The Academic Impact of the COVID-19 Lockdown on the 2019-2020 United States Freshman Classes as Measured by SAT Performance

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Abstract

The COVID-19 pandemic has had lasting impacts on the world. The impacts range from economic to educational and personal. There has been a large focus on the educational impact that students have experienced due to the pandemic. This impact stems from the lockdown and school closures that occurred during the pandemic, which resulted in students in the US losing three to four months of in-person traditional instruction. Unfortunately, many studies around academic losses due to the COVID-19 lockdown have been focused on primary school level students, meaning that little has been published about the lockdowns' impact on secondary level students. The author sought an answer to the question, has student performance overall been statistically impacted at the secondary level of education due to the COVID-19 pandemic and lockdown? The answer was determined through box plot analyses of 2017-2022 SAT datasets which showed that there was some negative impact to student performance overall from the COVID-19 lockdown that had resulted in students losing three to four months of in-person instruction, even with other forms of instruction being offered where available. However, the drop in performance was reassuringly not found statistically significant as determined by a Z-Test that was performed on the overall country average performance values.

Keywords: Student evaluation, School evaluation, COVID-19 academic impact, SAT performance

1. Introduction

The COVID-19 pandemic has had lasting impacts on the world. The impacts range from

economics to educational and personal. There has been a large focus on the educational impacts that students have experienced due to the pandemic. These impacts stem from the lockdown and school closures that occurred during the pandemic, which resulted in students, in the United States (US), losing three to four months of in-person traditional instruction, although other forms of instructional time were made available, when possible, to all students during this time.

The first school closure in the US took place on March 15, 2020, occurring to the Center for Disease Control ("Timeline", 2023); and all schools in the US were allowed to reopen for in-person traditional instruction in the following August, which was the start of the next academic year (España et al., 2021). Nearly four years later, several studies have been conducted, and academic losses are still in the headlines of major news outlets. A recent headline from *US Today* stated that "Education in US and around the world suffered historic setbacks due to COVID-19 pandemic (Binkley, 2023)"; and *Education Weekly* has stated that "students aren't rebounding from the academic effects of the pandemic (Schwartz, 2023)". These headlines are complemented by the studies that have been conducted on this topic. One study by Giorgio Pietroa (2023), demonstrated that the losses experienced by students academically from the COVID-19 pandemic are comparable to that of any natural disaster. However, students have not recovered academically within the following academic year (Pietroa, 2023). These academic losses were also not localized to any one specific group, or area within the US, as demonstrated by Havard's Graduate School of Education with their recent 2023 study that investigated the effects that the pandemic had had on student learning. That 2023 study demonstrated that, in any standard school district, the documented academic losses, as assessed by test scores, were evident in all students, regardless of socio-economic status and race/ethnicity ("New", 2023).

Unfortunately, many of the studies around academic losses due to the COVID-19 lockdown have been focused on primary school level students, meaning that little is known about the lockdowns' impact on secondary school level students. The key question is, was student performance overall statistically impacted at the secondary level of education due to the COVID-19 pandemic and lockdown?

2. Method

This descriptive quantitative study followed a logical approach to the type of student performance data and sample population that was selected. The logical approach was broken into two sequential steps. The first step was to determine what types of student performance assessments are used at secondary level schools and to select an appropriate testing type for this study. Based upon the selected type of testing, the second step was to identify the sample population for the study. The sample population was chosen to be the students that potentially were the most impacted by the COVID-19 lockdown, namely freshmen.

2.1 Student Performance Assessment

The tool used to understand a student's growth and ability to perform at any given level is assessment. An assessment can be either standardized or non-standardized. A standardized

assessment is an assessment that requires all participants to answer the questions from a common bank of questions ("Standardized", 2015). The questions that are included in the bank are constructed in a manner that allows for the assessment to be scored in a consistent manner ("Standardized", 2015). This method of scoring makes it possible to compare the relative performance of different students, and groups, for the purpose of assessing the overall performance based upon an accepted benchmark and against peers ("Standardized", 2015).

The two most common standardized assessments that are used in the US to gauge the overall performance of high school students are the SAT and the ACT. The SAT, and the ACT, are both exams that are used by the majority of colleges and universities in the United States to determine if a student is a suitable candidate for enrollment ("ACT", 2024; "SAT", 2024). Colleges and universities use the SAT, or the ACT, scores when making enrollment decisions because the score that a student receives on either the SAT, or the ACT, is meant to be a measure of that student's readiness for college. Additionally, an SAT, or ACT, score provides the college or university with a common data point for all students, allowing for more informed comparisons to be made of all applicants ("ACT", 2024; "SAT", 2024).

2.2 Why Standardized Was Selected

The non-standardized assessment style that was considered for this study was that of student portfolios. Student portfolio assessment do not focus on a set of specific criteria, but on the individual student (Sackstein, 2024). Student portfolios allow students to demonstrate their growth in a multitude of content areas over a long span of time (Sackstein, 2024). Although students are still required to attach a standard-based reflection about which aspect of the course is demonstrated by each piece in the portfolio, what they have learned throughout the process (Sackstein, 2024). Additionally, this method of performance assessment is not common outside of primary school level students (Sackstein, 2024). This lack of common usage in a student's secondary level of schooling, makes this style of assessing student performance unreliable and thus not selected for this study.

The standardized style of assessing was selected for this study, due to that style of assessment being the most common type of assessment utilized by colleges to gauge student ability, with over 80% of colleges requiring an SAT or ACT score (Churchill, 2024). When considering which standardized test, whether the SAT or the ACT, that this study would utilize, student participation numbers were the basis of choice. Through investigation, it was determined that the majority of students take the SAT, instead of the ACT. [According to 2023 test-taking data, 1.9 million students took the SAT ("Which", 2024), while only 1.39 million students took the ACT in that same year (Arundel, 2023). Consequently, the SAT was chosen to be the standardized test for usage within this study.

Additionally, the investigation also determined that the SAT questions are of a lower skill level than those on the ACT (Montgomery, n.d.). The SAT English language Arts (ELA) sections focus on close reading skills and argument analysis and mathematics sections focus mainly on Algebra 1 level questions, with only a few upper-level questions in Geometry or Trigonometry (Montgomery, n.d.). While the ACT ELA and mathematics sections cover a

broader spectrum of content spanning multiply years of secondary level education (Montgomery, n.d.). Making it harder to determine what the impact was on individual grade level skills.

2.3 Sample Selection

Secondary freshman level students were selected for this study due to their class losing in-person instructional time for the majority of the content that is covered within the SAT. The SAT test has approximately 44 questions in the Mathematics section, and at least 50% of those questions are Algebra 1 based ("Math", 2024), which is the freshman level Mathematics course. The other secondary level students (sophomore, junior, and senior) had most likely already completed their Algebra 1 course, meaning that they had already acquired the base knowledge needed to adequately perform on the SAT Mathematics section.

Collegeboard.com also states that the ELA portion of the SAT is split into 2 sections ("Reading", 2024). Each section consists of short reading passages combined with multiple choice questions ("Reading", 2024). The short reading passages range in varying lengths from 25 and 150 words and across four different areas of interest in ELA ("Reading", 2024). These four areas of interest consist of literature, history or social studies, humanities, and science ("Reading", 2024), while the multiple-choice questions for the reading passages focus on specific aspects of English writing: structure, information, standard conventions, and expression of ideas ("Reading", 2024). The level of difficulty of these questions was not included in the description provided by collegeboard.com.

For this study, the assumption was made that the difficulty level for the ELA section is equal to that of the Mathematics section. Meaning that the ELA readings and questions are at the secondary freshman level. The other secondary level students (sophomore, junior, and senior) had most likely already completed their freshman level ELA course, meaning that they had already acquired the base knowledge needed to adequately perform on the SAT Reading & Writing section.

2.4 Research Design

This study was a descriptive investigation into the COVID-19 lockdown impact on student performance outcomes as measured by students' SAT scores. The quantitative data that was gathered was analyzed under the guidance of a single hypothesis.

H1: The COVID-19 lockdown had a significant negative impact on secondary level freshmen student academic outcomes, as measured by their SATs.

The hypothesis was investigated, and evaluated, through the answering of four research questions. Each research question explored a different avenue of student performance that is measured by the SAT. The four research questions were as followed:

RQ1: Is SAT participation for the 2022 test dates significantly lower than for previous years.

RQ2: Is SAT overall performance for the 2022 test dates significantly lower than for previous years.

RQ3: Is SAT Mathematics performance for the 2022 test dates significantly lower than for previous years.

RQ4: Is SAT English Language Arts performance for the 2022 test dates significantly lower than for previous years.

2.5 Data Gathering

The SAT data for this investigation was gathered from National Center for Educational Statistics (NCES) archives of collegeboard data for the 2017-2022 SATs. The variables included in the dataset consisted of four values across each state, and the overall country, for each year from 2017 till 2022. Each state, and the country, had a Mean and Standard Deviation value for the Overall SAT score, the ELA portion, and the Mathematics portion. Additionally, each state, and the country overall, had a percentage value associated with each year. The percentage value indicated the percentage of the eligible student population that had taken the SAT that year.

For this study all four available data points were utilized. To analyze SAT participation, the total percent of the eligible student population that had taken the SAT at the state, and country, level for all years was utilized. While analyzing performance, the study used the Mean scores for both the ELA and Mathematics portions at the state, and country, level for all years. The Standard Deviation values for the scores in the ELA and Mathematics sections were utilized in a corroborating analysis of the data to ensure that the findings from the initial analyses were of a significant value.

2.5.1 Data Limitations

The dataset from the NCES archives of collegeboard data for the 2017-2022 SATs utilized for this study had two main limitations. The first limitation of this dataset was that the dataset did not include any demographic information. Demographic information pertains to gender, race, ethnicity, and socio-economic status. With demographic data not being present within the dataset, it was not possible to perform any comparisons between subgroups. The second limitation of this dataset was that the values within the dataset had already been averaged across each state, equating the entire state to a single value. This averaging of values across a state removed the ability to perform a comparative analysis between different areas within each state. The different areas within a state could now, and potentially usefully, consist of rural, sub-urban, and urban.

2.6 Data Analysis

This study conducted two types of statistical analyses. The first statistical analysis being a box plot analysis and the second being a Z-Test. A boxplot analysis is used to summarize a set of data into discrete sections ("Numeracy", 2024). The discrete sections provide and illustrate a shape of the overall distribution of data within the set. The shape of the distribution also shows any outliers, or data points that exist outside of an accepted range of values within the data set ("Numeracy", 2024). Typically, the maximum, or minimum, values dictate what is considered to be an outlier ("Numeracy", 2024). In contrast, a Z-Test is used to determine if

two population means are statistically different when the standard deviations of both populations are known (Chen, 2024).

The box plot analysis was chosen for this study because this type of analysis can be used to determine potentially significant values, *i.e.*, outliers, thus only needing a minimal number of data points, which fit the circumstances of the data that was gathered for this study. The minimum amount of data points required for a box plot is five data points, which is exactly the amount of data points that the NCES collegeboard dataset provides.

The Z-Test was selected to be performed in this study as an additional clarification check for statistical significance of any outliers that were discovered by the boxplot analysis. Additionally, the Z-Test can be performed with a minimal number of data points.

2.6.1 Box Plot

The SAT data was analyzed through a comparison between the 2022 SAT testing data and the SAT testing data from the previous four years. The comparison of the testing data was used to determine if the 2022 SAT testing data would be considered as outliers as determined by Box plot analyses conducted utilizing Microsoft Excel. For a breakdown of the equation utilized during the box plot analysis and the definitions of the variables included, please see Appendix B.

2.6.2 Z-Test

A Z-Test analysis was performed to further determine if the findings from the box plot analysis are statistically significant. However, due to the data points provided by the dataset that was utilized, the Z-Test was only to be performed at overall country level. Since the state level data would be a sample size of 1, due to the actual number of test takers in each state not being noted in the dataset. This resulted in all individual state data not being able to be used in a Z-Test. The Z-Test was conducted in Microsoft Excel. For a breakdown of the equation utilized during the Z-Test analysis and the definitions of the variables included, please see Appendix B.

3. Results

The results from all four research questions demonstrate clear evidence for the rejection of the null hypothesis, that the COVID-19 lockdown had no significant negative impact on secondary level freshmen student academic outcomes, as measured by the SAT, as negative impacts were noted by statistical LB outliers in overall performance and the subject of Mathematics. However, these drops in performance were not statistically significant when viewed at the country level, as evident by the results of the Z-Test. Additionally, RQ1 was excluded due to not being a performance outcome, but instead a relevant metric for monitoring the impact of the COVID-19 lockdown.

3.1 SAT Participation

The results from the analysis for the RQ1 determined that there was no negative impact from the COVID-19 lockdown on the average percent of the country's population that participated

in an SAT exam for 2022 testing dates, as shown in Table 1. However, RQ1 was eventually excluded from this study due to not being an academic performance metric.

Table 1. Average SAT participation percentage for the US from 2017-2022

Test Year	2017	2018	2019	2020	2021	LB	2022
Avg SAT Participation	48	58	60	60	41	28.38	47

Although, when looking at each state individually, it was discovered that 25 out of the 50 states did have a negative impact for participation percentage for the 2022 SATs, as displayed in Map 1. This is aligned with the other studies stating that negative academic impacts occurred due to the COVID-19 lockdown. These negative impacts in participation were determined through boxplot analysis of participation percentage by state. Any LB outliers found during these analyses indicated a negative impact. The results from these boxplot analyses can be found in Appendix A. Since RQ1 was excluded from the study, no further investigation into the impacted states was conducted. Furthermore, a Z-Test would not have been able to be conducted on any of the LB outliers that were discovered from the analyses of each state individually, due to the sample size for each state, $n = 1$, being below the recommended sample size, $n \geq 30$.
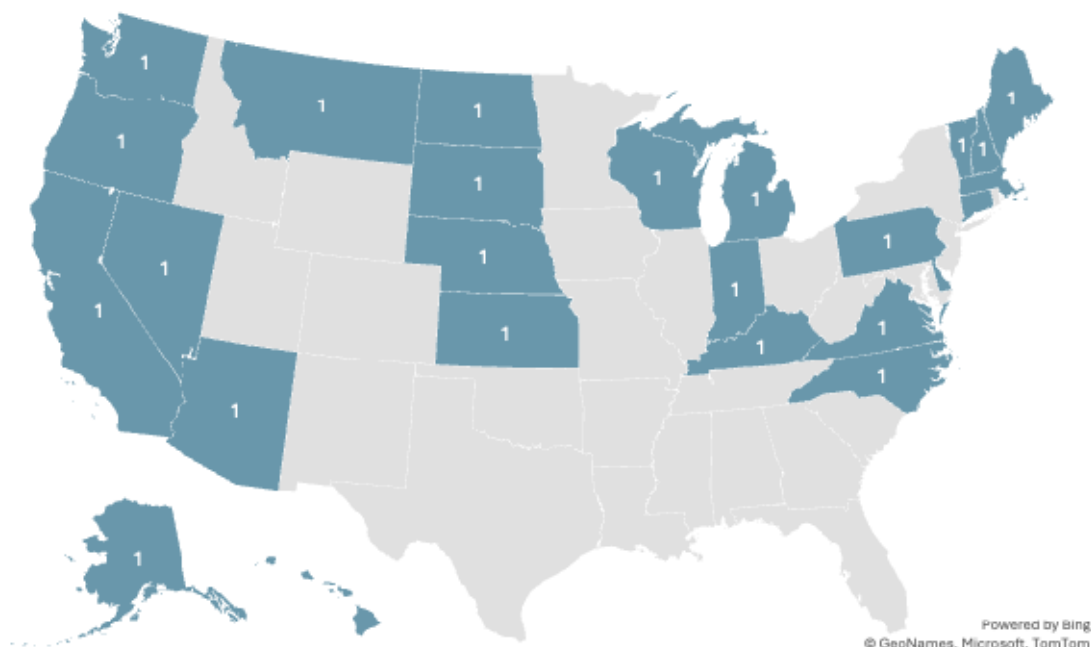
Map 1. Drops in 2022 SAT participation

Note. States are shaded using a gradient, the dark shaded states were discovered to have experienced more negative impacts.

3.2 SAT Overall Performance

RQ2 had a potential significant result noted by the average overall score for the SAT test dates in 2022 for the US being a statistical outlier, when compared to the boxplot of the 2017-2021 SAT dataset. The LB threshold for the 2017-2021 overall SAT performance was 1057.5, while the 2022 value for overall SAT performance was 1050, as shown by Table 2, demonstrating that the 2022 SAT participants were academically negatively impacted by the COVID-19 lockdown.

Table 2. Average mean overall SAT score for the US from 2017-2022

Testing Year	2017	2018	2019	2020	2021	LB	2022
Avg Mean Score	1060	1068	1059	1051	1060	1057.5	1050

The result from the Z-Test was used to determine if the discovered statistical outlier from the RQ2 boxplot was statistically significant. After inputting all necessary data points into Equation 2, the resulting Z-Test value was, $Z = -0.31$, while the Z-Score value for the sample population was $z = 0.04$. The comparison of the Z-Test and Z-Score values indicated that the Z-Test value is less than the Z-Score value, which determined that the drop in the overall average SAT performance for 2022 was not statistically significant.

Overall, the results from RQ2 are in alignment with the findings from D. Doz and E. Doz (2023); which stated that at the secondary level, students should perform relatively similar to their pre-lockdown performance levels post lockdown, due to the students not being exposed to additional academic stressors (D. Doz & E. Doz, 2023).

3.3 SAT Mathematics Performance

RQ3 had a potentially significant result, as noted by the average Mathematics score for the SAT test dates in 2022 for the US being a statistical outlier, when compared to the boxplot of the 2017-2021 SAT dataset, as depicted in Table 3. The LB threshold for the 2017-2021 Mathematics section score was 525, while the 2022 Mathematics section score was 521. This outlier value demonstrated that the 2022 test takers were potentially significantly negatively impacted academically in the content area of Mathematics by the COVID-19 lockdown.

The noted drop in performance that was discovered by RQ3 aligns with the results from Egara et al. (2023), which stated that student performance was found to be poor, meaning lower than expected, in math after the lockdown. Additionally, the results from RQ3 aligned with Gasteiger et al. (2023)'s findings. However, a true comparison between the RQ3 results and the results from Gasteiger et al. (2023) could not be made due to the students in Gasteiger et al. (2023)'s study not being at the secondary level of education. Also, the results from RQ3 were in contradiction to D. Doz and E. Doz (2023) that stated that student performance should remain relative stable from pre- to post-lockdown in secondary students.

Table 3. Average mean math score for the SAT in the US from 2017-2022

Testing Year	2017	2018	2019	2020	2021	LB	2022
Avg Mean Math Score	527	531	528	523	528	525.5	521

Additionally, a Z-Test could not be used to determine if the discovered statistical outlier from the RQ3 boxplot was statistically significant. This is due to the sample size being below the recommended minimum value, $n \geq 30$. Limiting the results for RQ3 to be anecdotal. With the results from RQ3 not being able to be statistically verified, the noted drop in performance may not be statistically significant and actually in alignment with D. Doz and E. Doz (2023) after all.

3.4 SAT English Performance

RQ4 did not have any potentially significant result, as noted by the average Reading & Writing score for the SAT test dates in 2022 for the US, when compared to the boxplot of the 2017-2021 SAT Reading & Writing sections, as depicted in Table 4. The LB threshold for the 2017-2021 Reading & Writing sections was 528, while the 2022 value for the Reading & Writing sections was 529. Demonstrating that the 2022 test takers were not negatively impacted in the content area of ELA by the COVID-19 lockdown. With no LB outlier being determined by the boxplot analysis used for RQ4, it was unnecessary to attempt a Z-Test. Additionally, the results from RQ4 contradict the findings from Egara et al. (2023), since the ELA performance on the 2022 SAT's was not lower than expected. Which aligns with D. Doz and E. Doz (2023), who stated that student performance should remain relative stable from pre- to post-lockdown in secondary students.

Table 4. Average mean reading & writing score for the SAT in the US from 2017-2022

Testing Year	2017	2018	2019	2020	2021	LB	2022
Avg Mean Math Score	533	536	531	528	533	528	529

4. Further Analyses

After the initial Box Plot analyses were performed and potentially significant results were obtained, more detailed analyses were performed to gain a better understanding of the academic impact overall. When looking at each state's performance on the 2022 SAT overall, it was determined that 11 out of the 50 states had lower overall average scores in 2022 when compared to the 2017-2021 SAT data. When Mathematics performance was explored for each state, it was discovered that 6 out of the 50 states had lower overall Mathematics average scores in 2022 when compared to the 2017-2021 SAT data. ELA performance was also

explored for each state, and it was discovered that 7 out of the 50 states had lower overall Reading & Writing average scores in 2022 when compared to the 2017-2021 SAT data. When all four categories (participation, overall score, Mathematics score, Reading & Writing score) were compared by state, the results displayed that 2 out of the 50 states had negative impacts in two of the four categories, 5 out of the 50 states had negative impacts in three of the four categories, and 1 out of the 50 states had a negative impact in all four categories.

5. Conclusion

Academic losses due to the school closures in 2020 caused by COVID-19 have had negative impacts on academic performance overall for High School freshman at that time according to the SAT results. These negative impacts are not localized to any one region across the US, as shown in Map 2. These widespread negative impacts corroborate the findings from Harvard school of graduate studies, which revealed that students were most academically impacted based upon where they lived ("New", 2023). Unfortunately, no explanation was included in the Harvard study as to why certain states were not impacted at all by the COVID-19 lockdown or why certain states were impacted more than their neighboring states ("New", 2023).

Based upon the findings noted by this study, more investigation into the academic impacts from the COVID-19 lockdown is warranted. The educational system would benefit from a more targeted investigation into the states that had any negative academic impacts, especially if a state had negative impacts in multiple categories. The purpose behind these suggested targeted investigations would be to gain a better understanding as to what may be influencing these noted declines in performance in the state when compared to the neighboring states.

Additionally, to ascertain if the noted negative impacts have created a trend across the other lower grade levels, this comparison of pre- and post-pandemic lockdowns SAT scores should be completed each year over the next eight years. The timespan of eight years was selected because it will allow for the remaining school age students that were enrolled in a primary level school during the COVID-19 lockdown to reach the age as to when they are eligible to take the SAT.

Map 2. Number of categories with negative impacts pre state
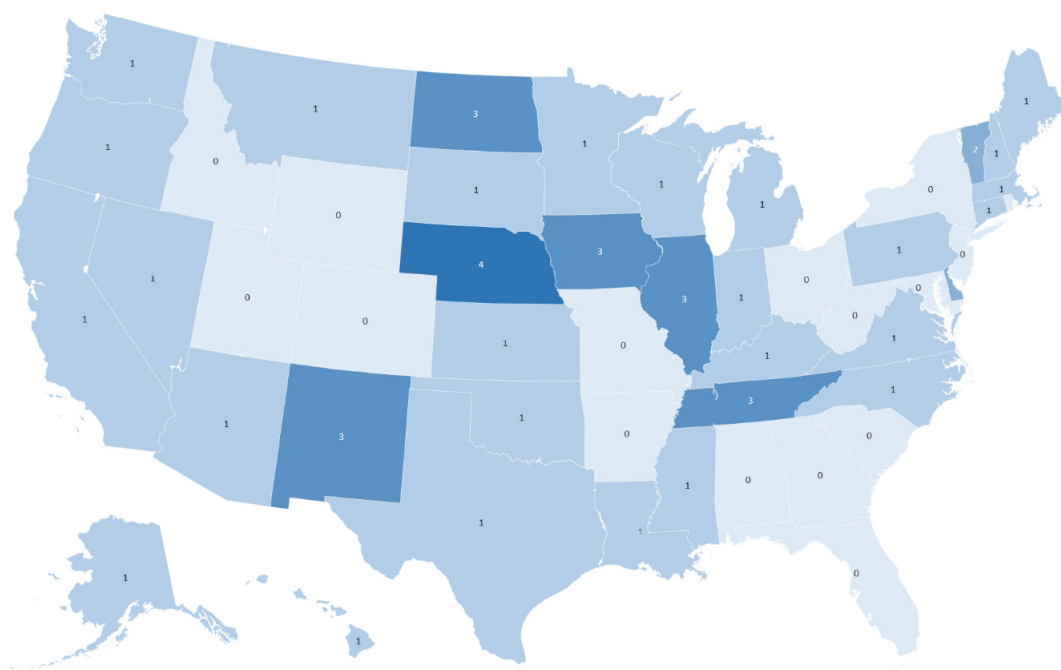
Note. The states shaded blue had a negative academic impact when compared to previous years data. States are shaded using a gradient, the darker the state is shaded the more negative impacts that were discovered.

6. Discussion

Being that the negative impact to academic performance is well-documented in this and other studies (D. Doz & E. Doz, 2023; Egara et al., 2023; Gasteiger et al., 2023), it would be a good recommendation for school districts across the country to ensure that their Multi-Tiered System of Support (MTSS) intervention programs are being utilized within all of their school because that program has been shown to be beneficial to student success ("I-MTSS", 2023). This recommendation is in conjunction with the recommendation that was made by (Egara et.al., 2023). Oddly enough, the recommendation for introducing an academic intervention program is contrary to the current body of research that states that academic interventions are largely ineffective for students (Cassibba, 2022). Even so, it is better to do something, rather than nothing, especially if the potential for negative effects on the students is low.

The MTSS program in each school and school district should build their remediation plans upon Reading and Mathematics benchmarks that are conducted throughout the year. This would ensure that any academic deficits are addressed to increase the potential for all affected students to increase their overall academic performance. A second recommendation ,in conjunction with the first, would be for local and federal government officials in, and out of, the Department of Education to create academic plans/policies that would ensure, and increase, student engagement in school. As well as creating national academic plans/policies

that would focus on increasing student interest in Reading and Mathematics. Ensuring student academic growth in both ELA and mathematics, along with allowing for an effective implementation of an MTSS program in all schools.

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Appendix A

SAT DATA Table

State	Avg participation overall	2017	2018	2019	2020	2021	2022	LB	Avg mean score overall	2017	2018	2019	2020	2021	2022	LB	Avg mean math overall	2017	2018	2019	2020	2021	2022	LB	Avg mean English overall	2017	2018	2019	2020	2021	2022	LB
Alabama	5	5	6	7	7	3	4	2	1138	1165	1166	1143	1051	1159	1146	1110	564	572	571	560	551	568	560	543.5	587	593	595	583	576	591	586	568
Alaska	35	38	43	41	37	23	26	31	1080	1107	1106	1097	1127	1119	1110	1064	543	533	544	541	543	553	560	536.5	559	547	562	556	555	567	565	544.5
Arizona	24	30	29	31	29	11	14	27.5	1140	1116	1149	1134	1098	1181	1159	1066.5	571	553	572	565	568	589	577	554.5	576	563	577	569	571	592	583	557
Arkansas	4	5	5	6	4	2	2	0	1174	1208	1169	1141	1139	1194	1191	1061.5	577	594	576	559	567	584	581	541.5	600	614	592	582	590	610	610	560
California	48	53	60	63	67	24	21	38	1065	1088	1076	1065	1157	1072	1021	1028.5	533	524	536	531	522	530	503	513.5	537	531	540	534	527	527	560	516.5
Colorado	75	11	100	100	100	56	84	-10	1042	1201	1025	1024	1049	1072	1021	954.5	523	595	519	506	512	527	503	473	536	606	519	518	518	544	518	479
Connecticut	93	100	100	100	100	69	89	100	1053	1041	1053	1046	1012	1072	1025	1023	515	512	516	519	506	505	505	501.5	531	530	535	529	511	545	520	520
Delaware	99	100	100	100	100	96	95	100	995	996	998	985	1039	984	968	965.5	486	492	492	486	481	485	477	474.5	499	503	505	499	498	499	491	493
District of Columbia	94	90	92	94	100	90	100	84	975	950	977	975	978	987	985	970.5	484	468	480	480	482	487	484	477	496	482	497	495	497	500	502	490.5
Florida	91	83	97	100	100	81	87	57.5	998	1017	1014	999	992	993	983	961.5	521	497	493	483	479	480	473	460.5	516	520	522	516	512	513	510	502.5
Georgia	61	61	70	71	68	41	54	47.5	1052	1050	1064	1058	992	1086	1060	1029	521	515	522	519	516	534	520	507	541	535	542	538	537	551	541	529.5
Hawaii	46	55	56	54	51	26	31	45	1101	1085	1099	1100	1053	1144	1124	1062.5	553	541	549	550	546	572	558	540	555	544	550	550	549	572	566	547.5
Idaho	97	93	100	100	100	90	97	82.5	1011	1011	1001	993	1095	985	986	975	488	493	493	488	484	483	483	470.5	505	513	508	500	500	502	499	493
Illinois	81	9	99	100	98	80	97	51.5	1020	1115	1019	1013	984	1007	981	989	509	556	506	504	503	498	485	498.5	515	559	513	509	504	508	495	500.5
Indiana	59	63	67	66	64	43	48	58.5	1069	1074	1086	1080	1007	1095	1073	1056	537	532	539	537	534	544	544	526.5	544	542	546	543	540	551	540	536
Iowa	3	2	3	3	3	2	3	0.5	1216	1275	1265	1244	1074	1243	1196	1210	619	635	631	622	609	620	594	603.5	622	641	634	622	611	623	602	604
Kansas	3	4	4	4	4	2	2	4	1245	1260	1265	1241	1220	1243	1238	1212.5	624	628	631	623	620	623	617	615.5	623	632	633	618	618	619	621	597
Kentucky	3	4	4	4	4	2	2	4	1234	1247	1248	1232	1237	1219	1219	1209.5	608	616	618	612	598	603	600	583.5	621	631	630	620	617	616	618	595
Louisiana	4	4	4	5	5	3	3	2.5	1196	1198	1210	1200	1207	1188	1171	1184.5	584	586	595	591	573	583	574	571	606	611	615	610	609	605	597	596
Maine	77	95	99	99	98	29	43	89	1065	1060	1080	1013	1170	1099	1081	884	511	499	501	502	491	541	529	494.5	525	513	512	504	597	558	546	510.5
Massachusetts	69	69	76	82	88	47	54	49.5	1116	1116	1125	1120	1029	1184	1075	1035.5	565	551	563	561	559	593	531	553	566	555	562	560	522	591	567	524.5
Michigan	92	100	100	100	100	68	84	100	1028	1005	1011	1003	1119	1031	1000	966	498	495	499	496	495	508	495	489	510	509	511	507	503	523	506	501
Minnesota	3	2	4	4	4	1	3	1.5	1227	1295	1298	1284	998	1263	1225	1215	639	607	655	648	633	636	602	613.5	631	644	643	624	628	626	613	600.5
Mississippi	3	2	3	4	4	2	2	1.5	1233	1242	1236	1236	1203	1202	1226	1227	601	607	606	608	603	589	589	572	623	640	630	610	610	612	606	585
Missouri	3	3	4	4	4	2	3	1.5	1232	1271	1262	1236	1219	1225	1200	1154.5	613	631	629	614	603	606	594	571.5	621	640	633	614	610	614	609	585.5
Montana	8	10	10	9	10	5	6	7.5	1206	1196	1198	1199	1212	1225	1206	1177	595	591	592	596	587	607	597	583.5	607	605	606	603	598	618	609	598.5
Nebraska	3	3	3	3	3	2	2	1	1236	1253	1252	1260	1185	1246	1222	1235.5	620	625	623	631	614	620	609	612.5	623	629	629	628	615	625	613	619
Nevada	16	26	23	20	17	4	6	8	1168	1116	1140	1156	1229	1195	1172	1057.5	574	553	566	576	571	598	580	551	581	563	574	580	579	596	592	565
New Hampshire	89	96	96	95	93	71	81	88.5	1073	1052	1063	1059	1150	1065	1050	1050	524	520	528	526	524	526	521	521	534	532	535	533	531	540	530	527.5
New Jersey	71	70	82	82	82	48	63	52	1083	1056	1094	1090	1055	1125	1079	999	543	526	547	545	540	563	537	529.5	545	530	547	541	541	562	543	532
New Mexico	23	11	16	18	19	30	42	11.5	1060	1138	1093	1073	1081	996	976	1043	520	561	540	530	522	496	480	495	535	577	552	540	543	508	496	504.5
New York	70	67	79	79	79	48	59	49	1104	1052	1098	1064	1068	1057	1136	1041.5	531	523	534	533	530	531	562	525.5	530	528	554	531	528	526	534	523.5
North Carolina	42	49	52	51	51	23	27	43.5	1104	1081	1098	1100	1058	1150	1136	1052.5	550	535	543	546	544	571	562	538.5	560	546	554	554	553	578	573	551.5
North Dakota	2	2	2	2	2	1	1	2	1228	1256	1283	1263	1096	1258	1212	1245.5	625	621	643	636	617	628	603	598.5	626	635	640	627	615	631	610	615
Ohio	17	12	18	19	21	15	18	9	1113	1149	1099	1097	1231	1048	1053	1019	541	570	547	548	534	507	525	513	545	578	552	550	536	525	528	512
Oklahoma	13	7	8	22	20	6	17	-12.5	1023	1108	1062	963	1070	1042	951	1012	494	517	521	472	481	467	485	427	512	530	541	490	490	535	485	422.5
Oregon	39	43	48	51	51	17	22	31	1095	1095	1117	1112	971	1119	1143	1094.5	553	548	553	550	550	554	563	540.5	549	560	564	562	557	565	580	554
Pennsylvania	60	65	70	70	67	39	48	57.5	1093	1071	1086	1082	1104	1123	1091	1049	540	531	539	537	547	557	540	526.5	565	540	547	545	543	566	551	537
Rhode Island	88	71	97	100	100	68	93	27.5	1023	1062	1018	995	1078	1011	971	934.5	497	524	505	492	534	504	477	472.5	511	539	513	503	501	514	494	486.5
South Carolina	57	50	55	68	68	48	51	23	1037	1064	1070	1030	990	1036	1030	979	510	521	523	504	489	507	507	478.5	533	543	547	526	524	529	526	500.5
South Dakota	6	3	5	6	7	4	5	2	1198	1216	1241	1268	1026	1215	1219	1176	615	603	618	635	610	610	611	598	615	612	622	633	609	605	608	589.5
Tennessee	65	62	66	68	73	59	64	53	1220	1228	1231	1220	1238	1220	1200	1208	598	604	607	602	585	602	589	599	616	623	624	618	601	618	610	610.5
Utah	3	3	4	4	3	2	2	1.5	1044	1020	1032	1022	1186	1003	1001	1002	503	507	512	500	500	498	495	489.5	512	513	520	515	510	505	506	502.5
Vermont	57	60	64	66	63	41	48	54	1197	1238	1230	1230	1010	1238	1233	1218	613	614	612	615	603	617	615	607.5	616	624	618	614	601	621	618	603.5
Virginia	59	65	68	68	65	41	48	60.5	1127	1114	1117	1106	1204	1151	1124	1099	548	541	554	546	549	553	552	535.5	563	562	565	567	559	571	558	552.5
Washington	55	64	69	70	69	45	32	56.5	1119	1102	1120	1119	1103	1151	1096	1079	552	534	550	551	534	567	554	546	570	561	567	567	567	584	572	567
West Virginia	61	14	28	99	98	27	84	-77	1086	1086	999	943	1116	1007	938	1063.5	536	528	486	460	460	535	456	532.5	542	541	539	483	539	537	481	536
Wisconsin	3	3	3	3	3	2	1	3	1212	1230	1294	1283	936	1215	1252	1101	636	649	653	648	628	611	629	596.5	625	627	641	635	615	604	622	427.5
Wyoming	3	3	3	3	2	2	2	0.5	1241	1230	1257	1238	1243	1233	1244	1218	612	604	625	615	606	607	617	592.5	625	626	633	623	614	626	627	618.5

Appendix B

Equations and Variables

(1) Box Plot

The 2022 SAT testing data points would be considered as Lower Bound (LB) outliers, if the data points were below the 2017-2021 LB Threshold, as determined by Equation 1,

$$LB = Q1 - (1.5 \times IOR) \qquad (1)$$

The term Q1, or Quartile 1, refers to the median value of the first half of a data set. The term IQR, or Inter Quartile Range, refers to the difference between the median values of the first and second halves of the data set. While the LB is the threshold that determines if a value is potentially statistically significantly different from the other values in the data set. These values are referred to as outliers.

(2) Z-Test

The Z-Test were performed utilizing Equation 2, displayed below ("Numeracy", 2024).

$$Z = \frac{\overline{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \qquad (2)$$

This equation states that the Z-Test value (Z), is equal to the difference of the sample mean, the 2022 Average SAT Score for the country, $(\overline{x})$ and the population mean, the average of the 2017-2021 SAT Scores for the country, (μ). That difference is then divided by the quotient between standard deviation of the sample, the standard deviation of the 2022 Overall SAT average score for the country, (σ), and the square root of the sample size, (n). The sample size, (n), that was entered into Equation 2 was 50. The value of $n = 50$ was selected due to the sample and population means being averaged across all 50 states. Again, the Z-Test was not able to be performed on any state level data due to the sample size, $n = 1$, being too small. The recommended sample size for a Z-Test is $n \geq 30$ ("Numeracy", 2024). The resulting Z-Test value is interpreted using the following conditional statement: If the Z-Test value is greater than the Z-Score value, then the Z-Test Value indicates a significant result.

Competing Interests

I declare that I have no knowledge of competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed Consent

Obtained.

Ethics Approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data Sharing Statement

No additional data are available.

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