How Education Finances Relate to Student Success in American School Districts

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Abstract

For the past six decades, researchers have investigated how the funding of schools affects the educational success of their students. However, this important relationship is of such incredible complexity that it is still an ongoing subject of research to this day, with high volumes of studies yielding different findings. Using data science and statistics, this research paper aims to add to the understanding of this topic by scrutinizing the relationship between per-pupil school district finances and student scoring on statewide assessments in the United States. By triangulating data sets from the U.S. federal government, this study explores this interconnection using Bayesian inferential analysis. The results reveal statistically significant positive correlations between total per-pupil education funding/expenditures and student performance. When examined in greater detail, sub-categories of funding and expenditures have nonuniform correlations with student achievement — some positive, some negative, some statistically insignificant. This investigation shows that the connection between money and student success is far from straightforward, and discusses reasons for the different correlations. This study calls for a data-based reevaluation of how best to help students succeed and improve equity in education.

1 Introduction

The human race has known the benefits of good education for thousands of years, ever since the earliest civilizations [Britannica, 2023]. Good schooling gives students necessary critical thinking skills and knowledge that prepare them for better chances of success later in life [World Vision International, 2022]. A society with a good education system often sees greater economic success, social growth, as well as advanced technological and scientific developments due to increased human capital [Hanushek and Wößmann, 2010]. As such, many governments from all over the world invest up to tens of thousands of U.S. dollars per student in education every year [National Center for Education Statistics, 2022].

Public education has a long history in the United States of America. Before the American Revolution, most schools were organized and funded by parents. Education was neither mandatory nor funded by taxation. In the 1830s, the notion of public education began to slowly take shape, with 55% of children enrolled in public schools [Kober and Rentner, 2020]. Throughout the 19th and

20th centuries, universal public education continued to spread, growing to its current form today.

In 21st century United States, hundreds of billions of dollars are invested into public school districts by federal, state, and local governments every year [Hanson, 2022]. Schools then spend these funds on a variety of expenditures aimed at supporting students at succeeding in their education. Yet, some school districts receive and spend far more money than others [Wermiel, 2023]. This leads to the question: does more money necessarily mean better learning and greater success for students? In other words, is there a clear link between education financing and educational outcomes?

For decades, the connection between money and student success has been a focus of educational research. This paper contributes to this subject by examining the following question: **how does the amount of money a school district receives, spends, and the way in which it allocates those funds relate to the educational outcomes of its students, as measured by performance on statewide assessments?**

This paper will first review research studies relevant to the topic at hand. Then, the methods used in this statistical investigation will be presented. Next, findings of the analysis are explored, followed by a discussion of the implications. Lastly, the limitations of this study will be evaluated, in addition to suggestions on future research in this subject area and concluding thoughts.

2 Literature Review

Schools that receive and spend more money should produce better educational outcomes and more successful students. This makes sense logically. After all, the more funding a school has, the more it can spend in various ways such as teacher training, improved learning materials, or advanced technological integration. These should then in turn, help teachers teach better and help students learn better. A survey of academic literature studying the connection between funding and student learning, however, reveals that the connection is not so clear. In fact, a surprising number of studies could not establish a correlation between the per-student funding/spending of a school and the academic accomplishments of the school's students. At the same time, a great number of studies did establish a connection between education funding and the outcomes of a school's students. Different data and methods contribute to these sometimes drastically opposing

results. Details of these findings are discussed below.

In 1966, sociology researcher James Coleman published "Equality of Educational Opportunity." More commonly known as the Coleman Report, this education policy research commissioned by the United States federal government was the first of its kind. Perhaps its most significant and controversial finding is summarized in the report as follows:

> Taking all these results together, one implication stands out above all: That schools bring little influence to bear on a child's achievement that is independent of his background and general social context [Coleman et al., 1966]

The approximately 700 pages of research found the impact that school factors have on student achievement to be minimal compared to other factors such as "family background" and the "social composition of the student body."

While the report also has other significant findings such as achievement gaps between demographics, its most remarkable discovery was the lack of connection between schools and their students' academic performance. In the 60 years since, the Coleman Report has inspired a large number of policy research using similar outcome-based investigative approaches. Some agreed with its original findings. Others disagreed.

Since the 1970s, economics researcher Eric Alan Hanushek has written extensively on educational issues including how various factors are or are not related to student performance. In a 2016 article, Hanushek reviewed the findings of the Coleman Report after 50 years of new data and research. In regards to the relation between education finances and student performance, he wrote the following:

> Achievement Gains Are Unrelated to Increased Spending... no reason to believe that increasing school spending will by itself boost student achievement. [Hanushek, 2016]

The article emphasizes that "research does not show that money never matters or that money cannot matter" but rather that "providing more funds to a typical school district without any change in incentives and operating rules is unlikely to lead to systematic improvements in student outcomes."

On the other hand, there is also abundant research that found school spending to have influence on a variety of different outcome metrics. A 2015 paper

led by Northwestern University economic policy researcher Kirabo Jackson studied the effect of "school-finance-reform-induced changes in school spending on long-run adult outcomes" and concluded the following:

> a 10 percent increase in per-pupil spending each year for all twelve years of public school leads to 0.27 more completed years of education, 7.25 percent higher wages, and a 3.67 percentage-point reduction in the annual incidence of adult poverty; effects are much more pronounced for children from low-income families [Jackson et al., 2015]

Clearly, there is fierce debate about this topic on a national level. A great deal of research has also been done on the state level, with mixed results as well. [DeGrow and Hoang, 2016] studied the relationship in Michigan and found "no statistically significant correlation" between school spending and student achievement. [Lafortune, 2022] did the same for California and found that "sustained spending increases improved student outcomes."

One thing is certain: there is no certainty as to whether education spending impacts students' academic achievement. This research paper contributes to the body of literature by examining data on all public school districts in the United States and how various characteristics match up with student achievement. While the debate of whether funding impacts student performance is unlikely to be resolved, recent data and a statistics-oriented approach should shed new light on the topic.

3 Methodology

This research paper applies numerous methods of data science and statistics. Among them are data preprocessing, data visualization, data merging, correlation analysis, and Bayesian inference. This section will present how the investigation was done and why certain choices were made.

3.1 Data Building

The data sets used in this paper were created by merging data from multiple sources. The merged data was then explored to provide a holistic understanding of education funding in the United States. To ensure only accurate data of the

highest quality was used, all data were sourced from official websites of the United States federal government.

Data collected and analyzed in this paper focuses on the school year 2018-2019. Due to the disruption caused by the COVID-19 pandemic, the data collection process was interrupted for the subsequent years[1]. Furthermore, given the changes in educational experiences from 2019 onwards, such as online teaching, the unprecedented nature of the pandemic may skew data and therefore analysis outcomes.

3.1.1 Source 1: National Center for Education Statistics

The first data source used in this research is from the U.S. Department of Education National Center for Education Statistics. Using its Elementary/Secondary Information System (ElSi) table generator, a custom data set with relevant variables[2] was generated. This data set provides, among other variables, detailed information on the government funding received by each school district and how funds were expended by each district.

3.1.2 Source 2: ED Data Express

Data regarding student performance on statewide assessments was built on and downloaded from the U.S. Department of Education ED Data Express's Data Builder. Two custom data sets[3] were built and used in this research, containing performance information on statewide mathematics and reading/language arts assessments.

3.2 Data Preprocessing

To ensure only relevant and high-quality data was merged and used in the data analysis, several data manipulation steps were taken.

For data from Source 1: National Center for Education Statistics (where each row contains information about one school district), only elementary, secondary, and elementary-secondary school systems were kept, and school districts with 0 schools, students, teachers, or funding/expenditures were removed.

[1] U.S. Department Education websites confirm disruption of the data collection and reporting process beginning in school year 2019-20.

[2] The NCES ElSi data set configuration is saved with Table ID 647862. A glossary of the selected columns can be accessed here.

[3] The EDE Data Builder sites with the filters used in this research applied can be accessed here: Mathematics Performance and Reading/Language Arts Performance.

Additional variables were calculated and added to the data, including per-pupil expenditure values by function and per-pupil education funding.

The resulting data contains over 16,000 school districts.

For data sets from Source 2: ED Data Express, a simple missing data removal was performed, where rows containing NAs were taken out.

The resulting data contains around 12,000 school districts.

3.3 Data Merging

Two data sets with school district characteristics and state assessment performance data were created by merging Sources 1 and 2 with a shared variable: NCES-assigned local education agency ID, which is a unique identifier for each school district. The first data set contains information on school district characteristics and student performance on mathematics assessments. The second contains reading/language arts assessments performance data instead.

While the raw data sets had almost 90 variables combined, the merged data sets each contain less than 20 columns.

The merged data sets have information on around 11,400 school districts.

3.4 Data Analysis

The data wrangling and analysis in this paper were done using R, a statistical programming language focused on data science [R, 2023]. The `ggplot2` package was used to create data visualizations and conduct exploratory data analysis.

In this study, inferential statistical analysis was done using Bayesian statistics methods, an approach in inferential statistics based on Bayes' Theorem. This rising field of statistics was used instead of more traditional frequentist inference procedures because its models are more intuitive to construct and its output statistics more straightforward to interpret. Its combination of prior knowledge with newly observed data to produce posterior probability statements allowed domain expertise in education statistics to better inform and constrain the prior and output more accurate results. For this paper, a review of relevant literature and descriptive results allowed the use of a weakly informative prior in the Bayesian inference. Its use of entire probability distributions rather than specific point estimates also precisely shows the uncertainty of inference results given limited data.

In this study, Bayesian inference was done using the R programming language. More specifically, the package used in this research is `brms`, which pro-

vides an interface to Stan [Stan, 2023], a statistical programming language used to build and fit Bayesian models. Bayesian inference in this investigation used Markov chain Monte Carlo (MCMC) algorithms. The models all used 4 Markov chains, each with 4000 iterations, 2000 of which warmup iterations. Feature scaling was done to the input data to normalize variables to a mean of 0 and a standard deviation of 1.

4 Results

This part of the paper will present the findings of the data analysis. First, the Descriptive Results section will explore summary statistics that describe features of the data. Then, the Inferential Results section will showcase the results from inference procedures, which infer properties of a population from a sample.

4.1 Descriptive Results

This section of the paper presents descriptive results, and aims to provide a better understanding of the data. The following subsections will describe various aspects of the data used in this research, and present data visualizations to illustrate distributions and relationships in the data sets.

4.1.1 Government Funding

Government funding for school districts comes from 3 different sources: federal, state, and local governments.

The following density plot and boxplot display the distribution of total government funding for school districts per pupil, which ranges from $5 to $649,294, with a median of $14,434.

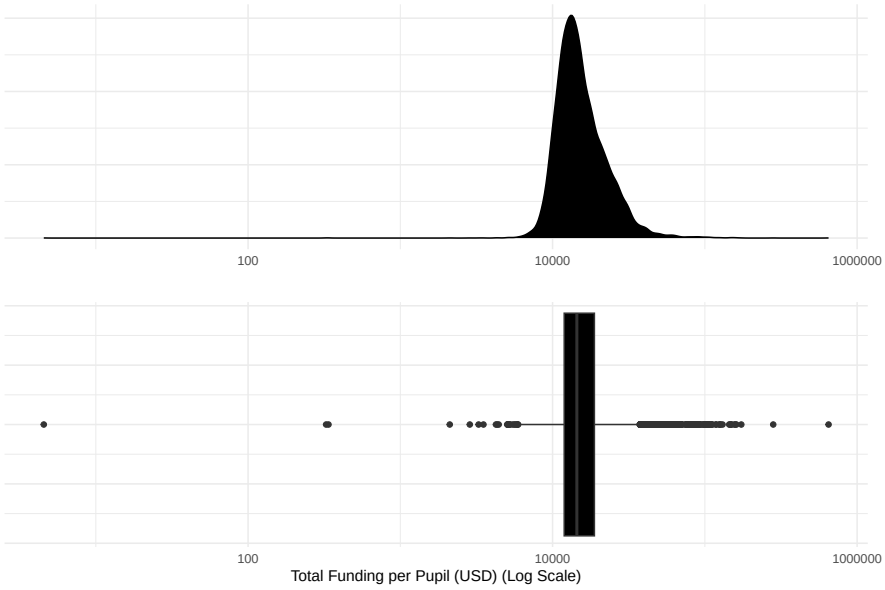


Figure 1: Distribution of Total Government Funding per Pupil at Each School District

Just as there is a great variance in government funding among school districts, there is also a considerable amount of funding disparity among different states. The two graphs below showcase states' mean government funding. Figure 2 is a bar graph of each state's average government funding per pupil, ordered from highest to lowest. Figure 3 is a map of the United States with each state colored based on its mean government funding per pupil.

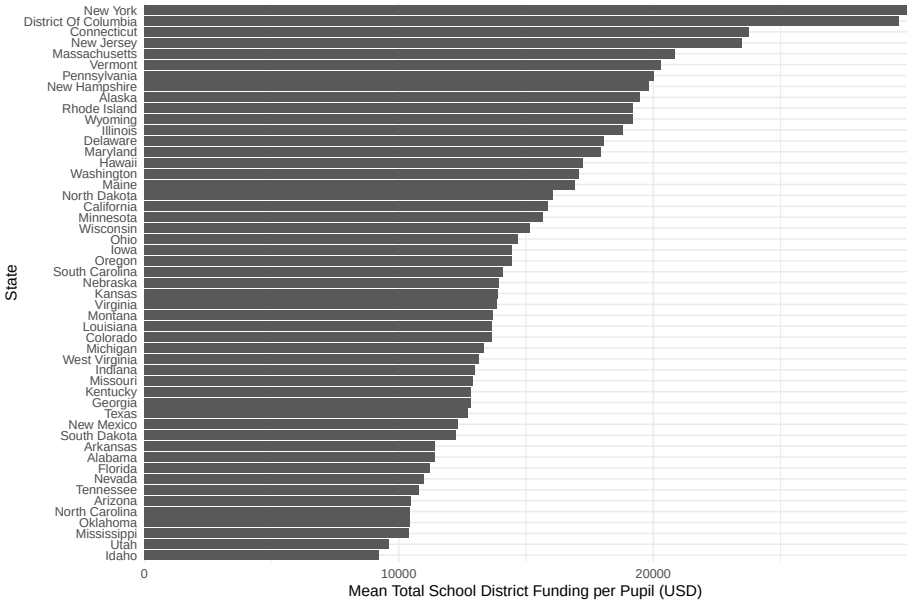


Figure 2: Bar Graph of Mean Total Government Funding per Pupil by State

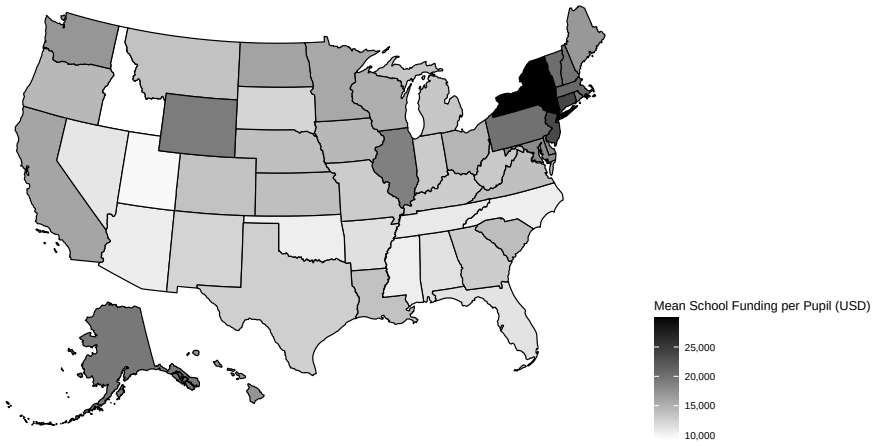


Figure 3: Map of States' Mean Government Education Funding per Pupil

As shown above, the funding difference between the states with the most per-pupil education funding and those with the least is around $20,000.

4.1.2 Education Expenditures

The statistical characteristics of school district expenditures are similar to those of school district funding. The plots below show the distribution of per-pupil expenditures among school districts.

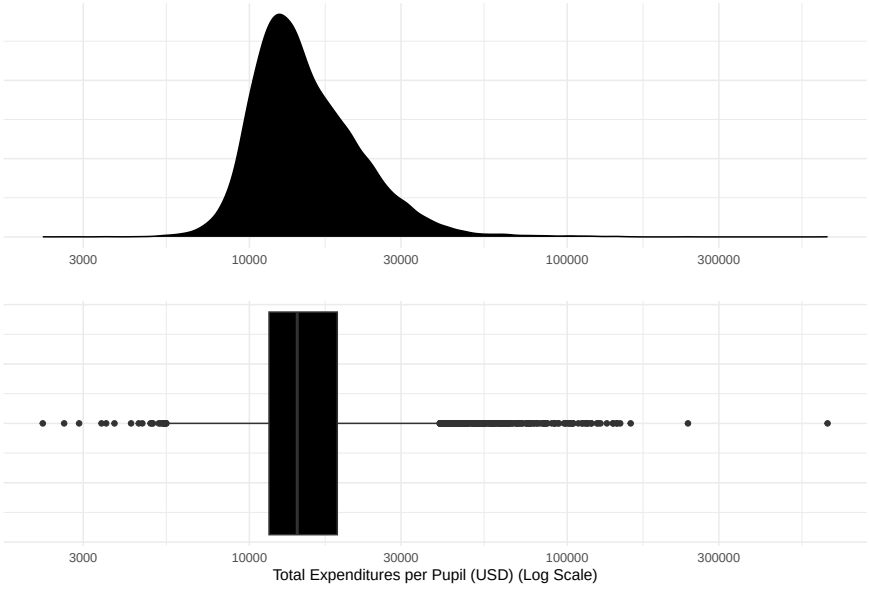


Figure 4: Distribution of Total Expenditures per Pupil at Each School District

The distribution has a median of $14,143 (same as per-pupil funding, in fact), a minimum of $2,238, and a maximum of $659,353.

The scatter plot[4] (along with marginal boxplots and a regression trendline) in Figure 5 shows the relationship between funding and expenditures at each school district. It shows that there is a positive linear relationship between the per-pupil funding and per-pupil expenditures of a school district.

A Bayesian regression model was constructed to determine the correlation between the two finance variables. $\hat{R}$ values for all the parameters are 1.00, indicating the model converged. The slope of the relationship is estimatedly 0.95

[4]The axes have limits set to better display the vast majority of the data points. 3 data points were removed by this action.

and the Bayesian R^2 value is 0.92. The difference between per-pupil funding and expenditures has a median of only $435.

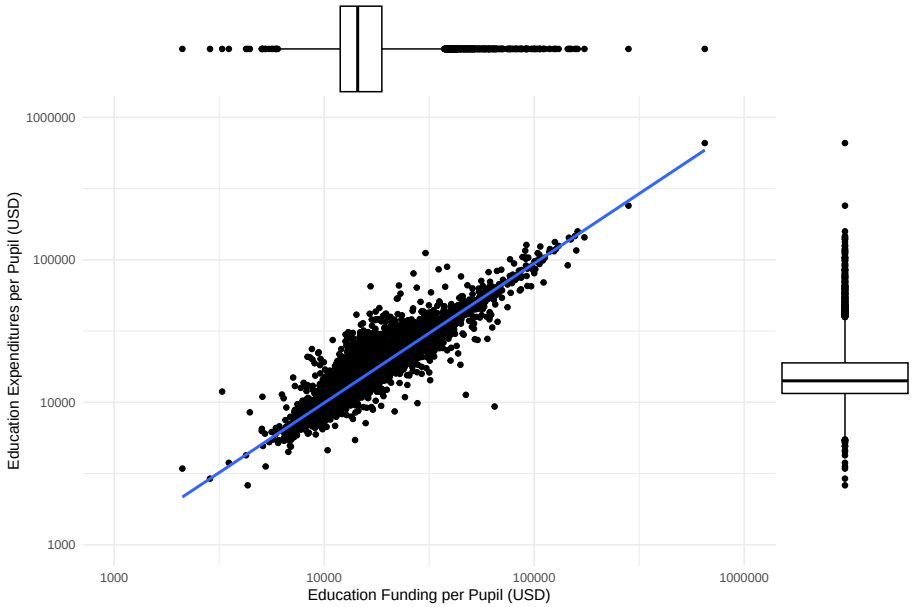
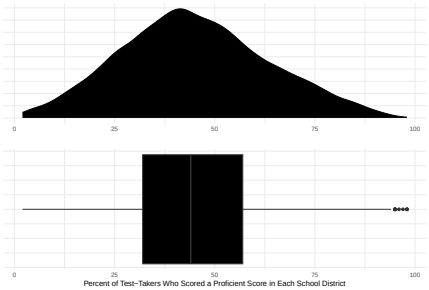


Figure 5: Relationship Between Per-Pupil Funding and Per-Pupil Expenditures at School Districts

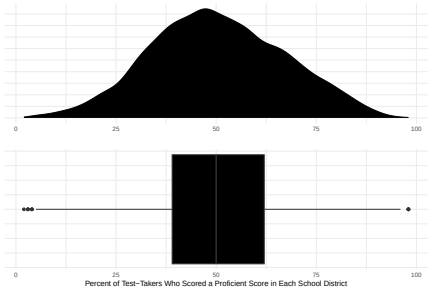
4.1.3 Assessment Performance

Source 2: ED Data Express provides information on the performance of students on statewide assessments administered across the country.

The two density plots and corresponding box plots below present the distributions of the percentage of students receiving proficient scores at each school district in the nation. Figure 6a shows data on statewide mathematics assessments. Figure 6b shows data on statewide reading/language arts assessments.



(a) Math Assessment Proficiency Distribution



(b) Reading/Language Arts Assessment Proficiency Distribution

Figure 6: Proficiency Distribution on Statewide Assessments

As the diagrams above show, the distributions of score proficiency are approximately normal with more data points near the center than there are far from the center. The distribution for math exams has a mean of 45% and a standard deviation of 18%; the distribution for reading/language arts exams has a mean of 51% and a standard deviation of 16%. Both distributions range from a minimum of 2% to a maximum of 98%.

4.2 Inferential Results

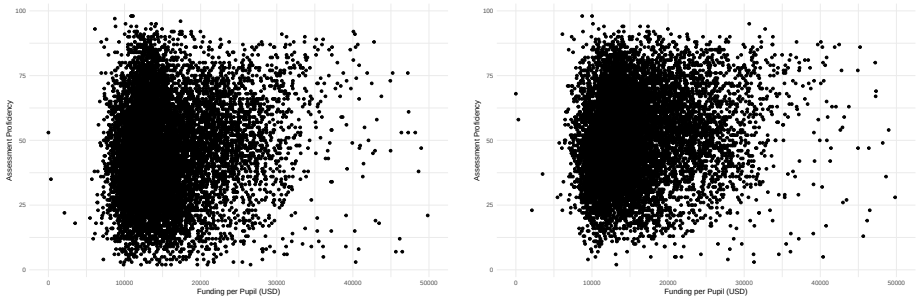
This section will use Bayesian inferential statistics to reveal how variables relate to one another, if they do. For all of the following models, the $\hat{R}$ values were 1.00 and the effective sample sizes were all of adequate values.

4.2.1 Funding and Student Achievement

The connection between per-pupil education funding and student achievement will be explored in this section.

Figure 7a and 7b show the relationship funding has with math and reading/language arts scores, respectively. In each scatterplot, each school district is represented as a dot, whose x-value is its funding per pupil[5] and whose y-value is the percentage of its students receiving proficient scores on each exam.

[5]The x-axis has a maximum set at \$50,000 to better display the vast majority of the data points. 17 data points were removed by this action.



(a) Funding vs Math Proficiency (b) Funding vs English Proficiency

Figure 7: Funding per Pupil vs Assessment Proficiency

From a brief glance, it is not clear what relationship, if any, exists between the two variables, especially due to the high number of overlapping points.

Bayesian linear regression models are more statistically informative than visual inspection so two were constructed, one for math performance and one for reading/language arts performance. The following formula was used for both:

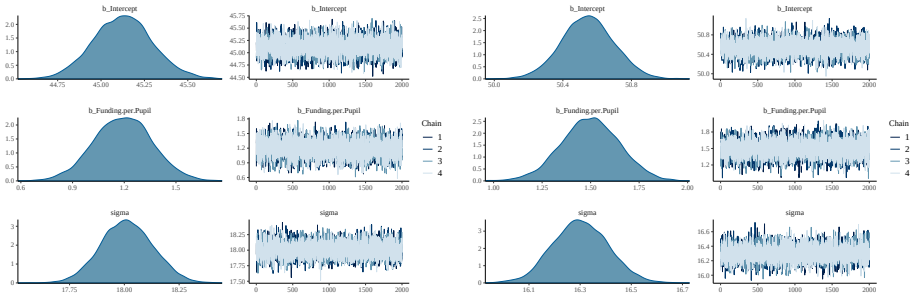
$$\text{Proficiency} \sim \text{Funding per Pupil}$$

The specifications for the Bayesian linear regression models are described in Table 1. Priors for the intercept (assessment performance) are consistent with the distributions of the test proficiencies themselves.

	Math	**English**
Prior for Intercept	$N(45, 18)$	$N(51, 16)$
Prior for Slopes	$N(0, 5)$	$N(0, 5)$
Number of observations	11,382	11,403

Table 1: Specifications for funding vs performance models

Figure 8 shows density and trace plots of the posterior distribution produced by the Bayesian models.



(a) Funding vs Math Proficiency (b) Funding vs English Proficiency

Figure 8: Density and Trace Plots of Funding vs Performance Models

Both models converged, as the $\hat{R}$ values for all the parameters were 1.00 and confirmed through visual inspection of the MCMC trace plots. Table 2 shows statistics about the posterior distributions.

Parameter	**Property**	**Math**	**English**
Intercept	Estimate	45.12	50.55
	Estimate Error	0.17	0.15
	95% CI	[44.80,45.46]	[50.25,50.85]
Funding	Estimate	1.20	1.50
	Estimate Error	0.17	0.15
	95% CI	[0.87,1.53]	[1.20,1.79]

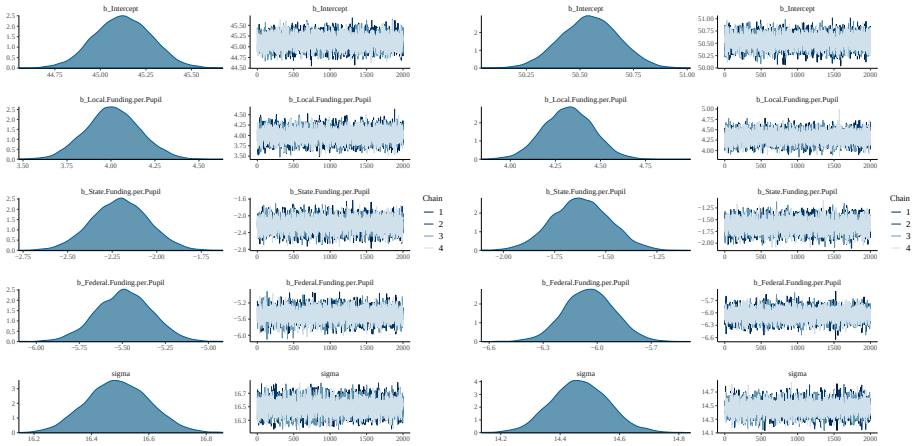
Table 2: Summary of total funding vs performance model

As the table and plots show, there is correlation between per-pupil funding and student performance on both math and English assessments. The correlation is statistically significant since the 95% credible intervals (CI) do not contain 0. The correlation is positive because the slope estimate values are both positive.

Since government funding for public education comes from local, state, and federal governments alike, this section next examines the relationship between student performance and funding from each of these government levels. This formula was used:

Proficiency $\sim$ Local Funding per Pupil + State Funding per Pupil + Federal Funding per Pupil

The trace and density plots of the outputs are shown in Figure 9.



(a) Funding vs Math Proficiency (b) Funding vs English Proficiency

Figure 9: Density and Trace Plots of Funding (by Source) vs Performance Models

Table 3 shows the output summary.

Parameter	Property	Math	English
Intercept	Estimate	45.12	50.55
	Estimate Error	0.15	0.14
	95% CI	[44.82,45.42]	[50.28,50.81]
Local Funding	Estimate	4.01	4.32
	Estimate Error	0.16	0.14
	95% CI	[3.71,4.32]	[4.06,4.59]
State Funding	Estimate	-2.21	-1.62
	Estimate Error	0.16	0.14
	95% CI	[-2.52,-1.90]	[-1.90,-1.35]
Federal Funding	Estimate	-5.49	-6.04
	Estimate Error	0.16	0.14
	95% CI	[-5.80,-5.18]	[-6.31,-5.78]

Table 3: Summary of funding (by source) vs performance model

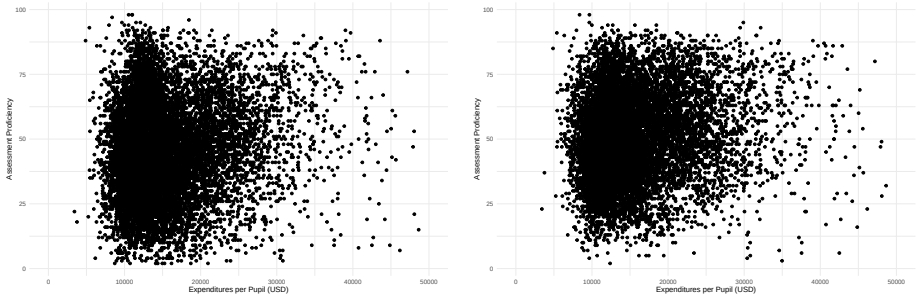
To conclude this section on the connection between school funding and student performance, there is statistically significant and positive correlation between funding and student performance — on both mathematics and reading/language arts assessments. When funding is examined with source taken into account, all correlations are statistically significant. Between local funding and performance, the correlation is positive; between state funding and perfor-

mance, the correlation is negative; between federal funding and performance, the correlation is negative.

4.2.2 Expenditures and Student Achievement

This section will investigate how school spending and student performance are connected.

As with the relationship between funding and student performance, the statistical relationship between expenditures and student testing proficiency is not directly apparent from visual inspection. Scatter plots in Figure 10 show this relationship[6]. Figure 10a does this for math, and Figure 10b does this for reading/language arts.



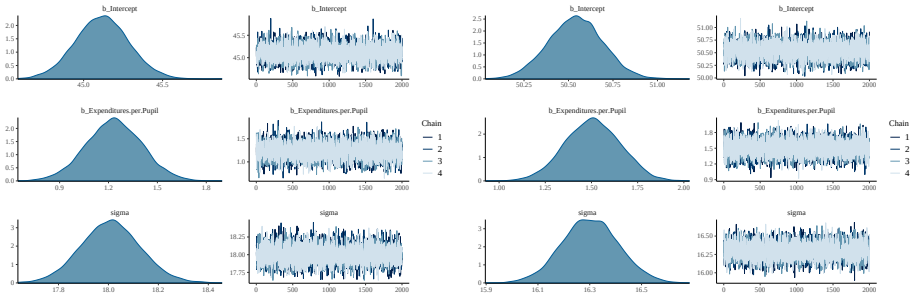
(a) Expenditures vs Math Proficiency (b) Expenditures vs English Proficiency

Figure 10: Expenditures per Pupil vs Assessment Proficiency

Once again similar to Funding and Student Achievement, Bayesian regression models were constructed to statistically determine this relationship. The following formula was used:

Proficiency $\sim$ Expenditures per Pupil

[6]The x-axis has a maximum set at \$50,000 to better display the vast majority of the data points. 16 data points were removed by this action.



(a) Expenditures vs Math Proficiency (b) Expenditures vs English Proficiency

Figure 11: Density and Trace Plots of Expenditures vs Performance Models

Parameter	**Property**	**Math**	**English**
Intercept	Estimate	45.13	50.55
	Estimate Error	0.17	0.15
	95% CI	[44.79,45.47]	[50.25,50.86]
Expenditures	Estimate	1.24	1.51
	Estimate Error	0.17	0.15
	95% CI	[0.91,1.57]	[1.21,1.81]

Table 4: Summary of total expenditures vs performance model

In addition to each school district's total expenditures per pupil, the data sets also contain information about each district's expenditures per pupil by function, including expenditure for instruction, support services, teacher salary, etc. A Bayesian regression model was once again constructed to determine how these variables correlate with students' performance on academic assessments. The following formula was used:

Proficiency $\sim$ El-Sec Education Expenditures per Pupil + Instruction Expenditures per Pupil + Support Services Expenditures per Pupil + Other El-Sec Programs Expenditures per Pupil + Salary Expenditures per Pupil + Benefits Expenditures per Pupil + Capital Outlay Expenditures per Pupil + Non El-Sec Programs Expenditures per Pupil

Parameter	Property	Math	English
Intercept	Estimate	45.12	50.55
	Estimate Error	0.16	0.14
	95% CI	[44.82,45.42]	[50.27,50.83]
El-Sec Education Expenditures	Estimate	-4.43	-2.54
	Estimate Error	4.01	4.05
	95% CI	[-12.18,3.66]	[-10.64,5.31]
Instruction Expenditures	Estimate	3.23	3.90
	Estimate Error	2.30	2.31
	95% CI	[-1.40,7.62]	[-0.59,8.50]
Support Services Expenditures	Estimate	-12.47	-9.97
	Estimate Error	1.91	1.92
	95% CI	[-16.25,-8.76]	[-13.68,-6.18]
Other El-Sec Programs Expenditures	Estimate	-2.55	-2.42
	Estimate Error	0.33	0.33
	95% CI	[-3.20,-1.92]	[-3.04,-1.77]
Salary Expenditures	Estimate	16.29	8.59
	Estimate Error	0.58	0.52
	95% CI	[15.14,17.45]	[7.56,9.62]
Benefits Expenditures	Estimate	-1.32	1.84
	Estimate Error	0.32	0.30
	95% CI	[-1.95,-0.70]	[1.27,2.43]
Capital Outlay Expenditures	Estimate	0.31	0.04
	Estimate Error	0.15	0.15
	95% CI	[0.01,0.61]	[-0.24,0.33]
Non El-Sec Programs Expenditures	Estimate	-0.27	0.24
	Estimate Error	0.15	0.14
	95% CI	[-0.56,0.03]	[-0.04,0.52]

Table 5: Summary of expenditures (by functions) vs performance model

To summarize the relationship between education expenditures and student performance on statewide assessments, the correlation is statistically significant and positive for both math and English. When expenditures are categorized by functions, the correlations between student performance and the following expenditures are statistically insignificant because the 95% credible intervals contain 0: el-sec education, instruction, capital outlay (for reading/language arts only), and non el-sec programs. Expenditures on support services, other el-sec programs, and benefits (math only) have negative correlations with student performance. Expenditures on salary, benefits (reading/language arts only), and capital outlay (math only) have positive associations with student performance.

5 Discussion

The results of the data analysis and Bayesian statistical inference in this paper have some important implications, which will be presented and discussed in this section.

The Bayesian model relating total per-pupil funding and student performance shows statistically significant and positive correlation between the two variables on both mathematics and reading/language arts exams. In other words, school districts with higher levels of per-pupil funding/spending tend to have higher proportions of assessment proficiency than those with less funding. Added to the disparity in education funding across the nation caused by regional socioeconomic differences, this confirms the education inequity that exists between different areas of the United States.

When funds are separated by their origins — local, state, and federal — the correlations between funding and performance are also all statistically significant. Student performance's correlation with local funding is positive; its correlation with state funding is negative; its correlation with federal funding is negative with greater magnitude. These indicate that education funding from local governments generally varies directly proportional to students' academic accomplishments. On the other hand, state and federal funds vary inversely with student performance. This means the prosperity of a school's local community plays an important role in the school's educational outcomes. Areas of high poverty tend to have low local funding and low student proficiency on academic assessments; more affluent areas on the other hand can often give higher levels of funding, and students in those neighborhoods usually have higher academic proficiencies. This could also indicate that local funding is more efficiently allocated than state and federal funds, and therefore has a greater and more positive impact on students' learning success by comparison. At the same time, performance's negative correlations with state and federal funding highlight potential education equity problems. School districts in low-income areas are more likely to depend on state/federal funding due to lower local funds. Thus, the schools that receive the highest proportion of their funding from federal and state governments usually face the greatest challenges that negatively impact student learning. However, the funds they do receive from the state and federal governments are not enough to overcome these challenges and significantly increase student performance.

Next, education expenditures and student performance on standardized tests

have a positive and statistically significant correlation. This aligns with common sense and indicates that school districts that spend more money per student usually have more students with proficient scores than those that spend less. Considering the large variation in education funding and expenditures, this points to a problem of unequal access to quality education.

The final Bayesian model attempts to establish a connection between student performance and education expenditures for different functions. The correlation between salary expenditures and student performance is positive, statistically significant, and of the greatest magnitude. This makes sense, since spending more on teachers and staff could increase the quality of teachers by hiring educators with more training, experience, and development. This then in turn improves students' educational success [Darling-Hammond, 2000]. On the other hand, spending on support services has a negative correlation with student performance on exams. This also makes sense, since expenditures on services such as "nurses, therapists, and guidance counselors... student transportation" do not directly contribute to the students' academic success. Additionally, this points to the scarcity of money available to school districts. While some spending could benefit the outcomes of students' education, spending on other programs plays a negative role in promoting academic learning. However, that does not mean these other programs are unimportant or that they harm students, but rather they do not directly contribute to students' test scores.

To summarize, both education funding and expenditures have positive and statistically significant correlations with student performance on statewide assessments. On the other hand, between funding by origin, expenditures by functions, and student performance, the statistical significance, direction, and magnitude of the correlations are mixed. These findings and their implications are consistent with some previous studies such as [Jackson et al., 2015], but stands in contrast with some studies like [Hanushek, 2016].

6 Limitations and Future Work

This section discusses the potential limitations of this work, and recommends future directions of research in this subject area.

6.1 Limiting Variables

One of the limitations of this research is the variables, which could limit the implications of the study.

The main input variables, funding and expenditures, are just two of many factors that can be used to describe education finances. Simplifying each school district's finances to just these a few high-level numbers ignores micro-level financial management and allocation. These include targeted intervention and special education budgets aimed at narrowing performance gaps. In addition, government funding is just one source of income for school districts. Fundraising through events and donations can also contribute a sizable portion to a school district's budget. Districts in more affluent areas often receive more private funds than those in less prosperous areas. The correlations established in this research did not account for money from these origins. Therefore, the degree of education equity could have been underestimated in this study.

The output variable of assessment proficiency is also a narrow measurement of education success, since students often learn much more than just arithmetic operations and literary analysis. Outcome variables such as digital literacy, problem-solving skills, leadership abilities, and other technical expertise are just some of the other metrics that could provide a holistic understanding of student success. In addition, learning is just one part of a student's life at school. While spending on support services has a negative correlation with statewide assessment, support services are crucial to students' well-being. Staff such as librarians, guidance counselors, nurses, therapists, bus drivers, instructional specialists, and building administrators may not play a direct role in promoting academic achievements, but they are essential to students' learning, health, and safety.

Therefore, it could be argued that the variables used in this study do not capture the whole picture about education finance and student success in schools. Nonetheless, these variables are important to policy-making, and are thus valuable targets of investigation. Future research on this subject would benefit from exploring education accounting and outcomes on a more nuanced level.

6.2 Causation vs. Correlation

Another limitation of the statistical methods used in this paper is that they did not establish causation. Rather, the inference models were only used to determine correlation. Therefore, even though statistical associations were made

between educational finances and education outcomes, causal relationships could not be confirmed. In context, this study determines that school districts with higher funding and spending tend to have higher academic proficiencies than those that receive and spend less money, but cannot determine that one causes the other.

Future research could aim for greater focus on causation rather than correlation. This could be done with longitudinal studies that explore how the cause variables and effect variables have evolved over time, with unobserved confounding variables controlled for. Alternatively, investigations could analyze how different policy changes in the past had impacted student success. These types of studies can best determine how education financing affects educational outcomes.

6.3 Scope of Data

The data used in this research consists of all public school districts from across the United States. However, there are several potential limitations to the results because of this. For instance, different regions — states, counties — could have different characteristics that change how education finances impact student education. Socioeconomic, cultural, and demographic variations across different areas of the country could influence students' experiences in dissimilar ways. Subsequent investigations can increase the power of their findings by taking these regional differences into account. Doing so allows more accurate inferences to be made about the relationship between school funding, expenditures, and student performance.

Additionally, the data sets used in this research only involved public schools, which leaves out all the private schools across the country. In fact, in school year 2019-2020, there were 30,492 private schools across the country. While this number is rather low compared to the 98,577 public schools [National Center for Education Statistics, 2023], the millions of private school students still represent a significant portion of the American education system. Since funding and expenditures for these schools are quite different from public school districts, private schools were not examined in this study. Studies in the future could create a more comprehensive picture by including private schools in the study or performing a comparative analysis on differences between public and private education systems.

7 Conclusion

This research studied the relationship between education finances and student success in American public school districts by statistically analyzing the following question: how does the amount of money a school district receives and spends and the way in which it allocates those funds relate to the educational outcomes of its students, as measured by performance on statewide assessments?

Using 2018-2019 data from the United States Department of Education, relationships between various finance variables and assessment proficiencies were established. The programming language R and Bayesian statistical methods were used to perform the analysis.

Using these methods, this research found that per-pupil education funding and expenditures have positive correlations with student performance. Local funding also has a positive association with academic success, while state and federal funds have negative associations. Expenditures on some functions such as salaries have positive correlations with student performance, while spending on others such as support services have negative correlations with the education success of students.

Despite limitations such as variables and data, the findings of this research have important implications that can inform policy-making. Ultimately, recent data combined with Bayesian inference methods provide insights that contribute to the body of literature and decision-making involving education funding and spending.

Education is one of the cornerstones of human civilization. A society with a good education system provides its people with the knowledge and skills they need to succeed in the world. This research, its predecessors, and the ones conducted in the future, will continue informing policy-makers on how best to structure an education system with specific academic goals in mind.

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