

# Enhancing Decision-Making for Parents and Authorities: A Comprehensive Analysis and Mapping of School Performance in New York City

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## 1. Abstract

This document is the final report towards the group project, where we presented our outputs, outcomes, and scope for future exploration. The document further highlights our initial hypothesis and how it had evolved over the development of the analysis. The problem under the scope of this analysis was that the easy modes to evaluate the performance of schools in NYC do not exist for cities and authorities. This creates a fragmented experience for the parents who would want to understand which schools are right for their children, the authorities who could better understand school level experience data to take improvement decisions and the students themselves whose experience and learning can be improved. Using two data sets, we explore the relationship between student's satisfaction and experiences such as opportunities for growth, belongingness with the community and feeling of safety with the schools' rankings in public schools of New York City. Using this we derive factors which affect schools' rankings and explore if there is any correlation between students' happiness and rankings.

## 2. Introduction

### 2.1. Background

There are many factors that can affect a parent's decision to move to a specific school district or send their child to a certain school. There are also numerous resources to consult if looking for advice or resources that rank schools to aid in this decision-making process. One popular resource is GreatSchools.org. They rank schools on a scale from 1 (lowest) to 10 (highest) based on test scores, student progress, and equity. U.S. News & World Report also publishes lists of the best schools in specific cities and states. They rank schools based on college readiness, state assessment proficiency, state assessment performance, underserved student performance, college curriculum breadth, and college readiness. For most parents, all these factors are likely very important to consider when deciding what school their child should attend. However, neither school ranking system considers student experience outside the realm of the curriculum and test taking. By looking at just one of the many sites that rank schools, GreatSchools.org, our goal is to bridge the gap and determine if there is a relationship between student experiences and school ratings.

### 2.2. Problem Statement

Analyze and describe the relationship between students' satisfaction and experiences, and public schools' ranking in New York City.

### 2.3. Objectives

By merging and analyzing the two datasets, the goal is to determine if there is a relationship between any independent variables relating to student satisfaction/experience and school ratings. If there does appear to be a relationship, the next question to answer is what factors have the largest impact on the school ratings.

### 2.4. Significance of the Study and its business impact

By employing the insights obtained through this exercise, we can strategically assess the most effective methods to promote and market public schools in New York City to prospective students and their parents. This analysis takes into consideration the influential factors affecting school rankings and students' experiences, empowering us to make informed decisions that will maximize our business potential. In the short and long term, we see the following key business impact:

Short Term	Long Term
<ul style="list-style-type: none"> <li>Promote and market schools on strengths.</li> <li>Assist parents in informed decisions.</li> <li>Highlight overlooked factors in rankings.</li> </ul>	<ul style="list-style-type: none"> <li>Lead to sustainable improvement of school infra over time.</li> <li>Promote positive competition across schools.</li> <li>Inform policy and decision making.</li> </ul>

### 2.5. Organization of the Paper

This paper is organized into five key sections:

- **Introduction:** Describes why the problem of analyzing the relationship between students' satisfaction and experiences, and public schools' ranking is important and highlights the background information about the data sources we are working on.
- **Literature Review:** This section looks at desk research of relevant studies and research around factors that may have the largest impact on school ratings.
- **Methodology:** Describes the approach for undertaking this analysis, this section highlights the data collection methods, data analysis techniques, and variables used to examine the research questions.
- **Dashboard:** Highlights our approach and structuring towards visualizing the datasets and key outcomes from the analysis.
- **Results & Discussion:** Describes the output of the analysis and key learnings.
- **Future scope:** Highlights potential ways in which the study can be continued in the future or the scope for future development.
- **Conclusion:** Presents a compilation of our learnings from the study, we compare our initial hypothesis to our outputs and present our learnings.
- **References:** This section includes a list of all cited sources.

## 3. Literature Review

To determine the need for this study and what factors may have the largest impact on school ratings, several articles related to the topic were reviewed. The first article of interest is "How student satisfaction factors affect perceived learning" by Celia C. Lo. and it discusses a study performed at a research university in 2009 that aimed to determine if students' satisfaction in three different categories (instructor performance, student commitment to learning, and course policies) impacted perceived student learning. Researchers found that teacher performance and students' perceptions of the learning environment influence subjective perceptions of student learning. However, caution is needed when generalizing the findings due to the limited sample size and specific context. Students' perceptions of the learning environment relate to several survey questions in one of our datasets. Those survey questions are as follows:

1. Question 13 - This school is kept clean.
2. Question 18 - During this school year, I have felt safe when learning.
3. Question 63 - At this school students harass, bully, or intimidate other students.
4. Question 69 - At this school students get into physical fights.

The results of this study tend to support our hypothesis that there is a positive trend between student satisfaction/experiences and school rankings. The factors listed above will be considered in our analysis.

Another research article, “Prediction of Academic Achievement and Happiness in Middle School Students: The Role of Social-Emotional Learning Skills,” detailed the study of 337 middle schoolers and investigated the relationship between social-emotional learning skills and academic achievement and happiness. Researchers found that there is a positive correlation between these factors and that enhancing social-emotional learning skills can improve academic performance and happiness. Guidance and counseling programs, along with activities promoting social-emotional learning skills, can also support students' development. Due to the results of this study, we will include survey questions relating to students' happiness to determine if we also find a positive trend between this and school rankings.

## 4. Methodology

### 4.1. Data Collection

The following two datasets were used in our analysis:

- (i) **NYC 2022 School Survey ([link](#)):** Each year, members of the school community (families, students, and teachers) in grades 6-12 take the NYC School Survey. The survey provides leaders with an understanding of what the members of their school community think about their schools. Our dataset is for the year 2022. The survey is aligned to the DOE's Framework for Great Schools. It is designed to collect important information about each school's ability to support student success. In 2022, we have Likert based survey data for more than 1,000 schools. Each student survey had more than 80 questions.
- (ii) **Greatschools.org School Rankings ([link](#)):** The ratings are collected by an independent nonprofit organization Greatschools.org. Details on how ratings are collected are described in this [link](#). Each row is a public school in NYC, and each column describes the rating by GreatSchools.org and the demographic information collected. For the ranking dataset we used Great Schools API to collect the ranking of all the public schools in New York.
  - The API has a limit of 50 records with each call. This was an issue because we have more than 1500 schools in our survey dataset.
  - To get around this problem, we found another dataset which had all the zip codes for the city of New York. We looped through the zip codes to receive 50 schools in each zip code and compiled a final dataset.

The datasets used are available in this [folder](#).

### 4.2. Research Design/Approach

The research followed a two-phase approach: I) Exploratory data analysis and reporting and II) Statistical modeling.



Figure 1: Two phased approach for the analysis

#### Phase I: Exploratory data analysis and reporting

In the first phase we developed tableau visualizations on the datasets to understand the responses to different questions in the survey and study the commonality in patterns. Additionally, for schools that were common in the two datasets, we created a map-based visualization of New York schools and showcased the rankings alongside the responses to different survey questions.

#### Phase II: Statistical Modelling

In this phase, we investigated analysis relevant to survey data (ANOVA, correlation analysis, etc.), as well as used logistic regression to get a ranking of student satisfaction and experiences from dataset A.

- Positive answers increase student happiness probability.
- Negative answers decrease student happiness probability.

Using this student happiness ranking as an independent variable in dataset B to see if it correlates with rankings.

- Split into training and test data.
- Plot data points to understand existing relationships between independent and dependent variables. Also, to check for multicollinearity.
- Run initial regression.
- Check linearity, constant variance, and normality assumptions.
- Perform transformation, if necessary.
- Validate various models on validation data.
- Select the most suitable model to test on test data.
- Identify schools with great rankings and student happiness ratings as the top schools to promote to parents.

#### 4.3. Data Analysis

Before we could begin any data analysis the two datasets had to be combined, which was done based on common schools. We found that 296 names of schools' match exactly and those that did not match were due to misspellings. Since there was no common numerical identifier for the schools in each dataset, we determined that 296 schools provide sufficient data to analyze and move forward with.

Additionally, we converted our joined dataset from wide format to long format. This reshape was absolutely required for Tableau dashboards. We made the long format our default since it was also compatible with our statistical modelling aspirations. ([link](#))

#### 4.4. Variables and Measurements

Our research is based on the four key points:

- Identify factors having the highest impact on the schools' ranking.
- Measure factors that influence the student satisfaction and experiences.
- Investigate correlation in metrics.
- Determine if trend exists between survey factors & rankings.

We used the school names to join the two datasets. We also experimented with feature engineering Likert scale to binary responses. The independent variables are survey responses, whereas the dependent variable is the Great School ranking.

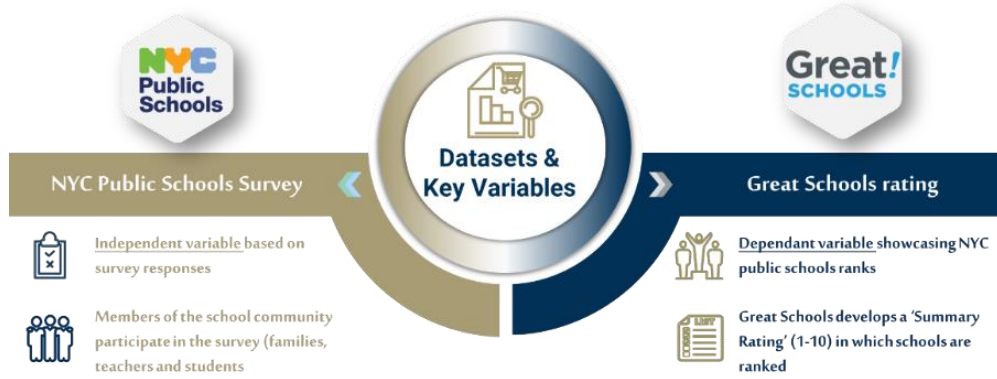


Figure 2: The datasets and key variables used in the analysis.

## 5. Dashboard

To enhance our analysis and gain deeper insights into the findings, we developed a user-friendly Tableau dashboard. The primary objective was to facilitate a comprehensive comparison between various aspects of lower-rated and higher-rated schools based on survey responses. The Tableau dashboard allowed us to visualize and explore the data more interactively, promoting a better understanding of the observed trends mapped across the NYC.

Upon examining the dashboard, we found that there is no discernible difference in how lower-rated schools and higher-rated schools responded to the survey questions. The patterns and trends displayed in the visualizations did not exhibit any clear distinction between the two groups. This insight challenges initial hypothesis and demonstrates the complexity of factors influencing school ratings. The dashboard is accessible through Tableau Public - [here](#).

Overall, the Tableau dashboard has proven to be a valuable tool in presenting and interpreting our analysis effectively. While the absence of distinct trends between lower-rated and higher-rated schools may initially seem surprising, this observation encourages further exploration and deeper investigations into the underlying determinants of school ratings. We remain optimistic that this research will contribute positively to the ongoing efforts to improve the educational landscape and foster a more equitable and enriched learning environment for all students.

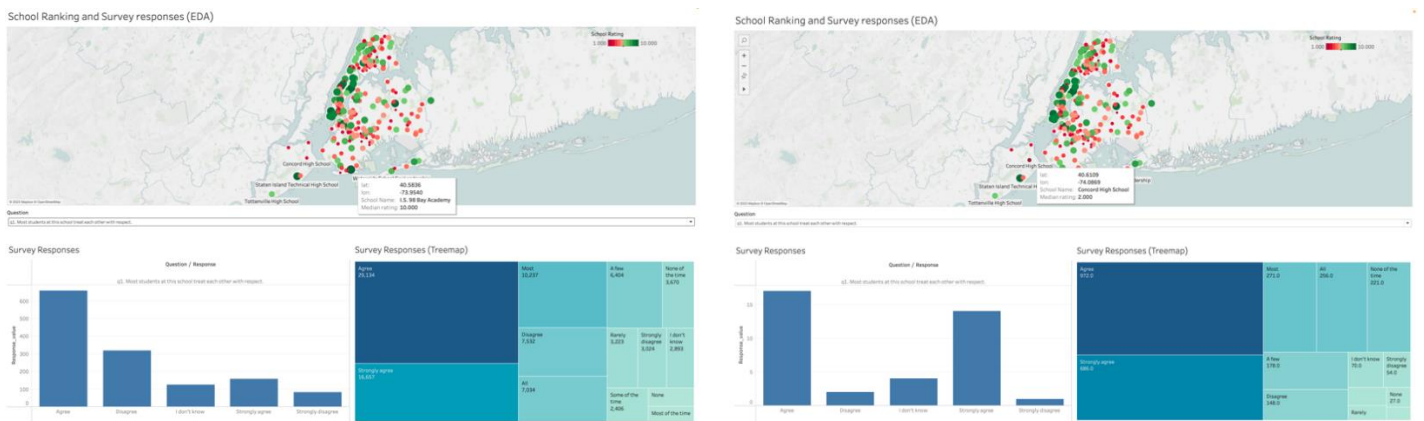






Figure 3: The distribution of responses for a school rated 10, and a school rated 1 or 2 are very similar.

## 6. Results & Discussion

- We were able to successfully conduct a correlation analysis on survey questionnaires and school rankings. Our research has yielded some intriguing results. Surprisingly, we discovered that the survey question “q21. During this school year, I have felt stressed out when learning” had the highest positive correlation (0.337) with the school rating. This unexpected finding shows that there may be a complex link between academic achievement and students reported stress levels.
- Furthermore, we discovered that the survey item “q39. My teachers check-in with me frequently about how I'm doing both personally and academically” had the most negative correlation (0.426) with school ranking. This data deviates from our initial hypothesis, implying that frequent teacher check-ins may have a different impact on academic achievement than previously believed.

Response	Question	rating
26	q21. During this school year, I have felt stressed out when learning.	0.337309
28	q22. During this school year, I have felt worried when learning.	0.319305
24	q20. During this school year, I have felt bored when learning.	0.196501
22	q2. Adults at this school communicate with me in a language that I can understand.	0.182894
70	q59. I feel safe...outside around this school.	0.166199
94	q77. If you are a student in grades 9–12, ANSWER this question. How much do YOU agree with the following statements? Adults at this school (including teachers, administrators, counselors, and the principal)... encourage students of all races, ethnicities, genders, cultures, and backgrounds to take challenging classes.	0.162275

Figure 4: Correlation analysis on the survey questionnaires and school ranking

- The survey questions presented in Figure 4 were carefully selected as they encompassed various aspects related to student satisfaction and experience. This is a subjective list, and different selections might have yielded different conclusions. The survey questions covered topics such as cleanliness and safety within the school, which are directly linked to the overall experience, while others focused on aspects like happiness during learning and expressing emotions, which are closely related to overall satisfaction.
- To assess the relationship between the percentage of students agreeing with these questions and school ratings, pairwise correlations were computed and depicted in Figure 5. A correlation of at least 0.60 would have indicated a significant association between the two variables. However, upon analysis, none of the independent variables demonstrated a correlation close to 0.60. As a result, the findings do not support the initial hypothesis.
- Although the hypothesized correlations were not evident, this study provides valuable insights into the complexity of factors influencing student satisfaction and experience within the school environment. The findings highlight the

multifaceted character of student opinions and the need to take a larger variety of factors into account when evaluating overall school ratings. These findings can be used to direct future research and policy efforts, ultimately creating an atmosphere that promotes student well-being, engagement, and achievement.

Survey Question	Pairwise Correlation
q13. This school is kept clean.	-0.071084
q17. During this school year, I have felt happy when learning.	-0.117139
q18. During this school year, I have felt safe when learning.	0.151665
q40. There is time at school to talk about feelings and emotions.	-0.298613

Figure 5: Survey questions related to student satisfaction/experience and corresponding correlation.

- Further, we implemented a random forest algorithm using train (60%), test (40%) split. The independent variables were the ratios of positive responses, and survey questions (we created interaction variables for survey questions) and the dependent variable was the school ranking. The training accuracy was 0.42 (which matches the highest negative correlation score), and testing accuracy was 0.16 (a little higher than 0.1 if classes were selected randomly). This deviated from our hypothesis because we initially thought the survey responses would be able to predict school ranking better than our results. ([Link](#))
- Logistic regression: We also ran a logistic regression model to see if there would be any differences compared to the random forest classifier. We used the same independent (ratio of positive responses and survey questions) and dependent variable (school ranking). Compared to the random forest classifier, we achieved a lower training accuracy of 0.21, but a higher testing accuracy at 0.19 using the logistic regression model ([link](#)). We can see the low testing accuracy from the output of the confusion matrix in Figure 6.

	Predicted									
	0	1	2	3	4	5	6	7	8	9
Actual 0	128	0	203	74	10	9	0	0	0	0
Actual 1	21	0	76	21	1	2	0	0	0	0
Actual 2	70	0	438	250	3	19	0	0	0	0
Actual 3	29	0	444	234	10	23	0	0	0	0
Actual 4	10	0	289	217	11	13	0	0	0	0
Actual 5	15	0	341	228	12	25	0	0	0	0
Actual 6	15	0	286	134	7	20	0	0	0	0
Actual 7	10	0	141	146	8	14	0	0	0	0
Actual 8	14	0	98	41	0	7	0	0	0	0
Actual 9	5	0	139	55	3	11	0	0	0	0

Figure 6: Confusion matrix output from logistic regression

Note that the diagonal cells (from top-left to bottom-right) represent the true positives for each class. The cells outside the diagonal represent the false positives for the corresponding row's class, while the cells inside the diagonal but outside the true positive cells represent the false negatives for the corresponding column's class.

- We used linear regression to model the relationship between students' positive responses to the question “During this school year, I have felt happy when learning” (independent variable) and school rating (dependent variable). A positive response was classified as support or strongly support. The data was divided into a training dataset (75%) and test dataset (25%). The model was created with the training dataset and predictions were made with the test data. If the accuracy score had been close to 1 as we predicted, then we could have concluded that there is a positive correlation between the two variables. However, the accuracy score was about 0.162. This indicated a very low correlation and does not support our hypothesis. Figure 7 further supports the conclusion that there is no clear relationship between the two variables. ([Link](#))

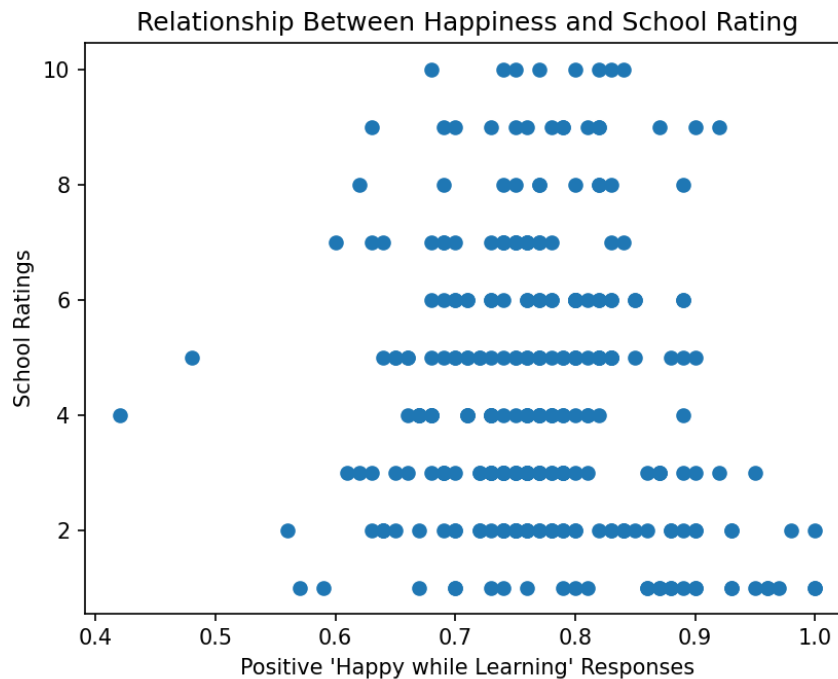


Figure 7: Relationship between positive responses to “happy while learning” survey question and school rating.

- This also seems to match the conclusions from the random forest classifier and logistic regression model and goes against our hypothesis that student responses would be able to predict school rankings.
- Ranking data is ordinal. However, we had ignored this up until now. We wanted to explore if our poor results were because of this assumption. Therefore, we developed another model using the mord package in python. The accuracy score did not improve. Weirdly enough, the predictions of school ranking were mostly a 2, 3 or 5 for both training and testing. This made us realize that the ordinality of the data was not as big of an issue as the data mostly being noise and not a signal to represent school ranking ([Link](#)).
- The range of ranking in our dataset is from 1 to 10. For parents, the level of granularity might not be relevant. Additionally, we wanted to experiment if a binary classification (we categorized ranking of 1-7 as “not good” and 8-10 as “good”, but we also experimented with different thresholds). Regardless, random forest algorithm with previous setting did not produce a good prediction model. The accuracy score was only 56% (slightly better than 50% if selected randomly given two classes) ([Link](#))
- Apart from bagging algorithms, we also experimented with boosting. We developed another model using the XGBoost package in python. We replicated the binary classification process discussed above in XGBoost. Here too, the accuracy of the model remained poor but comparatively better than bagging (55%) ([Link](#))



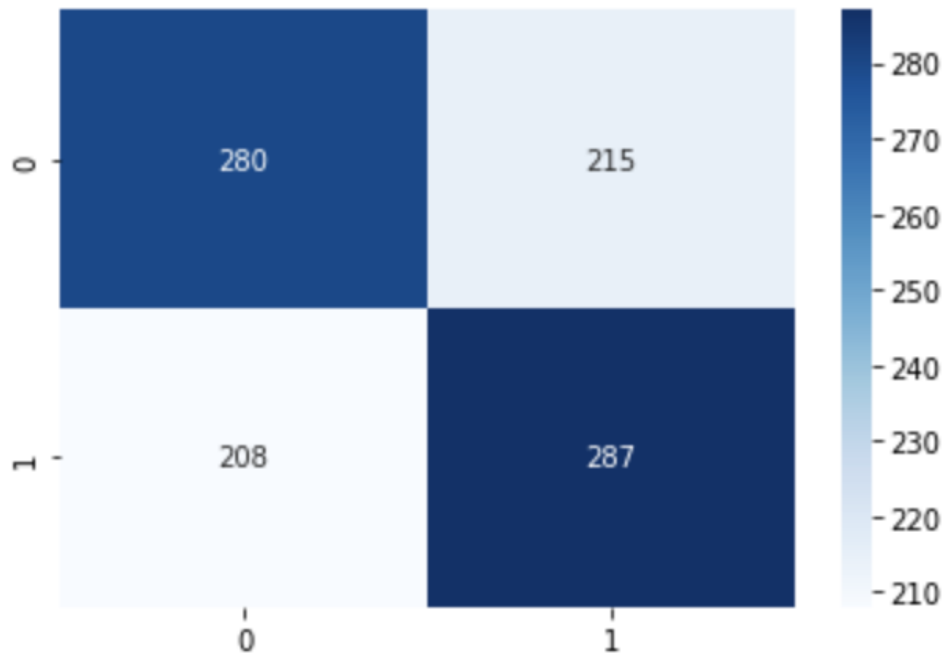


Figure 8: Confusion Matrix for XGBoost model.

- In all of the aforementioned models, we made sure to implement best practices. We used balanced data for training and made sure there was no data leakage. In one of the very first iterations, we were using school name as an independent variable. This resulted in an accuracy score of 100%. Unfortunately, we were leaking data.
- Our initial goal was also to calculate a difference in mean in the survey data between schools that ranked well and that did not rank well using ANOVA. However, after researching this, we realized that ANOVA is not ideal for Likert scales. The research indicated that an ordinal logistic regression would be much more apt for Likert scales. We had already completed this experiment with poor results. ([Link](#))

## 7. Future scope

Throughout our research, we acknowledge that time constraints have influenced the scope of our exploration. However, given more time, we would have pursued alternative approaches to delve deeper into the data and uncover further insights.

- Since we were using School Names to join two of our primary datasets, the cardinality of the intersection set was small. We would have wanted to experiment with Cosine similarity to increase the cardinality.
- Despite our initial hypothesis being rejected, we recognize the importance of continued investigation to uncover meaningful correlations between school ratings and other relevant factors. Future research could focus on exploring and analyzing different datasets that could potentially demonstrate stronger correlations with school ratings. For instance, examining the connection between school ratings and average income, average class size, or the size of the school district might offer valuable insights into the dynamics influencing educational outcomes.

While our study presents valuable findings, we recognize the potential for further research to expand upon our existing knowledge. The pursuit of new datasets and exploration of additional correlations will undoubtedly strengthen the foundation for evidence-based decision-making in the realm of education.

## 8. Conclusion

Overall, our analysis has yielded some unexpected and intriguing results. Notably, the survey question "During this school year, I have felt stressed" demonstrated a positive correlation with school rankings, contrary to our initial assumptions.

Similarly, the question "My teachers check-in with me frequently about how I'm doing both personally and academically" displayed a negative correlation with rankings. Additionally, the logistic regression and linear regression models did not reveal strong correlations between survey responses and school rankings.

The primary conclusion drawn from this project is that there appears to be no clear relationship between students' satisfaction and experiences and the rankings of public schools in New York City. The initial hypothesis proposing a positive correlation between the two variables was not substantiated by our in-depth analysis. Throughout the investigation, we also identified several limitations, such as challenges arising from handling ordinal data and the relatively small cardinality in the intersection set.

One key takeaway from this study is the realization that data analytics may not always align with our intuition or common sense. While it may seem intuitive to assume that students' satisfaction ratings would naturally correlate with a school's ranking, our rigorous analysis has indicated otherwise. This suggests the presence of other influential factors that warrant further exploration. For instance, we might consider investigating the impact of the school's location or whether students' satisfaction levels are more strongly linked to school ranking within higher-income families and similar demographics.

In conclusion, our project has provided valuable insights into the intricate factors that influence school rankings. Moreover, it highlights the need for continuous improvement in research methodologies to better understand the complexities of educational systems. This analysis aims to assist parents, authorities, and students in making more informed decisions by fostering a deeper understanding of the underlying dynamics influencing school experiences and rankings.

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