Effects of COVID-19 on Mathematical Learning Among Multilingual Students

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ABSTRACT

Mathematics is a big driver in addressing the world's complex problems, such as feeding a growing population, ethical use of artificial intelligence, and environmental sustainability. Previous research has established that due to the COVID-19 pandemic, many students suffered learning loss, particularly in math. The learning gap in math education due to the pandemic and socioeconomic inequalities will have long-lasting implications for many students, contributing to the lack of career opportunities and increasing income disparities. This study aims to understand the role of language in the mathematical performance of students who attended school virtually during the COVID-19 pandemic.

Introduction

With the COVID-19 pandemic, students around the globe faced challenges with online learning, schedule changes, technology glitches, and online fatigue. According to the Global Education Coalition launched by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), over 186 countries worldwide faced partial or nationwide closures of educational institutions including schools, colleges, and universities. More than 1.6 billion learners, representing nearly 80% of the world's student population in primary and secondary schools, were affected by school closure (UNESCO). At the peak of the pandemic, the closures affected at least 55.1 million students in 124,000 US public and private schools. Nearly every state either ordered or recommended that schools remain closed through the end of the 2019-20 school year (Edweek). A team of researchers from the Center for Education Policy Research, Harvard University used testing data from 2.1 million students in 10,000 schools in 49 states including Washington DC to investigate the role of learning loss including widening gaps in achievement by race and school poverty. Students who stayed home for most of 2020-2021 lost the equivalent of about 50 percent of a typical school year's math learning during the study's two-year window. One of the most concerning findings is that online schooling widened both socioeconomic and racial inequality in math learning (Goldhaber, Kane, McEachin, Morton, Patterson, Staiger).

Research shows that the impact of the pandemic on K–12 student learning was significant, leaving students on average five months behind in mathematics. The pandemic played a significant role in widening preexisting achievement gaps, impacting historically disadvantaged students even further. This impact was particularly exacerbated for multilingual students whose native language was not integrated into the school curriculum. Multilingualism is the ability to use several languages with equal fluency by an individual. The US Census Bureau reports that more than 60 million residents over the age of five years old, or about 20% of the US population, speak a language other than English at home (US Census). In this study the students labeled multilingual could be bilingual or English Learners.

During the pandemic due to remote schools, parents from all backgrounds had to take on additional responsibilities of being educational facilitators for their children. This additional burden was challenging for linguistically diverse families of multilingual learners, many of whom depend on schools to make web-based learning accessible to them. (Government Accountability Office). A survey of 589 families and 575 teachers in the summer of 2020, found that only 39% of the Spanish-speaking families surveyed felt prepared to support a child learning from home (TalkingPoints).

This study reviewed a wide array of publicly available data sources and research that documents the impact of COVID-19 on students in the United States. While recognizing that the entire education system was affected, this study is aimed to understand whether language was a factor that impacted the math performance of multilingual students.

Method

It is hypothesized that while studying virtually during the COVID-19 pandemic, socioeconomic factors impacted mathematical learning among multilingual students. The data that I collected is quantitative, focusing on student performances on standardized tests as well as socioeconomic factors such as school district demographic, household income percentiles, parental education, ethnicity, and geographic location. Since my research is focused on mathematical performance, I removed all the data about non-math subjects. Since the research focuses on the impact of remote learning during COVID-19, I have limited the data for the school years 2018-2019 and 2020-2021.

To understand the math performance of the student cohort during the COVID-19 pandemic, I sourced the mean achievement data from the NWEA anonymized longitudinal student achievement database. I compared the pre-pandemic data from 2018-2019 with the 2020-2021 academic school years. In the United States, school districts use NWEA® MAP® Growth™ assessments to monitor elementary and secondary students' reading and math achievement and gains, with assessments typically administered in the fall (between August-November), winter (between December-March), and spring (between late March-June). MAP Growth is a computer adaptive test that precisely measures achievement even for students above grade level and is vertically scaled to allow for the estimation of gains across time (NWEA, Kuhfield, Meghan, Lewis). The sampling I used for the mean achievement data is composed of 25,000 public schools across all 50 states from grades 3-8 that uses MAP Growth math assessment. I also used the NWEA data that includes demographic information, including student race/ethnicity, gender, and age at assessment. An indicator of student-level socioeconomic status is not available. In this study, there is one main variable – the mean percentile of the student math score. I considered two independent variables – student grade level and ethnicity. To perform a comparison between the means of pre-pandemic and pandemic math scores, I studied the data of the student population by 5 main races – Asians, Whites, Hispanics, AIAN, and Blacks. Since the study aims to understand the learning abilities of multilingual students during COVID-19 and the lack of data directly related to students' language diversity and proficiency, the study hypothesized that a majority of Hispanic households are multilingual and at least half of Asian students are exposed to more than one language at home.

I used a t-test analysis to compare the math performance in pre-pandemic and during the pandemic of the 5 groups of the student population. I chose t-test analysis for this study as it allowed me to compare the means of test scores for each of the groups defined above. For this paired test, I derived the t-values by comparing the 2021 scores of each group with the 2019 scores. I used the following equation to derive t-values.

After calculating the t-value, I used the t-distribution table to obtain the p-value. I calculated it by looking at the significance level, which was 0.05. After obtaining the p-value, I compared my p-value to the significance level (0.05) and concluded that there was significant evidence for my alternative hypothesis because the p-value was less than the significance level.

Table 1. Number of Students by Sample and Subgroup

Grade	Asian	White	Hispanic	AIAN	Black

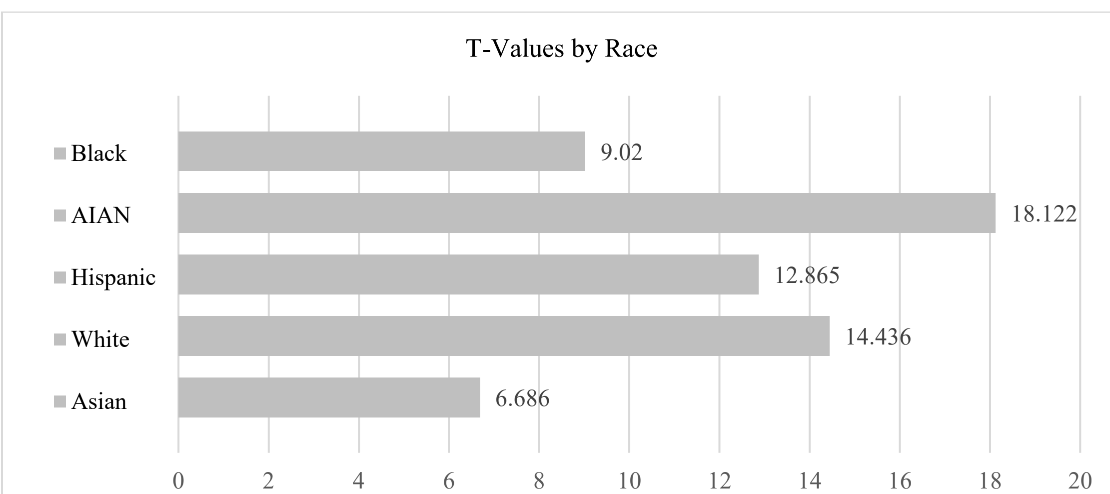
3	32,327	375,868	143,566	11,786	144,271
4	31,863	375,528	149,950	12,607	140,167
5	30,725	377,781	142,023	12,674	136,692
6	31,435	382,300	145,512	13,246	135,620
7	29,787	367,872	136,729	12,204	127,419
8	28,456	349,974	125,691	11,405	117,728

Note: Raw data for Table 1 is sourced from the NWEA Technical Brief: Student achievement in 2021-22

Table 2. Percentile Math scores of students by race based on MAP Growth Assessment between 2019-2021

Race	Asian		White		Hispanic		AIAN		Black	
Year	**2019**	**2021**	**2019**	**2021**	**2019**	**2021**	**2019**	**2021**	**2019**	**2021**
Grade 3	75	70	64	57	43	31	39	29	38	28
Grade 4	77	74	65	58	47	32	36	26	39	23
Grade 5	78	71	65	58	47	33	37	25	38	24
Grade 6	81	73	65	58	45	32	34	25	34	23
Grade 7	80	72	63	54	42	32	33	23	33	25
Grade 8	80	76	65	55	44	35	36	28	36	27
T-value*	6.686		14.436		12.865		18.122		9.02	
P-value*	0.00055		0.00001		0.00003		0.000005		0.0003	

* Note: Raw data for Table 2 is sourced from the NWEA Technical Brief: Student achievement in 2021-22, for the t-value and p-value analysis



Note: Raw data for Figure 1 is sourced from the NWEA Technical Brief: Student achievement in 2021-22
Figure 1. T-Values Based on Race of Student Population

Table 3. Percentage of Students On Grade Level by Income Group- Math Assessment in Fall

Household Income	<$50,000		$50,000-$75,000		>$75,000	
	Historical Fall	**Fall 2021**	**Historical Fall**	**Fall 2021**	**Historical Fall**	**Fall 2021**
Grade 3	12%	7%	18%	13%	27%	22%
Grade 4	22%	12%	29%	20%	40%	30%
Grade 5	25%	15%	34%	23%	46%	35%
Grade 6	24%	17%	33%	25%	45%	37%
Grade 7	19%	15%	27%	21%	39%	31%
Grade 8	18%	14%	25%	19%	36%	30%

Note: Raw data for Table 3 is sourced from the Curriculum Associates Research Brief, November 2021

Table 4. Percentage of Students Below Grade Level by Income Group-Math Assessment in Fall

Household Income	<$50,000		$50,000-$75,000		>$75,000	
	Historical Fall	**Fall 2021**	**Historical Fall**	**Fall 2021**	**Historical Fall**	**Fall 2021**
Grade 3	37%	49%	28%	37%	20%	26%
Grade 4	34%	47%	26%	35%	18%	25%
Grade 5	34%	47%	26%	35%	18%	25%
Grade 6	40%	52%	31%	42%	22%	30%
Grade 7	46%	55%	36%	45%	26%	34%
Grade 8	54%	59%	45%	50%	33%	38%

* Note: Raw data for Table 4 is sourced from the Curriculum Associates Research Brief, November 2021

The study shows that the drop in the math performance of multilingual students from low-income households was higher compared to multilingual students from mid to higher-level household incomes. Table 3 and Table 4 highlight how multilingual math learners whose household income was less than $50,000 saw a greater decline in their scores. These students were at grade level pre-pandemic, but the language and socioeconomic factors exacerbated the decline in their math performance (Curriculum Associates).

A higher t-value signifies a larger difference between the two sample data points for each group. The results of each t-test show that there was a high difference between the sample result and the null hypothesis. All of the groups displayed statistically significant results.

Asian: t-value (6.686) = 0.00055 < 0.05: statistically significant
White: t-value (14.436) = 0.00001 < 0.05: statistically significant
Hispanic: t-value (12.865) = 0.00003 < 0.05: statistically significant
AIAN: t-value (18.122) = 0.000005 < 0.05: statistically significant
Black: t-value (9.02) = 0.0003 < 0.05: statistically significant

Discussion/Conclusion

The results of this study demonstrate that the pandemic has significantly impacted the math achievement of students in the United States. The impact on math learning loss is compounded for those that are multilingual and are historically underserved communities. While language barriers played a role in math learning, the impact on students from mid to higher household incomes was less compared to those students that came from low-income households. Overall, the study indicates that the pandemic interrupted academic progress, but it also highlighted the need to support multilingual students with additional resources, particularly in the mathematics classroom.

In conclusion, the results from this study suggest that the shift to remote learning in schools in 2020-2021 in the United States impacted all students but multilingual students and socioeconomic factors compounded the academic loss in mathematics compared to pre-COVID. While additional research is needed to understand whether language proficiency and other factors played a role, this study may help inform educators in identifying learning methods that take the language of instruction into consideration and develop strategies to help narrow the performance gap in mathematics as we recover from the COVID-19 pandemic.

Limitations

In this study, there are several limitations worth noting. It is possible that some students might perform better in math than others as a result of access to additional resources outside of schools such as parental support, tutoring, and prep classes due to higher household socioeconomic status. There was no data available that measured whether the decline in test scores could also be due to technology and Internet glitches as students tested remotely. There are several confounding factors that might have influenced math learning during COVID-19, especially among students from lower-income households. Availability of a dedicated computer or comfortable study work area are some factors impacting learning. Additionally, uneven funding for school lunches across the country during COVID-19 meant an additional burden on low-income families to feed the students at home and this could add to confounding variables.

The sample size was limited to the number of students who took the MAP assessment during the study period. These sample sizes are shown in table 1 above. The sample data is based on students who took MAP assessment during the study period but there is an under-coverage bias since not all students in the country took a MAP assessment. The study estimates that about 30% of the student population took this assessment which provides a good sample for the overall US student population. Another limitation of this study is that some students may have dropped out of school during the pandemic, for which no data was found. Finally, I did not have access to per student household income data or per student language proficiency, so I was unable to disaggregate data by student-level poverty, English Language status, or multilingual proficiency.

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