

Alchemy of Education: Unveiling SAT Score Dynamics in Massachusetts



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Introduction

Amidst the quest for educational excellence and equitable outcomes, the relationship between educational expenditure and student achievement remains a topic of fervent debate. As we navigate through the complexities of educational funding and student performance, it becomes imperative to scrutinize the interplay of various factors shaping the educational landscape. In Massachusetts, renowned for its academic prowess, the persistence of achievement gaps within school districts underscores the urgency of our inquiry.

Our research endeavors to unravel the intricate dynamics between per pupil expenditure, average teacher salaries, student graduation rates, and Scholastic Aptitude Testing (SAT) scores in Massachusetts elementary schools. By delving into these relationships, we aspire to glean insights that can inform evidence-based policymaking and practice, steering us towards educational equity and excellence across the state. Through this exploration, we strive to uncover pathways to optimize educational investments and foster student success, thereby propelling Massachusetts schools towards a future of enhanced quality and opportunity.

Research Question

How do Scholastic Aptitude Testing (SAT) scores differ when compared to per pupil expenditure costs, average teacher salaries, and student graduation rates of district schools in Massachusetts?

Hypotheses:

- H1-1:** There exists a significant correlation between SAT scores and per-pupil expenditure.
- H1-2:** There exists a significant correlation between SAT scores and average teacher salaries.
- H1-3:** There exists a significant correlation between SAT scores and student graduation rates.

Interested Variables are:

- Independent (Explanatory):**
 - Per pupil expenditure
 - Average teacher salaries
 - Student graduation rates
- Dependent (Outcome):**
 - Scholastic Aptitude Testing (SAT) scores
- Control:**
 - Low-Income Population

Contribution:

My research fills a critical gap by examining SAT scores alongside per-pupil expenditure, teacher salaries, and graduation rates in Massachusetts district schools. Unlike previous studies focused solely on MCAS scores, my approach offers a broader perspective. By considering additional factors, such as teacher salaries and graduation rates, the study aims to enhance understanding of the relationship between school funding and student success. This comprehensive analysis provides valuable insights for informing educational policy and practice.

Dataset

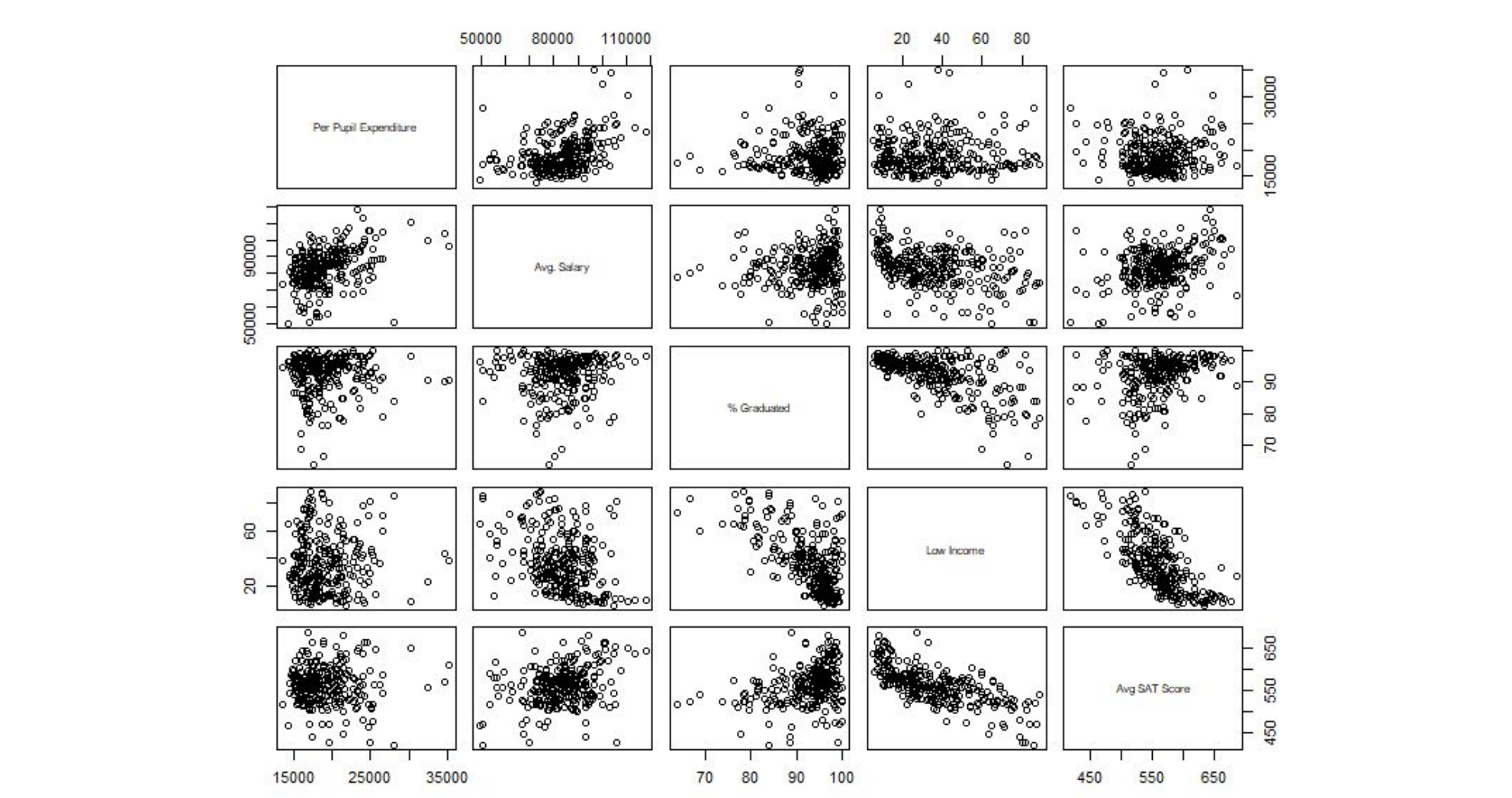
The dataset utilized for this analysis is sourced from the Department of Elementary and Secondary Education (DESE) in Massachusetts, comprising publicly available reports categorized into distinct sections. These reports offer comprehensive insights into district and school profiles within the state and are regularly updated to ensure accuracy and relevance. The datasets include information on per pupil expenditures, SAT performance, teacher salaries, graduation rates, and selected populations.

- Per Pupil Expenditures:** Provides details on in-district and total expenditures, calculated by dividing a district's operating costs by its average pupil membership (FTEs).
- SAT Performance Reports:** Offer mean scores at district and school levels for selected populations and all students.
- Teacher Salaries:** Encompasses average salaries for full-time equivalent (FTE) teachers, derived from end-of-year financial reports.
- Graduation Rate Reports:** Present district-level graduation rates.
- Selected Populations Report:** Provides enrollment data for various student groups in public and charter schools within the state.

Descriptive Statistics Final_df N: 269					
	% Graduated	Avg SAT Score	Avg. Salary	Low Income	Per Pupil Expenditure
Mean	92.50	560.72	83413.37	36.26	19119.71
Std.Dev	6.16	44.83	11323.35	20.59	3352.95
Min	63.80	418.00	49544.00	5.80	13660.99
Q1	90.50	532.00	76921.00	19.70	16704.59
Median	94.50	562.00	84365.00	33.40	18320.35
Q3	96.70	585.00	89676.00	48.30	20857.87
Max	100.00	687.00	117960.00	88.80	35113.70
MAD	4.45	38.55	10318.90	20.90	3060.01
IQR	6.20	53.00	12755.00	28.60	4153.28
CV	0.07	0.08	0.14	0.57	0.18
Skewness	-1.61	-0.08	-0.30	0.62	1.46
SE_Skewness	0.15	0.15	0.15	0.15	0.15
Kurtosis	3.06	0.71	0.72	-0.45	3.45
N_Valid	269.00	269.00	269.00	269.00	269.00
PCT_Valid	100.00	100.00	100.00	100.00	100.00

Methodology

Our study employs hypothesis testing through linear regression analysis to examine the associations between Scholastic Aptitude Testing (SAT) scores and key variables, namely per pupil expenditure, average teacher salaries, and student graduation rates within Massachusetts district schools. By leveraging this analytical approach, we can scrutinize specific hypotheses regarding the significance of these variables in predicting SAT scores. Through hypothesis tests, we evaluate the significance of regression coefficients, providing valuable insights into the strength and direction of these relationships. Additionally, diagnostic tools such as Cook's distance and leverage plots are employed to evaluate model performance and identify influential data points. Furthermore, we integrate low-income population enrollment as a control variable to mitigate potential confounding effects. Our methodology encompasses the exploration of various model iterations to comprehensively examine the relationships between these variables and SAT scores.



Results

In the initial model assessing the relationship between per pupil expenditure and average SAT scores:

- The estimated coefficient for per pupil expenditure was not statistically significant ($p = 0.97$), indicating no significant impact on SAT scores.
- The model lacked statistical significance, with a low R-squared value and high p-value.

For the second hypothesis regarding average teacher salaries:

- There was a statistically significant positive relationship between average teacher salaries and SAT scores.
- However, the effect size was small, explaining only a small proportion of the variability in SAT scores.

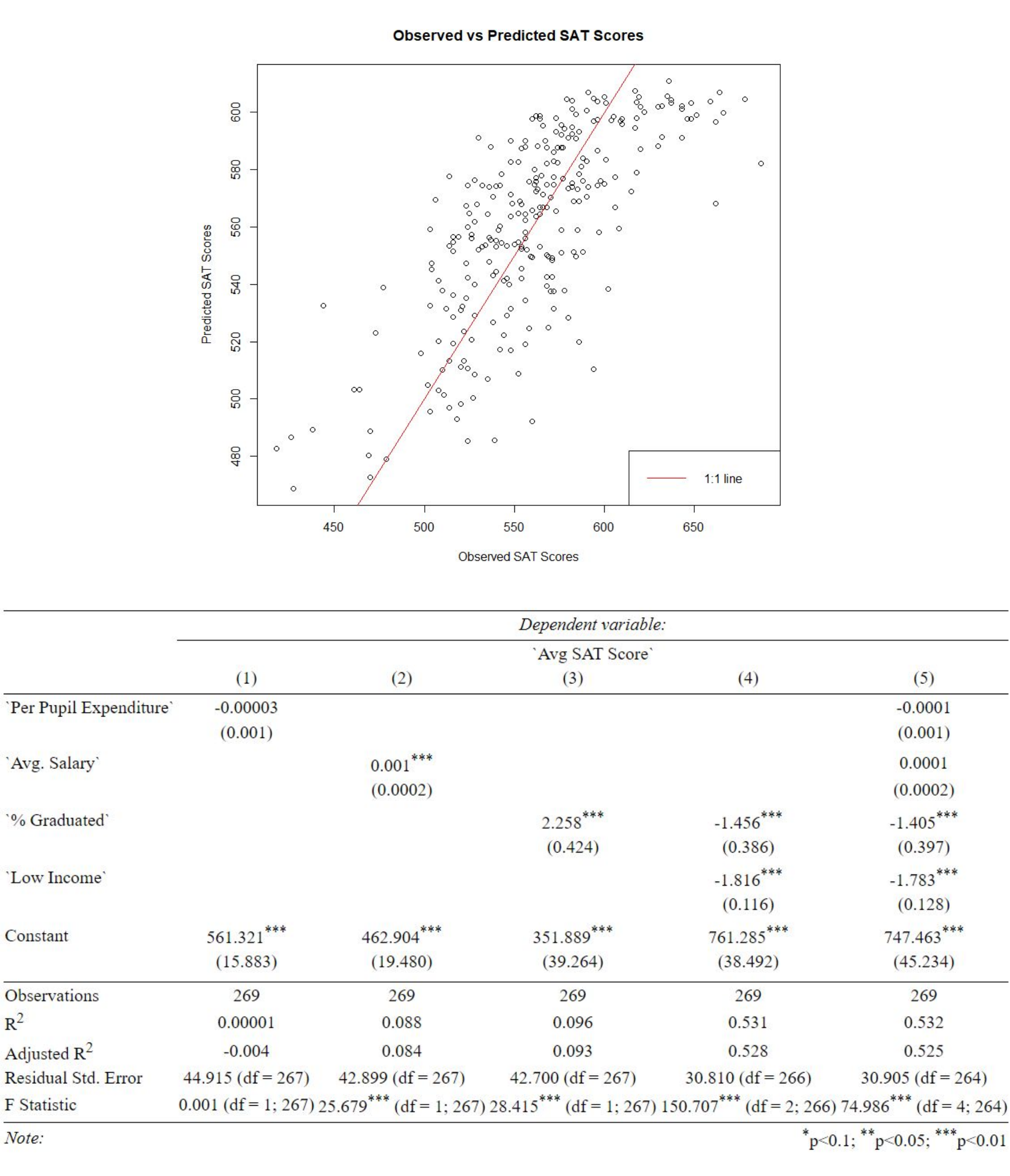
Regarding the third hypothesis on graduation rates:

- There was a statistically significant positive relationship between graduation rates and SAT scores.
- Similar to average teacher salaries, the effect size was small.

In the enhanced regression model:

- Including average teacher salaries, graduation rates, and low income as control variables did not significantly enhance the predictive capability of the model.
- The percentage of students from low-income backgrounds remained the most significant predictor of SAT scores.

Overall, the regression analyses suggest that while average teacher salaries and graduation rates have statistically significant relationships with SAT scores, they explain only a small proportion of the variability. The inclusion of additional control variables did not substantially improve the model's predictive power, highlighting the dominant influence of low-income populations on SAT performance.



Model Comparison

After testing various regression models, we found that certain independent variables had a significant impact on SAT scores. Our analysis revealed that models including graduation rates and low-income population as predictors performed the best. Out of all the models tested, the seventh model, which included only these two variables, stood out. It exhibited statistical significance and achieved the highest R-squared value, explaining about 53% of the variation in SAT scores. Additionally, when comparing the AIC and BIC values across all models, the seventh model consistently outperformed the others, indicating its superior predictive capability. Therefore, we selected the seventh model as our final model for its strong explanatory power and favorable AIC and BIC values.

	Model	AIC	BIC	Adj_R_Squared	Num_Observations
1	Mod_1_h1	2814.344	2825.128	-0.003739853	269
2	Mod_1_h2	2787.141	2800.428	0.084321023	269
3	Mod_1_h3	2787.141	2797.925	0.092801582	269
4	Mod_2	2626.619	2644.593	0.504148631	269
5	Mod_3	2614.546	2632.520	0.525911508	269
6	Mod_4	2616.173	2637.742	0.524774583	269
7	Mod_5	2612.553	2626.932	0.527682032	269

Conclusion

Our exploration of SAT scores in Massachusetts district schools yielded intriguing findings. We investigated three explanatory variables—per-pupil expenditure, average teacher salary, and graduation rates—to understand their impact on SAT scores. Additionally, we included a control variable: the enrollment of students from low socioeconomic backgrounds.

- Significant correlations found between SAT scores and average teacher salaries, as well as student graduation rates.
- Per-pupil expenditure showed no significant relationship with SAT scores.
- Percentage of low-income students emerged as a crucial predictor of SAT performance.
- Both graduation rates and percentage of low-income students were statistically significant and included in final model. However, both variables were negatively correlated with SAT scores, indicating complexity.
- Model Achieved a subsequent R-Squared measure of 53%.

These findings underscore the multifaceted nature of academic achievement, which is influenced by various factors beyond financial investment alone. Further exploration is warranted to unravel the complexities of this relationship for success..

References

- Educational Analysis & Policy Evaluation; Hanushek; 1997
- Does Money Matter; C. Taylor; 1997
- Learning From School Choice; Peterson & Hassle; 1998
- School District Size & Student Performance; Hicks, Faulks & Devaraj; 2018
- Do Community Factors Matter; Arteaga & Glewwe; 2019
- The Effect Of District Level Expenditure; A. Kopco; 2022