of attending school instead of pursuing paid work or leisure activities.

Ultimately, this model's key assumption is that students will stay in school if the sum of the benefits are greater than the sum of the costs.

$$\text{Finish High School if: } B_S + B_L + B_W > C_F + C_E + C_T$$

$$\text{Dropout of School if: } B_S + B_L + B_W \leq C_F + C_E + C_T$$

This equation was heavily affected by Covid-19 and the nation-wide shock to school systems and learning modes. Learning mode changes and Covid-19 restrictions not only limited in-person instruction and the socializing that comes with it, but also significant social-emotional experiences at the end of one's high school journey. Attending prom, graduation ceremonies, and final competition seasons for student-athletes are important experiences that balance out the stress and difficulty of schoolwork, and their absences significantly reduce the social benefit of attending school for many students. Additionally, the switch to different learning modes reduced the structured nature of a student's education, reducing the benefit of learning in an organized

environment. Without these experiences, the benefit of finishing high school can be expected to decrease, specifically B_L and B_S.

However, the Covid-19 pandemic influenced the costs of finishing school in multiple ways, prompting the use of past studied to fully determine the pandemic's effect on student costs. As discussed in the literature review, learning loss, virtual learning, and the digital divide severely hampered student experiences, significantly increasing a student's effort cost C_E as it was more difficult to engage with the classroom material. However, this increased cost is mitigated by relaxed expectations by teachers, as students might not have needed to exert as much effort on their assignments to fulfill their courses' standards. Also, the pandemic decreased a student's time cost C_T – there were fewer job opportunities and leisure possibilities due to business-opening restrictions, social distancing initiatives, and masking requirements (Walmsley et al., 2021). Because paid work is the primary alternative to class for dropouts, Covid-19 greatly reduced a student's opportunity cost of staying in school.

Insight from past studies such as Harris and Chen (2022), however, allow one to weight the effect of Covid-19 on costs differently, as their study observed higher graduation rates which were attributed to lower teacher standards. Therefore, this specific impact of the pandemic greatly reduced effort costs as relaxed standards incentivized high school completion due to notably lower demands from teachers, allowing one to presume that students' overall costs were reduced significantly instead of experiencing an ambiguous effect. Therefore, the overall effects of Covid-19 on the costs and benefits of finishing high school are ambiguous due to the uncertainty associated with both decreasing costs and benefits – it is up to the empirics to further explore the practical dynamics of these costs and benefits.

IV. Data Description

The primary data for this analysis describe this paper's variables of interest and outcome variables: school learning modes and graduation and dropout rates. Learning mode data was drawn from the Covid School Data Hub, which is a public dataset identifying schools' monthly enrollment for each learning mode during the 2020-2021 school year. This source also tracks schools' Covid-19 transmission and masking policy data, though only the learning mode data is of interest in this study. Its creators collected the data through reports from state education agencies, settling for district-level data if necessary. There are four possible learning modes in the dataset: closed, in-person, virtual, and hybrid, which indicates a classroom setting that uses both in-person and virtual formats. All measures have been corrected so that months that schools were closed (in the summertime) do not reflect full-year learning mode shares, effectively accounting for schools' differing start and end dates.

The other crucial data comes from the Illinois State Board of Education's annual report card, which is a school-reported table of information including a school's geographic and demographic information, its educational outcomes such as graduation and dropout rates, and information about a school's teachers and services offered. Because the State of Illinois publishes the reports, no private schools are included in the dataset. This paper uses report card data from 2012-2021 to analyze 530 public high schools in Illinois. Schools were only included if data could be found for all years 2012-2021. Specifically, Illinois is identified as the setting of this paper to control for graduation requirements.

The last source of data utilized in this paper is county-level political data from the 2020 presidential election, used to characterize a school's county's political climate. This data comes from the MIT Election Data and Science Lab and includes county-level vote tallies and

percentages for the Democratic and Republican candidates in the 2020 presidential election, which is filtered to only include observations in Illinois.

These three data sources are combined to form two distinct datasets. The primary dataset is an annual panel dataset for 530 high schools in Illinois which includes yearly learning mode estimates, operating under the assumption that all school years prior to 2020 operated in-person. Also included in this dataset is the Illinois Report Card data to identify this paper's outcomes of interest: the 4-year graduation rates and dropout rates, resulting in 4,689 observations. The second dataset created for this paper is a monthly dataset that tracks the month-by-month learning modes for schools in Illinois in addition to each school's report card data for the 2020-2021 school year and each school's county-level election results. The monthly dataset contains 598 schools, slightly more than the annual dataset, resulting in 6,578 observations.

This study's experimental design categorizes every school into one of three treatment groups based on the intensity of traditional, in-person instruction utilized. Figure 1 displays the distribution of in-person instruction for schools in the 2020-2021 school year. The distribution of in-person instruction is characterized by two key nodes: one between 0 and 20 percent and one between 80 and 100 percent. Thus, a school was characterized as "virtual" if they fell under the former node and "in-person" if they fell under the latter node, with the remainder being characterized as "hybrid" schools. Specifically, 220 of the 530 schools were labeled as virtual, 193 were labeled as hybrid, and 117 were characterized as in-person schools: the experiment's control group.

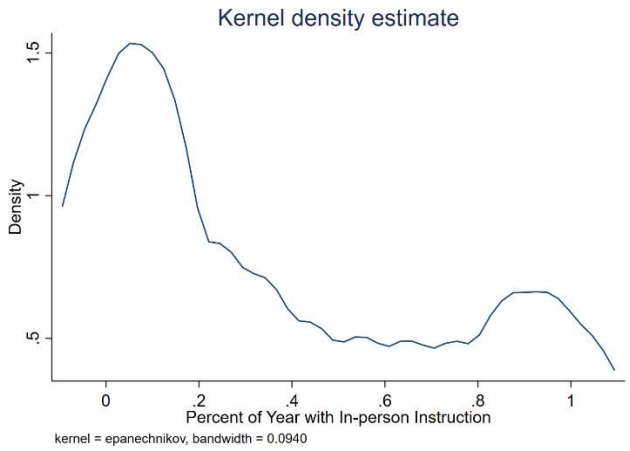


Figure 1: Density plot of schools' use of in-person instruction for the 2020-2021 school year

Table 2 gives an analysis of the means and standard deviations for each of the variables in this study, specifically for the post-treatment period (the 2020-2021 school year). Statistical significance for the hybrid and virtual treatment group means was indicated in reference to this study's control group, the array of in-person schools. It appears that the averages for in-person instruction are somewhat evenly spaced and contain statistically significant differences, resulting in well-defined treatment groups for this study. Furthermore, these treatment groups are similar regarding their variables of interest, as all groups' dropout rates do not contain statistically discernible differences and only the virtual group has a statistically supported divergence from the in-person group's graduation rate, albeit at the ten percent threshold.

In terms of schools' demographic makeups, schools that elected for virtual learning during the 2020-2021 school year are very different from in-person schools. They exhibit lower shares of white students by 38.22 percentages points and contain more low-income students by almost 13.623 percentage points. Meanwhile, hybrid-designated institutions are only statistically different from in-person schools' makeup through their share of white students enrolled, displaying lower shares by 8.22 percentage points.

Variable Means and Standard Deviations by Learning Mode: 2020-2021				
	Virtual	Hybrid	In-Person	Total
Instruction Share In-Person	0.026	0.409	0.935	0.366
Standard Error	(0.051)	(0.176)	(0.083)	(0.366)
Difference From Control Group (In-Person)	*-0.909****	*-0.526****		
High School Dropout Rate	2.901	3.098	3.315	3.064
Standard Error	(2.947)	(2.193)	(2.036)	(2.505)
Difference From Control Group (In-Person)	*-0.414*	*-0.217*		
High School 4-Year Graduation Rate	85.246	87.016	88.428	86.591
Standard Error	(12.992)	(8.779)	(6.896)	(10.483)
Difference From Control Group (In-Person)	*-3.182***	*-1.412*		
Student Enrollment - White %	51.030	81.030	89.250	71.760
Standard Error	(30.426)	(19.347)	(11.785)	(28.105)
Difference From Control Group (In-Person)	*-38.220****	*-8.220****		
Student Enrollment - Low Income %	51.265	37.855	37.642	43.384
Standard Error	(27.960)	(16.362)	(16.801)	(22.966)
Difference From Control Group (In-Person)	*13.623****	*0.213*		
Number of Observations	220	193	117	530

Statistically Significant Differences Marked By: *** p<0.01, ** p<0.05, * p<0.1

Table 2: Summary Statistics for the 2020-2021 school year, by treatment group

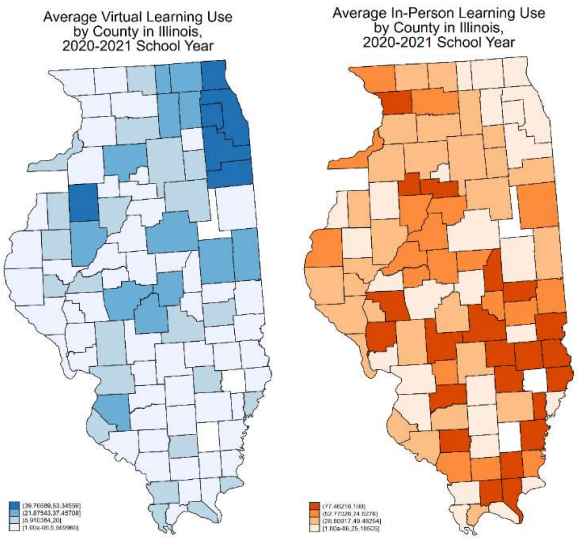
Furthermore, Table 3 compares the means and standard deviations for this study's variables of interest during the pre-treatment period (2012-2019). Crucially, one must understand that both hybrid and virtual schools demonstrate statistically significant dropout and graduation rates prior to Covid-19, indicating that the presence of virtual instruction allowed for convergence. Virtual and hybrid schools exhibited higher dropout rates by 0.742 and 0.327 percentage points, respectively, as well as lower graduation rates by 3.767 and 1.576 percentage points. Additionally, schools' demographics changed between pre- and post-treatment periods, on average. Both virtual and hybrid schools display statistically lower shares of white students and higher shares of low-income students, a stark contrast to virtual schools only being statistically different in both categories.

Variable Means and Standard Deviations by Learning Mode: 2012-2019				
	Virtual	Hybrid	In-Person	Total
High School Dropout Rate - Total	2.501	2.086	1.759	2.186
Standard Error	(3.449)	(1.989)	(1.633)	(2.655)
Difference From Control Group (In-Person)	*0.742***	*0.327***		
High School 4-Year Graduation Rate - Total	84.917	87.108	88.684	86.545
Standard Error	(11.394)	(9.327)	(7.553)	(10.018)
Difference From Control Group (In-Person)	*-3.767***	*-1.576***		
Student Enrollment - White %	47.698	83.875	91.464	70.773
Standard Error	(33.943)	(17.861)	(11.179)	(31.508)
Difference From Control Group (In-Person)	*-43.766***	*-7.589***		
Student Enrollment - Low Income %	52.194	36.901	35.727	42.992
Standard Error	(29.381)	(16.214)	(13.860)	(23.594)
Difference From Control Group (In-Person)	*16.467***	*1.174**		

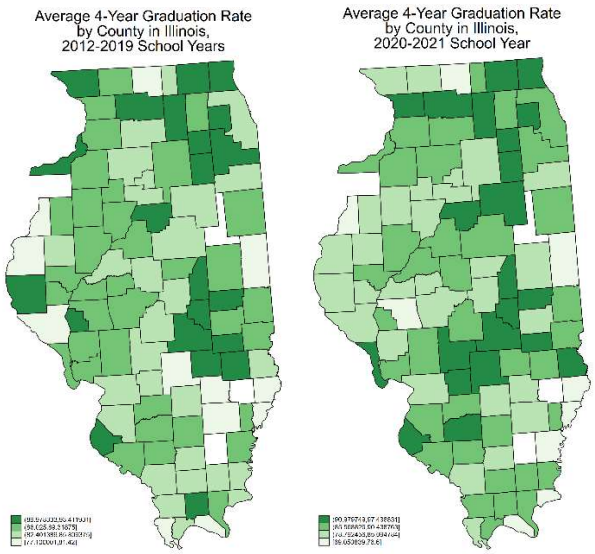
Statistically Significant Differences Marked By: *** p<0.01, ** p<0.05, * p<0.1

Table 3: Summary Statistics for school years 2012-2019, by treatment group

Figures 2-3 map the spatial variation in average educational policy by county, weighted by student enrollment during the 2020-2021 school year and two trends are apparent. Firstly, virtual learning is heavily concentrated in urban areas, as counties that surround Chicago are very dark, characterizing them as virtual-learning-heavy. Moreover, schools that primarily utilized in-person learning are found in Southern Illinois, indicating a rural-urban split in a school's chosen mode of instruction.

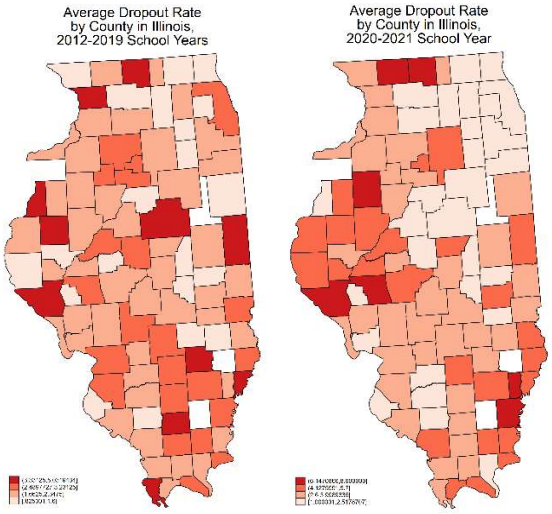


Figures 2-3: Average use of virtual and in-person instruction for the 2020-2021 school year, by county



Figures 4-5: Average Four-Year Graduation Rates for Pre-Covid and Post-Covid School Years, by County

Furthermore, Figures 4 and 5 display the spatial patterns for each Illinois county's average graduation rate for this data's pre-Covid years (2012-2019) and the post-Covid year (the 2020-21 school year). Few patterns are evident in these maps aside from counties directly outside of urban centers having the highest graduation rates – the darkest counties in the choropleth map surround the Chicago and Springfield areas. Temporally, there are few shifts between the pre-Covid and post-Covid eras, suggesting that county averages maintained relatively similar levels during Covid-19 and the switch to non-traditional learning modes.



Figures 6-7: Average Dropout Rates for Pre-Covid and Post-Covid School Years, by County

Likewise, Figures 6 and 7 offer a spatial analysis of the county-level average dropout rates for the pre-Covid and post-Covid periods. Unlike the four-year graduation rate, there are no spatial patterns to discern within these maps. However, there is a clear temporal shift between pre-Covid and post-Covid eras as the Chicago area experiences a relative decline in the dropout rate compared to the rest of the state. A connection may be observed between these schools' inclination towards virtual learning (Figure 2) and this relative decrease, though it is unclear if this is the product of the learning modes' causal effect.

VARIABLES	(1) In-Person Learning
Month-Year	0.009***
	(0.002)
Urban	-0.046
	(0.042)
Difference in Percentage Points	-0.293***
(Democrat)	(0.059)
Student Enrollment	-0.000***
	(0.000)
Student Enrollment White	0.000
	(0.001)
Student Enrollment Low Income	-0.003***
	(0.001)
Constant	-6.416***
	(1.579)
Observations	5,885
R-squared	0.202

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Linear probability model for the monthly occurrence of in-person instruction

Table 4 offers insight into which factors most influence a school's learning mode choice, as a descriptive linear probability model is run with this paper's monthly dataset. In-person learning, a binary variable that designates a school's choice to utilize in-person instruction during a given month, is this regression's outcome variable of interest. Its predictors contain a time

trend variable, allowing one to track how schools made decisions throughout the academic year, and demographic controls such as political alignment, the size of the school, and the ethnic and economic status of students. Schools are also designated as residing in an urban or rural county, as characterized by the United States Department of Agriculture.

Factors outside of a school's demographics distinctly affected schools' ability and choice to provide in-person instruction during the 2020-2021 school year. The month-year time trend variable facilitates the understanding that schools were more likely to progress to in-person instruction later in the school year. This finding makes sense, as the Fall of 2020 was characterized by new Covid-19 variants while high school students aged 16 and older were designated as eligible for the vaccine in the Spring. Furthermore, schools in counties that favored the Democratic party in the 2020 presidential election were more likely to remain virtual. Demographically, larger schools that contained more low-income students favored virtual instruction while the share of enrolled white students appeared to have no statistical impact on learning mode choice. Finally, a school's county's urban designation appears to have no effect on learning mode choice, though is generally associated with fewer white students, leaning towards the Democratic party, and containing more low-income students.

V. Empirical Framework

This paper will employ a difference-in-differences framework to estimate the effect of the various learning modes employed during the Covid-19 pandemic. The model is presented below:

$$Y_{it} = \beta_0 + \beta_1 Time_t + \beta_2 Virtual_i + \beta_3 Time * Virtual_{it} + \beta_4 Hybrid_i + +\beta_5 Time * Hybrid_{it} + \beta_6 D_{it} + \beta_7 L_{it} + \varepsilon_{it}$$

As previously discussed, the main outcome variables in this study are the dropout rate and the high school graduation rate, specifically the four-year graduation rate. This is important to recognize because most students plan on graduating within four years of entering high school –

by specifying the four-year rate, one can see how students' traditional educational journeys have been affected by the pandemic's educational shocks.

Schools have been divided into treatment and control groups based on the percentage of the year they spent using in-person instruction; $Virtual_i$ and $Hybrid_i$ are dummy variables which specifies a school's treatment group. The $Virtual_i$ variable refers to schools that utilized online instruction for 80 percent or more during the 2020-2021 school year while the $Hybrid_i$ variable identifies schools that used between 20 and 80 percent. $Time_t$ is a dummy variable that is zero before the onset of Covid-19 in 2020 and switches to one during the first full year of treatment: the 2020-2021 school year. It is important to note that this regression does not count data for the year 2020, as graduation requirements were reduced in Illinois, generating a bias towards completion. Ultimately, the interactions of the binary variables $Virtual_i$ and $Time_t$, as well as $Hybrid_i$ and $Time_t$ allow one to measure the average treatment effect of not using in-person instruction for the entire school year while graduation rates from the in-person control group will be captured by the constant.

The last two variables D_{it} and L_{it} are control variables that account for characteristics of a school that are predictors of the graduation rate or dropout rate. D_{it} represents the percentage of a school's enrollment that is white, as Heckman and LaFontaine (2010) note that white and minority students have different graduation rates – a school's demographics are a great predictor. Additionally, L_{it} accounts for the percentage of low-income students that compose a school's enrollment[1] (2010). Low-income enrollment acts as a predictor because it measures students' financial capacity to access resources outside of school, in addition to the services a school can

[1] The Illinois Report Cards define low-income students as those who "receive or live in households that receive Supplemental Nutrition Assistance Program or Temporary Assistance to Needy Families benefits; are classified as homeless, migrant, runaway, Head Start, or foster children; or live in a household where the household income meets the U.S. Department of Agriculture income guidelines to receive free or reduced-price meals."

provide, while also reflecting labor market conditions that might affect their household income and decision-making.

VI. Results

Table 5 provides estimates for the various levels of virtual learning's effect on the high school four-year graduation and dropout rates. The difference-in-difference specification posits that schools which used virtual learning for the entirety or near-entirety of the 2020-2021 school year experienced higher four-year graduation rates by around one percent, though this difference is not significant. Hybrid schools experienced a similar relationship as they exhibited higher

VARIABLES	(1) 4-Year Graduation Rate	(2) 4-Year Graduation Rate	(3) Dropout Rate	(4) Dropout Rate
Time	0.161	0.375	1.473***	1.343***
	(0.609)	(0.633)	(0.175)	(0.147)
Virtual	-0.129	0.753	0.157	-0.108
	(0.685)	(0.855)	(0.162)	(0.156)
Time*Virtual	1.083	0.974	-1.091***	-1.017***
	(0.765)	(0.730)	(0.245)	(0.171)
Hybrid	-1.287**	-1.288	0.300***	0.429***
	(0.532)	(0.803)	(0.099)	(0.156)
Time*Hybrid	0.101	0.006	-0.517**	-0.569***
	(0.791)	(0.755)	(0.211)	(0.203)
White Student Enrollment	0.006	0.015	0.004	0.003
	(0.015)	(0.021)	(0.003)	(0.003)
Low Income Student Enrollment	-0.211***	-0.243***	0.047***	0.049***
	(0.013)	(0.017)	(0.003)	(0.003)
Constant	95.695***	95.929***	-0.264	-0.237
	(1.620)	(2.314)	(0.301)	(0.367)
Weighted by Student Enrollment	NO	YES	NO	YES
Observations	4,664	4,664	4,689	4,689
R-squared	0.248	0.421	0.162	0.286

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Primary Difference-In-Differences Specification Results

graduation rates than their in-person counterparts by around 0.1 percent post-covid, though this change is not significant either. The use of weighting schools' graduation rates by their

enrollment to attain a better estimate in the aggregate offers no additional insight, as all estimates are very similar; the only real difference is the notion of hybrid schools having no significant differences in the outcome variable compared to schools that were in person for most of the year.

Contrary to the graduation rate, an analysis of the dropout rate brings one to the conclusion that greater use of virtual instruction during the pandemic school year resulted in more favorable outcomes for students. Schools that opted for more virtual learning experienced lower dropout rates by around 1 percentage point compared to the control group. Similarly, hybrid schools experienced lower dropout rates than the control group by a lesser extent: only by a margin of around .5 percentage points. The use of weighting by enrollment offers only marginal differences in this study's coefficients of interest – the weighted difference-in-difference interaction terms for the virtual and hybrid groups are both within 0.1 percent of their initial coefficients. However, these estimates are significant at the one percent threshold, suggesting that dropout rates were much more sensitive to a school's learning mode choice than graduation rates.

When describing these differences as "more sensitive," one notion must be made clear: virtual learning did not prompt students to drop out but worked as a vehicle to keep students in school. Making schooling more accessible to students during the pandemic allowed fewer students to drop out, which is made plain in this experimental framework. However, the lack of change in graduation rates due to altered learning modes might speak to the clunky, nonintuitive nature of nontraditional education during the pandemic. One would assume that fewer dropouts might boost graduation rates, but the absence of this occurring supports the claim that virtual learning is characterized by learning loss and that the mass change in learning modes by brick-and-mortar schools was inefficient. After all, graduation does require a certain level of

demonstrated knowledge while the dropout rate is not subject to that constraint, which is reflected in this primary specification. Therefore, it can both be true that nontraditional learning methods limited students' knowledge retention and provided greater accessibility to students.

However, it is also entirely possible that these results do not speak to the effectiveness or efficiency of nontraditional, virtual learning modes, but rather the accessibility that is the by-product of the learning modes or the time period. As discussed in the literature review, teachers' standards were lower during the pandemic, to which these positive outcomes are attributed. Instead of penalizing likely dropouts for their truancy or low academic performance, these numbers might reflect teachers' leniency and increased acceptance regarding their grading and classroom policies – the lower standards that were a side effect or byproduct of altered learning modes might be the driving forces behind the reduced dropout rates. This would allow for fewer dropouts but no gains in the graduation rate, as students who would not graduate anyways were still retained by schools. Therefore, these results describe decreases in the dropout rate for schools which used higher degrees of nontraditional education, but it is highly plausible that the source of this change may be the product of teachers' increased flexibility and lower standards within their classrooms instead of innate characteristics of atypical instructional methods.

Fortunately, this model's control variables also reflect the economic theory that was outlined in the literature review, alluding to this experimental framework's efficacy. Although no significant differences in effects on the graduation and dropout rates are suggested by a school's share of white students, the number of low-income students a school contains clearly affects this paper's variables of interest. This model asserts that greater shares of low-income students lead to significantly lower graduation and higher dropout rates, likely derived from fewer resources to aid students' education during and outside of class.

Because this difference-in-differences framework only contains one year of post-treatment data, the specification was run two additional times using different treatment periods as a falsification test. Ideally, the interaction terms in these specifications would yield no statistical significance, asserting that the treatment year's graduation and dropout rates remained consistent to pre-pandemic trends. This occurrence would ensure that the pre-treatment periods observe parallel trends and that the initial results are able to be accurately interpreted. Table 6 displays the primary specification's coefficients of interest (the interaction terms) using 2018 as the treatment year. Table 7 displays the same process using 2019 as the treatment year.

VARIABLES	(1) 4-Year Graduation Rate	(2) 4-Year Graduation Rate	(3) Dropout Rate	(4) Dropout Rate
Time (2018) *Virtual	-1.164*	-0.551	-0.277*	-0.335**
	(0.673)	(0.591)	(0.160)	(0.143)
Time (2018) *Hybrid	-0.710	-0.457	-0.113	-0.362**
	(0.652)	(0.591)	(0.144)	(0.148)
Weighted by Enrollment	NO	YES	NO	YES
Observations	3,653	3,653	3,674	3,674
R-squared	0.240	0.416	0.146	0.299

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Difference-in-Differences Framework using 2018 as the Treatment Year

The falsification test's results inform one of the primary specification's lack of interpretability. Although the "post-treatment" graduation rates for treatment years 2018 and 2019 are mostly insignificant, there are similar trends in the dropout rate to this paper's initial results, particularly if the treatment had occurred in 2018. These findings dilute the effect of learning modes on dropout rates, as schools who selected into treatment were already experiencing decreased dropout rates compared to the rest of the state. Therefore, the 2020-2021 school year's changes in the graduation and dropout rates can be partially viewed as a

continuation of previous years' trend, alluding to a break from parallel trends, and not entirely attributed to learning mode choice.

Nevertheless, the magnitudes of the interaction terms for the primary specification require some interpretation, as the change in dropout rates prompted by learning modes for hypothetical treatment years 2018 and 2019 are much closer to zero than the primary specification. For instance, "virtual" schools in 2018 experienced dropout rate reductions of between 0.277 and 0.335 percentage points compared to the full percentage point that is suggested in the initial regression. This increase in magnitude for the 2020-2021 school year suggests that there may have been an effect on dropout rates attributable to learning mode choice, but the falsification test asserts that any effect is overestimated because of the selection bias present and pre-existing dropout rate trends.

VARIABLES	(1) 4-Year Graduation Rate	(2) 4-Year Graduation Rate	(3) Dropout Rate	(4) Dropout Rate
Time (2019) *Virtual	-0.675	0.065	0.183	-0.194
	(0.713)	(0.667)	(0.257)	(0.258)
Time (2019) *Hybrid	0.756	0.535	-0.099	-0.295
	(0.684)	(0.664)	(0.231)	(0.255)
Weighted by Enrollment	NO	YES	NO	YES
Observations	4,172	4,172	4,195	4,195
R-squared	0.246	0.420	0.227	0.372

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Difference-in-Differences Framework using 2019 as the Treatment Year

To ensure that the relationships defined in this paper's primary specification hold, a two-way fixed effect model, using school and year fixed effects, was applied to this data context while also including changes in Illinois' minimum wage. This model has an advantage over the previous model in that it allows one to recognize continuous differences in the intensity of the specific learning modes applied within a school. However, its main disadvantage is that its

structure imposes a linear relationship between this paper's outcome variables and the extent of learning mode use by schools. The two-way fixed effect regression was run twice for each outcome variable, once weighted by a school's total enrollment and once without weights.

VARIABLES	(1) 4-Year Graduation Rate	(2) 4-Year Graduation Rate
Percent Virtual Instruction	2.807***	2.948***
	(1.001)	(1.020)
Percent Hybrid Instruction	0.891	1.912**
	(0.851)	(0.771)
Enrollment Share White Students	0.037	0.084***
	(0.042)	(0.027)
Enrollment Share Low-Income Students	0.003	0.002
	(0.019)	(0.017)
Minimum Wage	0.684***	0.747***
	(0.245)	(0.233)
Constant	74.138***	70.801***
	(4.267)	(3.453)
Weighted by Enrollment	NO	YES
Observations	4,664	4,664
R-squared	0.659	0.822

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Results from a two-way fixed effect specification regarding the graduation rate

Table 8 provides analysis of virtual learning's effect on the 4-year high school graduation rate from the perspective of the two-way fixed effect model. When weighing schools' graduation rates by their enrollment level, the model proposes that schools that used virtual learning for the entire year exhibited higher graduation rates by 2.948 percentage points compared to schools that were only in person. Even when not weighted by enrollment, a positive relationship is found between the use of virtual learning and graduation rates: schools that used virtual learning for the entire 2020-2021 school year are expected to have experienced higher graduation rates by 2.807 percentage points than fully in-person schools. Critically, these differences are significant at the one percent threshold, asserting that a relationship does exists between a school's use of virtual

learning and the graduation rate, as more virtual learning is associated with elevated graduation rates in schools which employed it. Conversely, the fixed-effect model only finds significance at the five percent threshold for hybrid instruction in the weighted specification. Weighting schools by enrollment clearly emphasizes the impact of hybrid instruction, but the overall specification provides conflicting results regarding the impact of hybrid learning modes, limiting possible interpretation of an effect.

Additionally, Table 9 discusses the relationship between a school's learning mode choice and their dropout rate. Like the primary specification, there is a negative relationship between a school's use of virtual learning and their dropout rate. Specifically, the weighted regression highlights that schools that used virtual instruction for the entire year were expected to have a lower dropout rate by 1.606 percentage points compared to schools that used in-person instruction full-time. Similarly, the unweighted regression estimates this difference to be a decrease in the dropout rate by 1.633 percentage points.

Like the graduation rate in this specification, these relationships are significant, implying that there is a clear relationship between a school's use of virtual learning and the dropout rate – the use of virtual learning during the Coronavirus pandemic resulted in lower dropout rates compared to those who remained in person. However, the consistency in statistical significance between models allows one to recognize that the dropout rate remains more sensitive to virtual learning than the graduation rates. However, this model suffers from lack of consistency with economic theory as the results imply that more shares of white students lead to higher dropout rates. This great divergence from theory is attributed to this model imposing a linear relationship between learning mode choice and the dropout rate, which may not be realistic. One must also draw from the primary specification's findings, as the learning modes might not be affecting

educational outcomes: schools that select into virtual or hybrid learning modes may just be experiencing lower dropout rates and higher graduation rates unrelated to learning mode choice.

VARIABLES	(1) Dropout Rate	(2) Dropout Rate
Percent Virtual Instruction	-1.633***	-1.606***
	(0.253)	(0.256)
Percent Hybrid Instruction	-0.740***	-0.892***
	(0.226)	(0.212)
Enrollment Share White Students	0.009	0.019**
	(0.013)	(0.007)
Enrollment Share Low-Income Students	0.007	0.010**
	(0.004)	(0.004)
Minimum Wage	0.538***	0.532***
	(0.065)	(0.066)
Constant	-3.676***	-4.347***
	(1.108)	(0.836)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Results from a two-way fixed effect specification regarding the dropout rate

VII. Limitations

Ultimately, this paper suffers from many limitations, mostly related to the data collection and quality. For one, the control group of this study is not representative of the treatment groups. The summary statistics highlight key differences in the control and treatment groups' characteristics, specifically the disparity in white and low-income student enrollment shares between the virtual and in-person groups. Additionally, a geographic disparity is present as no schools in the control group reside within the Chicago metropolitan area, so virtual learning policies implemented on a large scale such as those enacted by Chicago Public schools are not accounted for. These imbalances bias this paper's primary specification as the control and treatment groups are innately different, bringing into question this study's internal validity.

Selection bias is also present in this model's primary specification. The falsification test robustness checks provide insight into the perpetuation of pre-treatment trends within treatment groups, lessening the impact of any possible causal findings. This alludes to schools who were experiencing comparable processes selecting into similar treatments, so the treatment effect may be indistinguishable from the pre-existing trends. The reduced causality of this paper's findings is also the product of only having one post-treatment year in a difference-in-differences framework. More post-treatment data would allow for a greater sample size of non-traditional learning modes and a more accurate average treatment effect, but Illinois schools transitioned back to in-person instruction for the 2021-2022 school year, eliminating the possibility of and extended post-treatment period.

Furthermore, economic and political indicators such as the unemployment rate and party vote shares in the 2020 presidential election are not available at the school-boundary or school-district level, thus prompting this study to either use estimates at the county level or disregard them entirely. Had these data been available at this paper's unit of analysis, the models employed in this study could have been more descriptive and might have more accurately reflected the causal relationships between virtual instruction and a student's choice to drop out. When larger units of analysis were used for the political data, schools' societal contexts were incredibly generalized, which might not have been constructive to this paper's purpose. More specific data at a school-level unit of analysis would allow this paper to provide more insight on the individual choices that a student makes to stay in school or drop out. Ideally, this study would have utilized student-level data to estimate the effect of learning modes on individual educational choices, better explaining learning modes' effect on labor market outcomes associated with graduating or dropping out, but the data restrictions already required to generalized outcomes.

It is also critical to consider that one school's use of virtual hybrid learning is not consistent with other schools' use in the dataset. A wide spectrum of virtual learning may be implemented within and between schools, pointing to the different technologies and resources that schools might use to benefit their students. For instance, virtual instruction may be implemented in a synchronous setting in which all students tune in to their teacher's zoom call while the content is delivered live. Asynchronous structures might also be used, where instruction and assignments are given to students in advance, flexibly allowing for students to complete their coursework on their own time. This variability in virtual learning styles is not reflected in the data from the covid school data hub, so this paper must treat virtual instruction as a monolith. More insight into school implementation would be incredibly useful, as this paper would then be able to determine which styles of online learning are best for students staying in school.

VIII. Conclusion

This paper finds evidence of schools with higher percentages of nontraditional learning modes during the 2020-2021 school year experiencing decreasing dropout rates and negligible, though positive trends on the four-year graduation rate. One possible reason for this outcome is the ability of virtual learning to make schooling more accessible to students, especially during a pandemic in which outside opportunities and alternatives are limited, with another possible reason being the accessibility and lower standards in the classroom that are a byproduct of the nontraditional learning modes and pandemic-era education. However, these experiences may also be the result of selection bias, where schools with similar graduation and dropout trends select into treatment, making their innate qualities and similarities the driving factor rather than learning mode choice. This conflicting result signals to future policymakers that nontraditional learning modes may be able to increase ability of schools to retain students that would otherwise dropout in the hopes of greater retention leading to more diplomas earned, but future research is

required to determine if a causal effect is present. However, past studies have established that the presence of nontraditional learning modes during the pandemic resulted in increased learning loss and lower test scores, so some negative educational outcomes must be considered (Halloran et al, 2021). Future studies should extend this analysis to other contexts, as Illinois' distribution of learning modes may not result in applicable findings for other states, and an examination of future years' five- and six-year graduation rates might provide more insight into student alternatives to graduating in four years or dropping out.

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