A Natural Experiment in High School Education:
The viability of remote learning as told by COVID-19 in Texas
Research Proposal

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Overview

- Intended Audience: Texas Education Agency, and the schools that participate in the study.

In early 2020, a novel virus known as COVID-19 ravaged the world, slowed down our lives, and changed the way most individuals live. The phase we have entered, often referred to as "the new normal," made its way into high school education in the United States in the form of remote learning. Schools had to find the resources to transition to online learning, and students had to adjust to a new way of life and new methods of development. However, we have learned enough by now to know that older students typically do better than younger students in an online environment. We also see as students progress from Elementary to Middle to High school that class sizes increase and schools quickly overcrowd. Therefore, we are looking to discover if remote learning, or hybrid learning, can become a viable alternative to in-person instruction to mitigate overcrowding and large class size in high schools.

COVID-19 is a natural experiment that allows us to study the impact of remote learning on students. Where previously it was a rare choice for high school students to engage in remote education, it is not uncommon now as states across the country attempt to combat rising COVID-19 numbers. The results of the study will provide high schools insights on performance, and how remote learning has impacted the education system. The intended audiences of the study are school boards and state governments. There may be actions that the US education department should take if it is proven that remote learning slows the population's development. If remote learning proves viable, it could become a new normal for students going forward, providing them access to increased educational opportunities and better performance. On top of this, it could be a way to provide underserved populations and remote communities better access to education.

Research Question

Our main research question is:

- Is remote learning a viable alternative to in-person education for high school students?

Not every student has the same conditions to successfully perform academically. The persistent achievement disparities across income levels and between minority groups could affect the learning gap even more. School shutdowns could not only cause disproportionate learning

losses for these students—compounding existing gaps—but also lead more of them to drop out. This could have long-term effects on these children's economic well-being and on the US economy as a whole. Hence, to understand the distinct type of instructions in different groups, we are proposing the following questions:

- What student populations perform well with remote learning? We will analyze this by: Age groups, gender, Race / ethnicity, income groups, academic status (Special Education (SPED), school classification (Public, Private, Charter)

- Does a hybrid approach, where students can sometimes attend school in person, make a difference in student performance?

Data

This study will collect data from individual schools about each grade/year offered within the school. We plan to work with school data managers and administrators to collect 5 years of historical data as well as school data from the current calendar year. Many schools can generate reports relevant to many of the variables we are considering in our study through their school management software. The data collected from each school will be standardized into one format for study use.

We anticipate that schools will be willing to participate in the study as this is an area of concern for many schools and we can offer the data analysis results to them free as a result of their participation in the study. Hence, the data would have no cost to collect.

While we anticipate schools will participate, however, if a school declines to participate we may add additional schools to our sample to maintain statistical power. Schools who decline to participate at the start of the study will be retained as missing and we will report out the rate of missing data after the study. The rate of missing data will be calculated as x/n where n is the total sample size including schools that declined to participate and x is the number of schools that declined to participate. Schools that pull out of the study before completion will not be replaced.

We will also acquire COVID-19 data from publicly available data sources (The New York Times[1] and The Homeland Foundation Infrastructure Data[2]) to assess the impact of COVID-19 within the regions sampled during the time period studied.

Since the data collected for this study contains information about minors, we will provide all participant schools with an informational handout to distribute to the school community about the study. The data collected will not contain any identifying information for students and will not be collected at an individual student level. The lowest level of data collection will be grade-level data. All data collected will comply with the Family Educational Rights and Privacy Act (FERPA)

laws. In compliance with FERPA, participating schools will sign a consent form detailing what data will be collected and how their data will be used.[3]

Study Design

For our research design, we propose a longitudinal interrupted time series quasi-experimental design. We anticipate a large number of missing values for summer data. This time period will not be included in the analysis.

Stratifications in the sample:

- COVID-19 Impact/Regional Strata[1]: Harris County (Low Impact), Dallas County (Medium Impact), El Paso County (High Impact)
- Second Strata: Grade Level (9th, 10th, 11th, 12th)
    - Within each school, data will be collected for each grade level

Each COVID-19 impact/regional strata will contain schools that are quasi-randomly assigned one of three treatments as shown in Figure 1.

Pre-intervention Period:

- 5 years of historical data broken down by quarter for class/grade level per school before COVID-19 pandemic. A total of 19 data points from quarter one 2016 to quarter three 2020.
- Establish baseline trends for comparison with post-intervention data.

Post-intervention Period:

- 20-21 school year data after COVID-19 pandemic and learning modes implemented
- Quarter 4 of the 19-20 school year will be assessed to determine if it should be included in the study. We anticipate that this quarter will be an outlier and should not be included since the implementation of learning modes was inconsistent and a wide array of grading policies will impact data comparisons.

Interventions:

Interventions considered here are assigned by a random natural event - In this research's case, the COVID-19 pandemic forced school decisions.

- COVID-19 Impact
- Learning modes
    - Remote Learning: Online-only learning within a school
    - Hybrid Learning: Any mix of in-person and remote learning for student groups. Example: Students split into groups A/B. Groups A and B alternate in-person and remote learning each week.

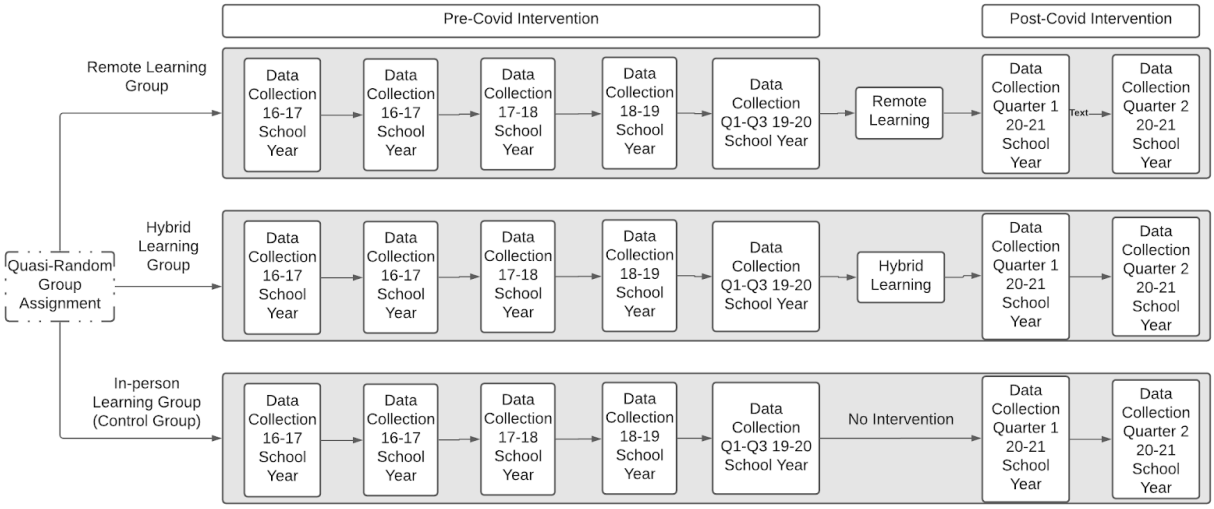


Figure 1

Visualization of longitudinal interrupted time series quasi-experimental design for each regional COVID-19 level. Breakdown of pre-COVID-19 intervention time periods, interventions and post-COVID-19 intervention time periods.[3]

Phase 1 Experiment:

- Compare pre-intervention historical trends to 20-21 first quarter grading period post intervention data within each school across grade levels and as a whole school trend.
- Analysis overall trends within COVID-19 and learning mode treatment groups and compare between COVID-19 and learning mode treatments.

Phase 2 Experiment:

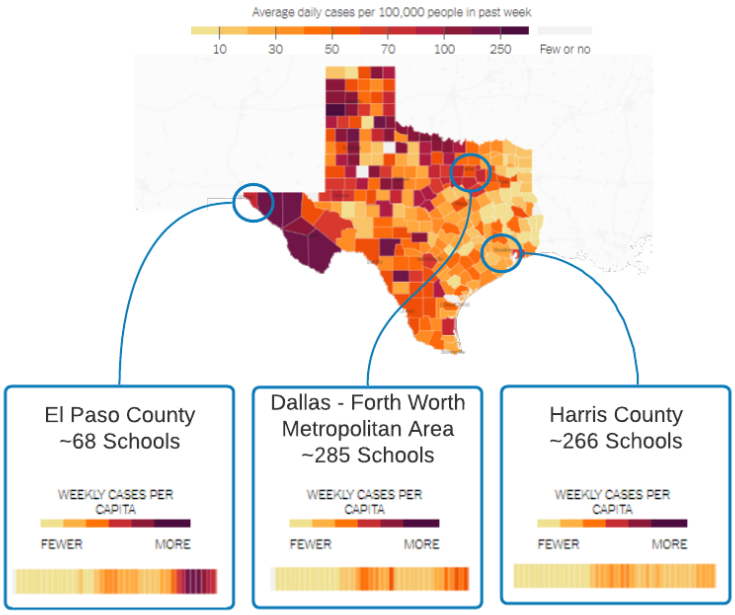
- Compare pre-intervention trends and initial post intervention trends with continuing trends in subsequent grading period during the 20-21 school year.
- An additional variable will be added to track schools that have transitioned between learning modes. Any transition combination will be considered. Additional comparisons will be made between schools that followed the same transition pathway (i.e. remote -> hybrid).
- Ideally, we will be able to consider multiple schools within transition pathways to reduce bias but that may not be possible due to outside influences.

See Statistical methods for further details on comparison methodology.

Sample

To help us answer these questions we will be looking at three distinct regions within the state of Texas at different levels of COVID impact. We choose a regional stratification sampling method of the schools in the state according to the total student enrollment in metropolitan areas that are experiencing different levels of COVID impact.

We based our selection of metropolitan areas by following the latest Texas coronavirus map and case count. Since the beginning of the pandemic there have been over 1,300,000 cases and 23,000 deaths in Texas. From which Harris county, Dallas-Fort Worth and El Paso are the top three counties in number of total cases, however, as you can see in the heat map below, the average daily cases per 100,000 shows these three areas represent different levels of impact.



Therefore, as a sampling frame we selected Harris-Houston county, Dallas–Fort Worth metropolitan area, and El Paso county as metropolitan sampling areas with low, medium, high COVID levels respectively.

Roughly the breakdown for the area:

Harris County has a population of 4.7 million and we are considering about 270 schools. 50% of schools in the sampling frame will correspond to Harris county. This will represent around 58% of the population of the sample.

The Dallas–Fort Worth metropolitan area represents a population of 6,3 million and has 285 schools. Around 37% of schools in the sampling frame are in Dallas county and represent ~32% of the population of the sample.

El Paso County has a population of about 800000, with around 68 schools. Around 13% of schools in the sampling frame will correspond to El Paso county. This represents about 10% of the population sample.

A list of schools and their quarter 1 learning mode will be generated for each county. A proportionate number of schools will be selected from each county to represent the portion of

schools in each county as you can see in the donut chart. 21 schools from El Paso county, 57 from Dallas county, and 75 from Harris county. Within each county's sample a proportionate number of schools from each learning mode will be selected.

Variables and/or Intervention

Interventions for this study are assigned by a random natural event - In this research's case the COVID-19 pandemic forcing school decisions. While the main focus of this proposed study is the learning mode intervention we acknowledge the COVID-19 pandemic in also an ongoing intervention. This intervention will also be monitored and analyzed as outlined in previous sections.

<table>
<tr><th colspan="2">Main Comparison Variables</th></tr>
<tr><td>Class/Grade Level
Number of students failing at least one course by class/year per quarter broken down by:
Gender, race, SPED/non-SPED, income category
Number of courses a student is failing by class/year per quarter
Number of students failing 1 class
Number of students failing 2 classes
etc.</td><td>COVID-19 Regional Level Data:[5][2]
COVID-19 cases
Total COVID-19 deaths
ICU headroom used</td></tr>
<tr><th colspan="2">Supplemental Variables</th></tr>
<tr><td>School Level Data:
School Name
School calendar year
Grading period
School classification (Public, Private, Charter)
Total Enrollment
Demographic Breakdowns: Age, Gender, Race, Household Income
Title I status (yes or no)
Percent of SPED students</td><td>Class/Grade Level Data:
Enrollment by class/grade
Average class size
Chronic absence rate
Suspension and expulsion rate
Quarterly drop out rate</td></tr>
</table>

Statistical Methods

This research is proposed to be conducted as a longitudinal study with each study group identified from the sampling-frame represented as longitudinal data.

- Longitudinal data represents values of variables measured on an unchanging sample at regular intervals over a defined period of time.
- Each group - the control and the intervention, would have its own time-series data which captures its trends that this study is interested in.
- By evaluating the difference in trends between the two time-series, a conclusion about how the intervention affects the outcome will be ascertained.
- To evaluate the difference in trends between the control and treatment group, this study intends to use the Difference in Differences technique(DiD)[6].
- The DiD analysis would also allow for arguments to be made about whether the intervention simply causes a constant effect over the outcome, or if there is a temporal mechanism which continues to have a scaling effect on trends.

Potential Risks

Potential risks and threats to validity, and how they will be addressed, are described below:

1. COVID-19 - potential threat to validity: Since a random natural event caused the intervention to occur, the event (COVID-19) introduces risk to the conclusions found in this study. It could cause, for example, students to get sick or not to be able to continue their studies because of their parents losing their jobs or health. Besides, Data for potentially the last half of the 2019-2020 school year and especially the last quarter of that year will be different with lots of variability due to various school reactions to the initial onset of COVID-19. For instance, some schools cut off grading and new material in March and did not enter true remote learning until the 2020-2021 school year.
    - Hence, in order to increase the validity, it is recommended that the study be continued after COVID-19 subsides, in order to have an accurate comparison without a random effect on the intervention.
2. Variations in Schools introduce bias to the research: Public, private, charter schools may be different sizes, while don't all have the same structure i.e. year round schools, trimester schools. We may also run into the scenario where a learning mode is not present in a county. In addition, schools that didn't exist are missing data for historical years.
    - Therefore a timeline for sampling will be defined for comparison, and we will also include the exception cases in which schools didn't exist in the study to not miss out on the opportunity to get data from those schools and environments. For schools with different structures, evaluating them as a whole school year would be fair to avoiding time differences and study load differences.

Deliverables

- Phase 1: December 2020 - January 2021
    - Collect data and compare pre-intervention 5-year historical trends to first grading period post intervention data within each school. Note that this analysis of trends is done within the same school groups, which are remote learning school groups, Hybrid school groups, and in-person school groups.
- Phase 2: February 2021 - March 2021
    - Compare pre-intervention trends and initial post intervention trends with continuing trends in subsequent grading period during the 20-21 school year.
    - Evaluations within schools that have transitioned between learning modes will be conducted, and any transition combination will be considered. Additional comparisons will be made between schools that followed the same transition pathway (i.e. remote -> hybrid).
- Final deliverable will be giving the result of efficiency of different learning modes, especially whether remote learning is a viable option in future education. Since we included hybrid learning in the study, the analysis will imply the difference that hybrid approach makes for student success.
- Looking further into the purpose and research question of the study, it's necessary to continue this study after COVID-19 subsides because of the noise and bias that pandemic could introduce to the conclusion. One complete semester or school year will be tracked after COVID-19 settles and when school and students can really make independent and free decisions regarding the learning modes. Timeline for this part will depend on COVID-19 settling date for the areas this study focuses, and one semester or school year will be required for observation and analysis.

Next Steps

Ideally, this study should continue after COVID-19 settles in order to reduce the noise and bias that pandemic could introduce to conclusions about student's performance with different instruction methods.

Should phase I and phase II analyses show hybrid/remote learning are viable options, schools could be more easily persuaded to continue piloting remote learning in a post COVID environment for a semester or year. The start of the study expansion would depend on when people get vaccinated in the studied regions.

Phase III analysis would be similar to phase II, but it would compare pre-intervention trends with continuing trends in a post-vaccine period. Pilots should be designed such that we have enough volume to track the distinct pathways. Since this would be a controlled experiment, bias due to outside influence would be less compared to phase II.

Depending on the results found in phase III, a strategy with different instruction methods could be designed so that education reaches more people and academic performance is optimized among the groups analyzed.

Statements of Contribution

- Aline Jaimes: Wrote sample section research design and presentation
- Heather Pieszala: Contributed to Data, Variables/Interventions, Potential Risks sections. Wrote overview in research design. Created and delivered overview and research questions slides in presentation.
- Laurie Cuffney: Wrote Data, Study Design, and Variables/Interventions sections. Developed infographics for sample and study design slides. Created and presented Study Design slide.
- Natali Ojeda Meneses: Contributed writing Research Question, Data, and Variables/Interventions. Wrote Next Steps Sections. Created and presented slides, including next steps infographic, about 'What do we need to answer the questions" (Data & Variables/Intervention) and "How can we expand on the study?" (Next Steps).
- Rakesh Walisheter: Researched and Write up for Statistical methods used in research design and corresponding presentation.
- Yu Bai: Wrote potential risks and deliverables sections in research design. Created and delivered corresponding slides in the presentation.

Entire team: Worked to narrow down broad proposal into remote education impact, with COVID-19 as a natural experimental element that allowed this study to occur. Collaboration and discussion was performed as a group on each section.

References

(1) https://www.nytimes.com/interactive/2020/us/texas-coronavirus-cases.html
(2) https://hifld-geoplatform.opendata.arcgis.com/datasets/hospitals
(3) https://www2.ed.gov/policy/gen/guid/fpco/ferpa/index.html
(4) https://www.tandfonline.com/doi/full/10.1080/13645579.2018.1488449
(5) https://github.com/nytimes/covid-19-data/
(6) https://en.wikipedia.org/wiki/Difference_in_differences
(7) https://github.com/nytimes/covid-19-data/tree/master/colleges
(8) https://www.nytimes.com/interactive/2020/us/texas-coronavirus-cases.html