*Abstract*

The goals of this report are to analyze and present how the COVID-19 pandemic affected K-12 education in the United States. Utilizing data-driven insights and visualizations, we'll showcase the main challenges faced by students and teachers due to the pandemic. We'll also pinpoint key areas needing improvement to make the education system stronger in the future.

*Introduction: Hypothesis*

In the wake of the COVID-19 pandemic, the landscape of education in the United States underwent a profound transformation. Months of school closures and reliance on hybrid learning prompted numerous agencies to collect data on K-12 education during the pandemic. This project sets out to examine this data and expose just how much the US education system was impacted by the events of the last few years. The disruption caused by school closures provokes a hypothesis that suggests a severe decline in US education standards. This report anticipates the data to show declining student exam scores, uptick in students’ use of technology in classrooms, spikes of teachers quitting, and unfilled teacher vacancies throughout the K-12 education system.

*Sources, Related Work and Expectations for Data Visuals*

To investigate this hypothesis, this final project will mostly draw upon datasets primarily sourced from the National Center for Education Statistics (NCES), as well as data collected from IES (Institute of Education Sciences), BestColleges.com, and Statista. It is noteworthy to mention that both NCES and IES have published their own collaborated reports on issues in public education post-pandemic. These reports, otherwise called their “School Pulse Panel”, will be extremely useful for drawing data in our project, as well as for pinpointing the optimal datasets to examine (since these datasets contain minimal amounts of missing values and have been scrutinized by multiple professionals for inconsistent errors). Accordingly, this final project is an explanatory, application-based report that will guide the audience through six different dashboards of data visualizations. Each of these six stages will require the utilization of multiple datasets, as well as the cleaning and formatting of these datasets in Excel. Please note that the datasets sourced from NCES and IES have been duplicated into new files to safeguard the integrity of the original data. Additionally, much of the data in these files has been cropped and transferred into self-assembled worksheets to optimize their compatibility with Tableau. Through these formatting and cropping processes, we aim to reduce the number of data sources within a single Tableau file from 30 to 10. Also, all the visuals presented in the final dashboards were generated using either Tableau or Python’s Matplotlib. Through these compelling data visuals, the report seeks to shed light on the disparities and challenges faced by students and educators in the aftermath of the pandemic. Ultimately, the anticipated findings aim to underscore the pressing need for major changes and updates to the quality of United States education.

*Dashboard 1: Comparison of Standardized Exam Scores*

In the first dashboard, titled “United States Education Crisis”, we see two separate line charts comparing the average nationwide SAT and ACT scores each year. The sources for the data presented in these line visuals came from NCES and BestColleges.com. Strikingly, the first line chart underscored a severe drop in both Math and ERW (English, Reading and Writing) results in 2023 for high school students. However, it is worth noting that this major decline did not begin right away in 2020, the year of the pandemic. In 2021, SAT results seemed to have bounced back from the drop evident in the 2020 lockdowns, increasing both Math and ERW scores by as much as 5 points. One explanation for this bounce back could be that the 2021 class of students were not as affected by the COVID lockdowns as the grades prior, because many of these students had already completed the necessary courses required for the SAT exam. This same explanation cannot be translated though for the 2022 and 2023 class of students. Following 2021’s slight scores boost, the subsequent class of students were burdened by the SAT exam, causing both Math and ERW scores to drop to their lowest levels in 5 years. Clearly, the information these students missed out on during the 2020 pandemic hampered their knowledge for the SAT exam. The most important classes that these students had to take for the SAT exam fell right during the 2020 COVID lockdowns. Additionally, when looking at the second line graph portraying ACT results by year, this animated chart painted an even more bleak picture. According to the Math and Science ACT results, as the animated chart flips through each year, it becomes clear that students did not experience any sort of boost in their scores immediately following the pandemic in 2021. Both the Math and Science curves were decreasing every year, and the decline became even more pronounced after 2019. Considering that SAT and ACT results were at their lowest levels in half a decade, this already emphasized just how much K-12 education had been impacted by COVID. The true effects of the pandemic are now being evidenced at full form in the education system.

*Dashboard 2 Part 1: Current State of Teachers in the US*

After reviewing two prominent standardized tests in the previous dashboard, the next dashboard delves into the “Current Condition of Teachers in the United States”. In this dashboard there are three distinct visuals: a scatter plot, text table, and symbol map. The scatter plot, positioned at the top, illustrates a grid representing average teacher salaries on the y-axis and the percentage of teachers relocating to different schools in 2022 on the x-axis. The 50 black stars in the plot correspond to the 50 states, each positioned based on its average teacher salary and the percentage of teacher movers. Additionally, a red line spans the visual, displaying the average salary for teachers in the United States. This red line simplifies the audience’s analysis of the graph by distinguishing states that have low versus high salaries for their teachers. Accordingly, observe in the scatter plot how nearly all the states located in the right-hand corner of the visual have salaries that fall well below this red average salary line. Furthermore, note the discernible negative correlation in the scatter plot, as indicated by the yellow trend line, illustrating that states with lower average teacher salaries tend to experience a higher percentage of teachers relocating. This suggests that the teachers in these states may be moving to different school districts in search of better pay. However, it's crucial to recognize that as these teachers move to different schools, the students in these states are at a higher risk of experiencing disruptions to their education. Teacher mobility has a significant impact on students, especially when teachers change schools in the middle of the education year.

*Dashboard 2 Part 2: Current State of Teachers in the US*

Secondly, when analyzing both the text table and the symbol map in this dashboard, the picture becomes even clearer of which states are experiencing the biggest decline in education standards. While the scatter plot reveals an inverse correlation between teacher salary and the percentage of teachers relocating, the text table and symbol map emphasize that there exists no discernible relationship between current teacher salary and the percentage of educators exiting the profession in 2022. Remarkably, out of the top 15 states with the highest rates of teacher attrition, 4 of these 15 states boasted average teacher salaries around $80,000 and above! These states, despite offering such lucrative compensation, like Massachusetts and New York, still faced alarmingly high departure rates among teachers. Additionally, 7 of these 15 states all had teacher salaries that were greater than the national average of $62,809. This underscores that while salary remains a crucial factor, other influences are certainly weighing heavily on teachers’ decisions to leave. When we look at the symbol map, there is a growing hotbed of teachers quitting their jobs on the east coast of the United States. Vermont, in particular, witnessed a staggering 17.4% of its teaching force depart in 2022. One cannot overstate the consequences of such waves of teachers leaving, particularly for the students of Vermont and other states grappling with similar issues of teaching departures.

*Dashboard 3: How Did COVID affect Teachers in the US*

In the next dashboard, the visuals that are presented here emphasize a stark reality: the teaching profession has become less appealing after COVID. We showed in the previous dashboard that salary is inversely related to teachers relocating to different schools, but what about salary’s implication on new graduates entering the teaching profession? Are administrators finding it increasingly more difficult to fill teaching positions and convince current educators to stay in the profession? To dissect this question, consider the line chart in the upper left-hand corner, which compares average teacher salaries adjusted for inflation over the past 60 years. Unbelievably, teacher salaries have remained nearly stagnant when adjusted to 2021 dollars. While it may appear that salaries have increased over time, this graph unequivocally proves that educators have not been incentivized to pursue or remain in the profession. Moreover, when examining teacher salaries in some of the higher income states like New Jersey, New York, and Massachusetts, the second line graph in the dashboard (in the lower right-hand corner) reveals that teacher salaries have decreased in the two most recent years after the pandemic. Consequently, many of the teachers and young graduates entering the profession in these affluent states could be growing frustrated at the cuts being made to teacher pay. This could explain why in the previous dashboard, the percentage of teachers that quit the profession was so high in these states. Another mark of teacher dissatisfaction could be the increased amount of work teachers are getting after the pandemic. The text table in the left-hand corner highlights that in 2020, teachers spent two fewer hours instructing students per week compared to 2015. However, in 2020 teachers were required by administrators to work more hours than in 2015, both during school hours and after-school, with an additional hour per week devoted to after-school work in 2020. This discrepancy implies that students are receiving less direct instruction time from their teachers, while educators are burdened with an increased workload, including grading online assessments and assignments. For all these reasons, prospective graduates may be less inclined to pursue careers in teaching. These factors are supported by the final chart in the dashboard, a bar graph which underscores spikes in teaching vacancies across various public-school teaching fields between 2015 and 2020. Specifically, the bar graph highlights how the most striking surge in teaching vacancies occurred in Special Education and Foreign Language instruction in 2020.

*Dashboard 4: Aftermath of COVID on Education*

In the fourth dashboard, all the previously considered factors have now led to these outcomes for K-12 teachers in the United States. At the top of the display, two donut charts compare the percent distribution of public-school teachers in the United States by years of teaching experience, contrasting 2016 with 2021. Notably, in 2021 there was a significantly smaller percentage of teachers with 3 years or less of teaching experience compared with the 2016 school year. Furthermore, there was a greater percentage of teachers in 2021with 15 or more years of teaching experience than in 2016. This emphasizes that after the pandemic, less prospective graduates entered the teaching profession compared to 2016, while more experienced teachers had to pick up the slack and extend their years of service. On top of this, when reviewing the scatter plot at the bottom of the dashboard, one can see the unsettling number of teachers that quit public education in the four years since the pandemic (2020-2024). Specifically, in quarter three of 2020, quarter three of 2021, and in the first three quarters of 2022, US public schools faced alarming waves of teacher resignations. These spikes happened to coincide with crucial pandemic-related incidents across the country, such as the reopening of public schools with social distancing measures and the emergence of a new variant in the United States. These results demonstrate an underlying gap that was created in the United States education system during COVID-19 - a gap that continues to plague teachers and students nationwide.

*Dashboard 5: Further Problems in Public Education*

In this dashboard, three more important issues are presented in the United States education system. Firstly, the culmination of events during the pandemic resulted in a significant increase in the number of students who missed key material during those school years. Note how in the bar chart at the top of the dashboard, public schools in all regions of the country experienced a greater percentage of students deemed “behind their grade level” by their educators post-COVID than in years prior. Moreover, the highest percentage of students deemed "behind their grade level" by their educators post-COVID were in schools located in the western region of the United States. States like Utah, Nevada and Washington, who we observed in previous dashboards had 10% of their teachers quit, are now grappling with burdensome setbacks to their students. Further scrutiny of this dashboard reveals that the largest disparity for students deemed “behind grade level” pre-COVID versus post-COVID occurred in the Northeast public schools. There is a 17% difference between the pre-COVID bar and post-COVID bar for schools in the Northeast, and nearly 50% of students in the Northeast are determined to be behind their grade level in 2022. This is not surprising but it is worrisome, considering that we also saw in previous displays the staggering number of teachers that shifted schools or left the profession in places like Vermont, Connecticut and Massachusetts. As an icing on the cake, when the bar chart is adjusted to display the location of schools instead of regions, it becomes evident that cities have up to 59% of their students falling below grade level benchmarks! Now, these numbers cannot all be attributed to the attrition rates of teachers after the pandemic. Examination of the two others graphs in this dashboard reveals that students after the pandemic are more distracted in classrooms according to their teachers, and they are absent in outstandingly greater numbers in 2022 compared to 2017. In the "student electronic use" scatter plot, public schools in the Midwest, South, and Northeast all report that students now use their cellphones in the classroom more frequently than before the pandemic. Moreover, when looking at the text table in the right-hand corner, student absences are spiking after COVID, and this is evident not just for high schoolers, but for grade 4 students! In 2022, the National Center for Education determined that approximately 21% of all grade 4 students missed 5 or more days in any given month during the 2022 school year. Consequently, all these results indicate that it wasn’t just teachers who experienced new difficulties during the pandemic, but student behavior and standards of education all dropped post-COVID.

*Conclusion: Dashboard 6 (Scores are Down)*

In this final dashboard, the displays presented here, accompanied by the information discussed in previous dashboards, answers the question if US public education is in a crisis. According to the tree map and the bar diagram in the dashboard, mathematics scale scores, as determined by NAEP (otherwise known as the Nation’s Report Card), are at their lowest levels for grade 4 and grade 8 students since 2005. The school year of 2022 produced some of the worst NAEP mathematics scores in nearly two decades, and this is even further highlighted by the decline of SAT scores in 2022 and 2023 compared to previous years. In the SAT percent difference bar diagram, the graduating class of 2023 had the greatest percent decrease in SAT results in the last 5 years. Consequently, when seeing these results, one cannot help but sound the alarm on a national public education crisis. The outcomes of this display, as well as the information from preceding dashboards, all point out the necessity for a reconstruction of the education system. Some of the major changes that need to take place are: increased salaries and better incentives for current public school educators, increased funding for public schools to fill vacancies in special education programs and STEM fields of study, a stricter establishment of rules for technology use in classrooms as well as maximum number of allowed absences, and a more intense focus on filling in gaps created during the pandemic in the mathematics and english subjects. We hope that the information highlighted in these data visuals not only brought attention to the challenges exacerbated by COVID in US education, but also illuminated significant areas for improvement in public schools moving forward.

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