Oregon Charter Schools Research

Research Question

How does the performance of students, as measured by scores from statewide assessments, differ between charter and non-charter public schools in the state of Oregon?

Introduction

The Oregon Department of Education defines a charter school as "a public school operated by a group of parents, teachers and/or community members as a semi-autonomous school of choice within a school district". Charter schools differ from traditional non-charter public schools in that charter schools are often exempt from many of the requirements and regulations imposed by the state board of education.

Oregon's first charter school opened in 1999, and since then, the number of charter schools in the state has experienced tremendous growth. In recent years, the state of Oregon saw the 4th highest increase in charter school enrollment in the nation. In the 2020-21 school year, Oregon had 132 charter schools in operation with around 46,000 students enrolled (8.25% of total students).

The following research aims to explore the student testing performance difference between charter schools and traditional non-charter schools. Various data science methods, including web scraping, correlation analysis, and data visualization, will be used to accomplish this goal.

Data description

This project uses several datasets, including the following:

- **Charter Schools Data**: list of charter schools and information about them, such as location, date opened, grade levels served, etc
- **State Assessment Data** (sheet 2 - `Schools_ELA–MATH_3YrTrend`): statewide testing scores for each school (number and percentage of students achieving levels 3 or 4, who are considered "on track for college and career readiness in that subject"). The data of school year 2018-2019 are used, since the subsequent years saw very low test-taking rate due to COVID-19.
- **Schools Membership Data**: enrollment data for each school, including racial demographics and grade levels

All of these datasets are read into Python as CSV files. School IDs are used to merge these data together. The resulting dataset has data on all Oregon schools as well as their enrollment and performance data.

Demographics data of Oregon counties is scraped off the U.S. Census Bureau website, including population by race, age, education, etc.

Methodologies

In order to accomplish the goals of this research, a multitude of data science methodologies were used to collect, process, present, and analyze data.

Web Scraping

Some data utilized in this research are collected through web scraping scripts, programs that access websites on the internet and extract useful information from websites' source code. In this project, Python's `Requests` library is used to send HTTP GET requests to web servers. The responses returned by the web servers containing website source code are then parsed by the `Beautiful Soup` library.

Data Processing

Raw data are often messy after they are gathered, and require some processing and cleaning prior to analysis and visualization. The data used in this research are relatively clean, so no intensive preprocessing was required.

Rows with missing data are dropped. In the state testing dataset, for instance, rows with missing values (`*`, `--`, `< 5.0%`, `> 95.0%`) are dropped. To make the most out of the available data, several new columns are created from existing columns, such as calculating the total number of test-takers from number and percent of high-scorers.

Since the datasets are all stored in tabular formats, the Python package `pandas` is used to manipulate data quickly during data cleaning.

Data Visualization

Huge data sets are often difficult to analyze just by looking at rows and columns of values. Data visualization is used to display data graphically. In this research, area plots, pie charts, and bar plots are all used to show different types of data. These are created using the Python libraries `Matplotlib` and `Seaborn`.

Correlation Analysis

Correlation analysis is a useful data science technique employed in this research. This type of analysis is used to determine and numerically measure the strength and direction of linear association between two variables.

Two-Proportions Test

The two-proportions test (aka two sample z-test for proportions) is a statistical test used to determine whether the difference between two proportions is statistically significant. In other words, this test is used to check whether the difference between two ratios could have occurred due to chance or not.

In this statistical test, the null hypothesis is that the two proportions are equal:

$H_0 : p_1 = p_2$

The alternative hypothesis is:

$H_A : p_1 \neq p_2$

The formula for calculating the z-value of two proportions is as follows:

$$z = \frac{(\hat{p_1} - \hat{p_2}) - (p_1 - p_2)}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{n_1} + \frac{1}{n_2})}}$$

By our null hypothesis of $p_1 = p_2$, we can rewrite $p_1 - p_2 = 0$

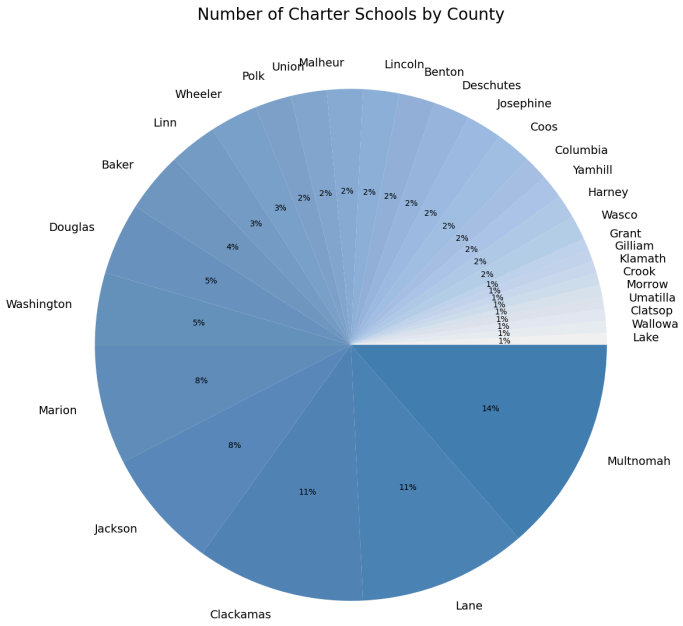
$$z = \frac{(\hat{p_1} - \hat{p_2}) - 0}{\sqrt{\hat{p}(1-\hat{p})(\frac{1}{n_1} + \frac{1}{n_2})}}$$

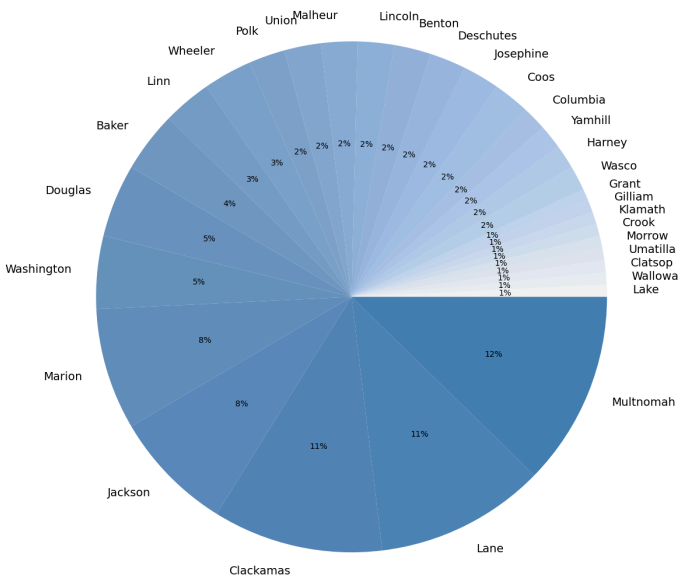
The calculated z-value is compared against a critical z-value, which is dependent upon the significance level used. If the calculated value is higher than the critical value in magnitude, it means that the two proportions are statistically different. And vice versa.

Exploratory Data Analysis

To better understand the data available, exploratory data analysis (EDA) is performed.

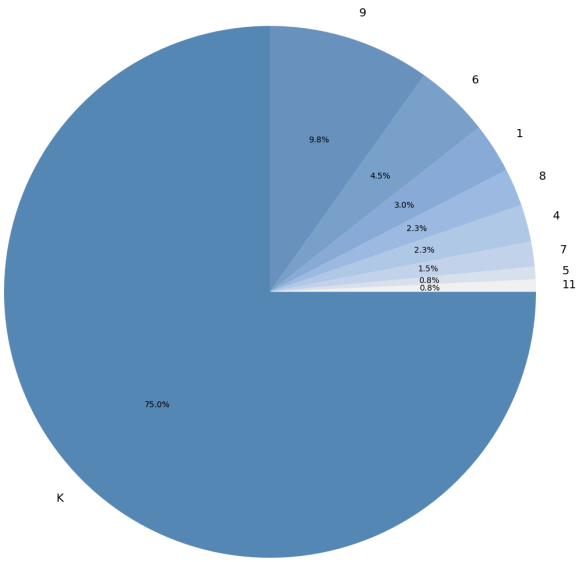
Let's first take a look at how many charter schools are in each of Oregon's 36 counties. As shown in the pie chart below, Multnomah County has the most charter schools at 14%, while several counties have less than 5%. In the pie chart to the right, as would be expected, charter school enrollment correlates with charter school count fairly well.



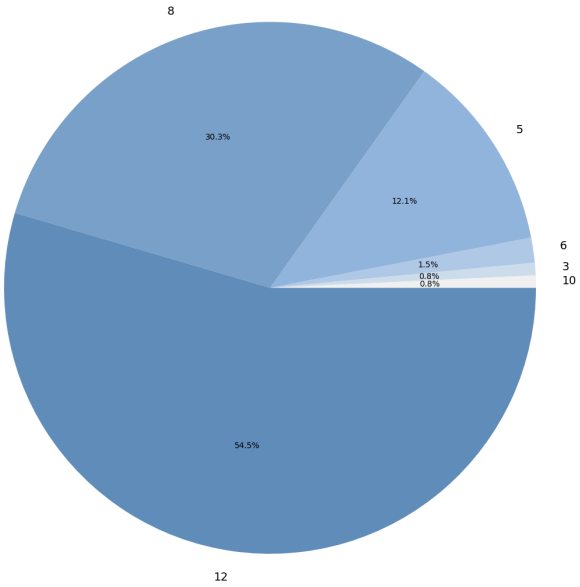


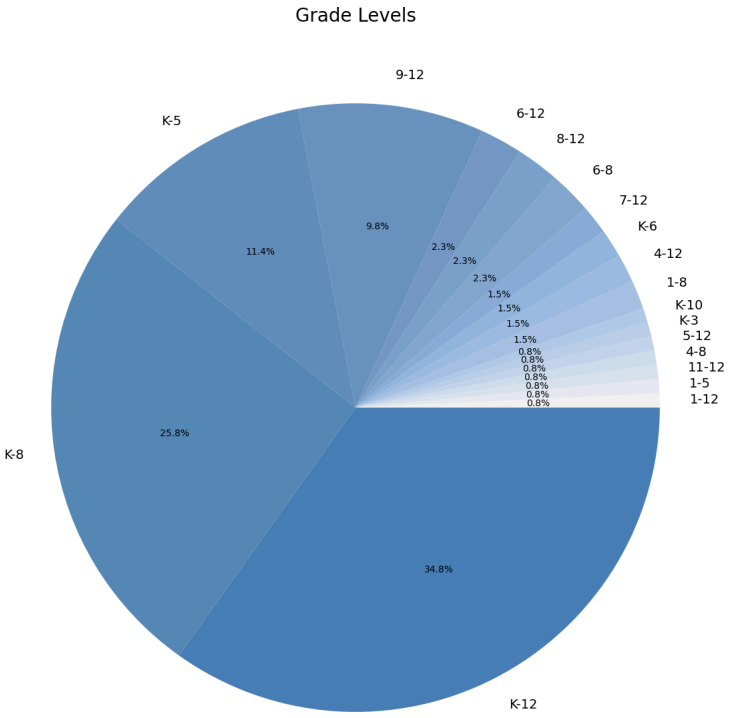
Next, to better understand the nature of Oregon charter schools, the grade levels of the schools are analyzed. The vast majority of charter schools (75%) start at kindergarten, followed by those that start in 9th grade. More than half of Oregon charter schools end at 12th grade, followed by 8th grade.

Starting Grade

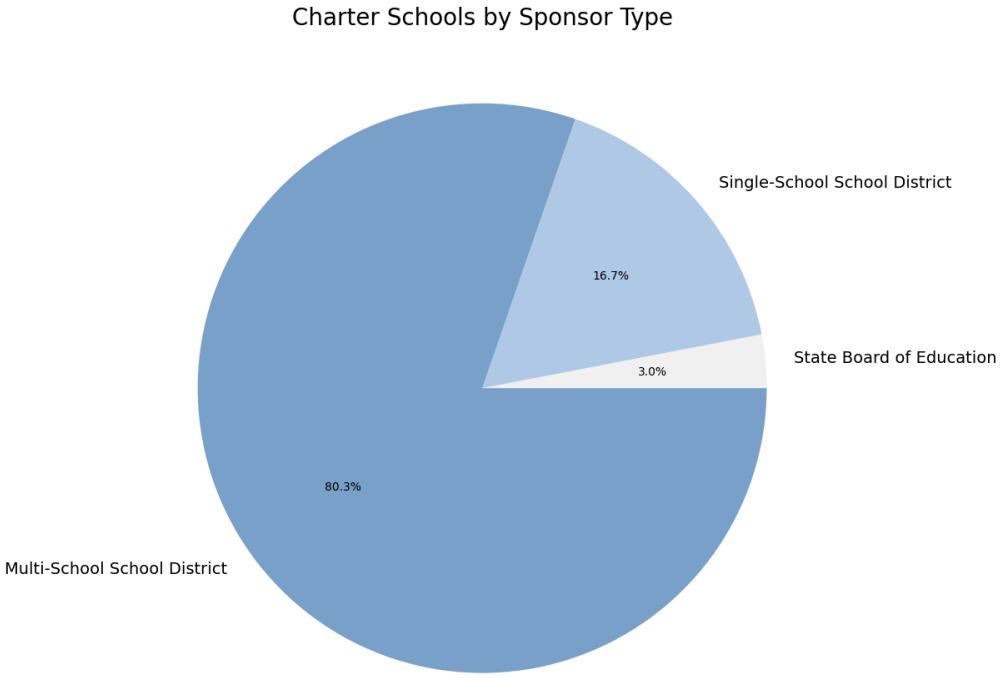


Ending Grade

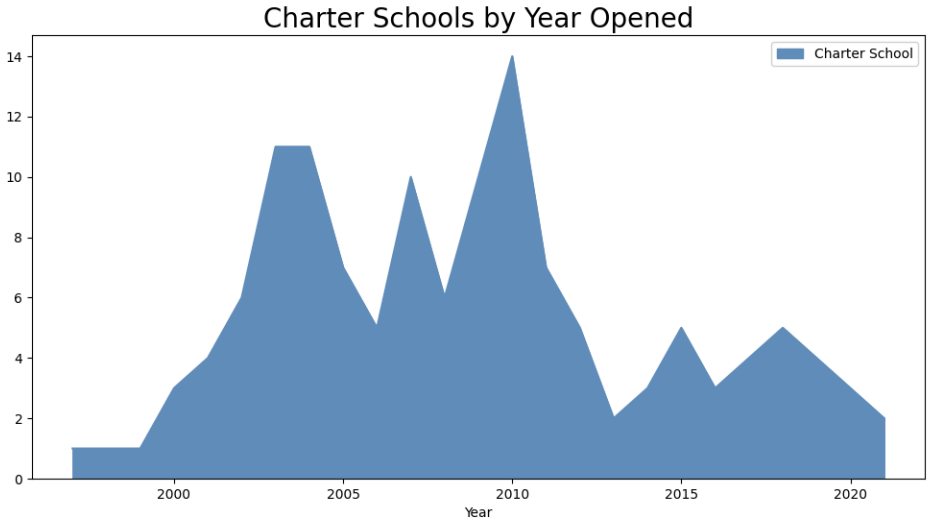




Charter schools operate under a binding agreement with a sponsor. The chart below shows the distribution of charter schools with the three types of sponsors in Oregon. 80% of charter schools are sponsored by a multi-school school district.

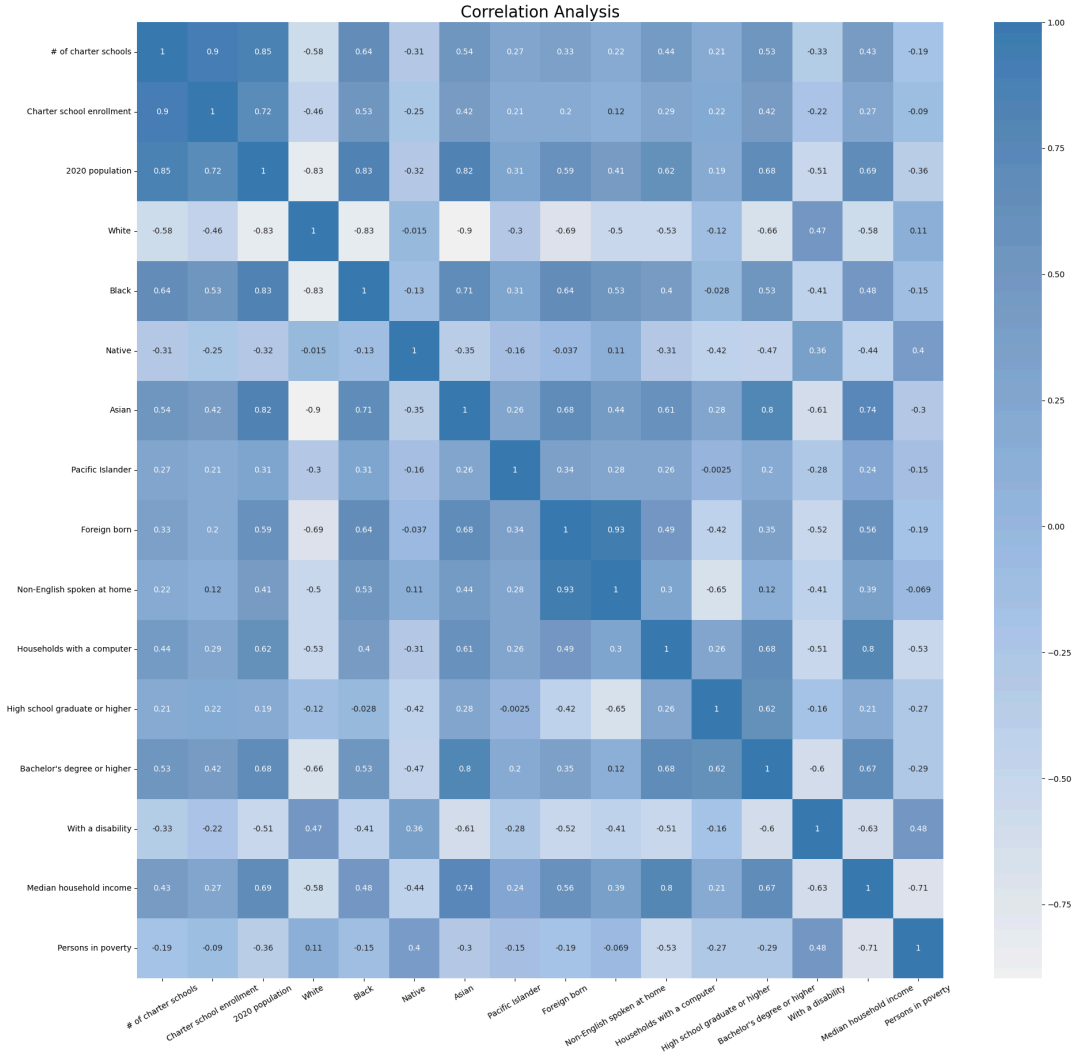


The plot below shows the number of new charter schools opened each year. The 2000s saw the greatest increase of charter school number in Oregon.

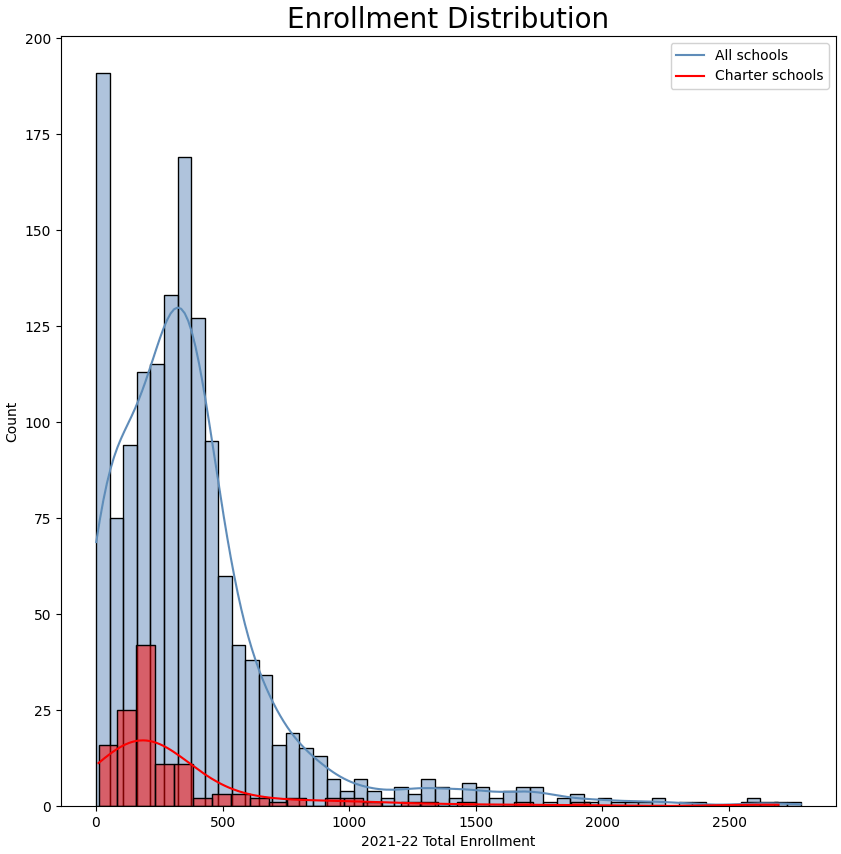


Correlation analysis is done to better understand the relationship between county demographics and the charter school numbers as well as enrollment in each county. The number in each grid is in the range between −1 and 1. The greater the magnitude, the greater the correlation between the row and the column. A negative value indicates a negative correlation, 0 indicates no correlation, and a positive value indicates a positive

correlation. For example, a county's 2020 population intersects with the number of charter schools in that county in a square marked `0.85`, a relatively high positive correlation. No significant unexpected correlation is found.



Now let us visualize the school membership dataset by taking a look at the distribution of enrollment. The histogram and density plot below visualizes this. Most schools are relatively small, with an enrollment of less than 500 students. Some schools have over 2500 students.



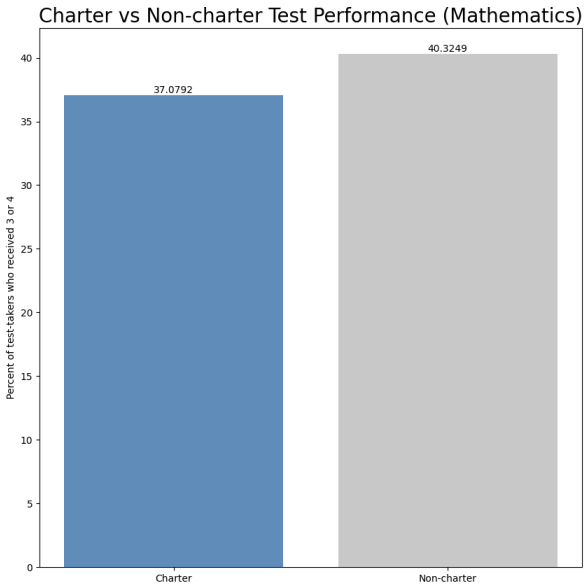
Findings

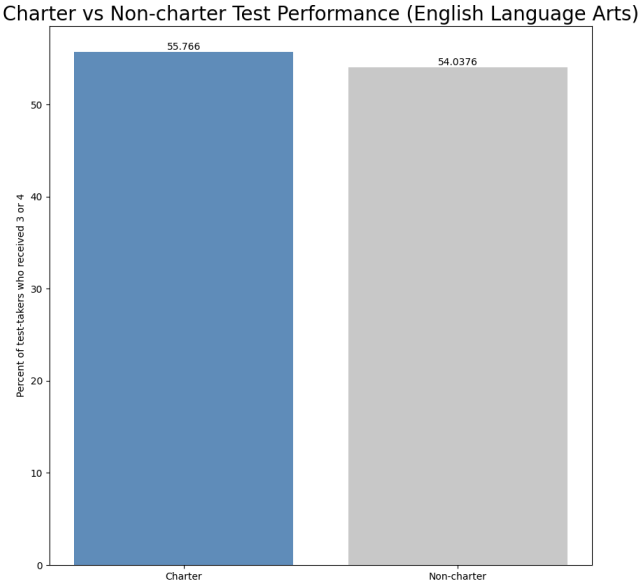
This analysis will be using data from the State Assessment dataset and the Charter Schools dataset, both provided by Oregon's Department of Education.

- A new column is added to the performance dataset, indicating whether each school is a charter school or not
- For each subject present in the dataset (`Mathematics` and `English Language Arts`),
  - Using the `count` and `percent` of students who received a high score (3 or 4), the `total` number of test-takers for that test in each school is calculated: `total = count / percent`
  - For each category of schools (`charter` and `non-charter`), the percentage of students who received 3 or 4 is calculated: `percent = count / total`

This analysis produces the following results:

	Non-charter 3/4	**Charter 3/4**	**Difference**
Mathematics	40.3%	37.1%	−3.2%
English Language Arts	54.0%	55.8%	1.8%





To determine whether or not the percent of students receiving high scores on statewide assessments differ significantly between students of charter and non-charter public schools, we will use the two-proportions test using a significance level of 0.05.

The formula from the Methodologies section and the following values are used.

	Description	Math	English
$x_{charter}$	3/4 count	6289	9657
$x_{noncharter}$	3/4 count	108639	146937
$n_{charter}$	total count	16961	17317
$n_{noncharter}$	total count	269409	271916
$\hat{p}_{charter}$	$x_{charter} \div n_{charter}$	0.3708	0.5577

	Description	Math	English
$\hat{p}_{noncharter}$	$x_{noncharter} \div n_{noncharter}$	0.4032	0.5404
$\hat{p}$	$\frac{x_{charter}+x_{noncharter}}{n_{charter}+n_{noncharter}}$	0.4013	0.5414

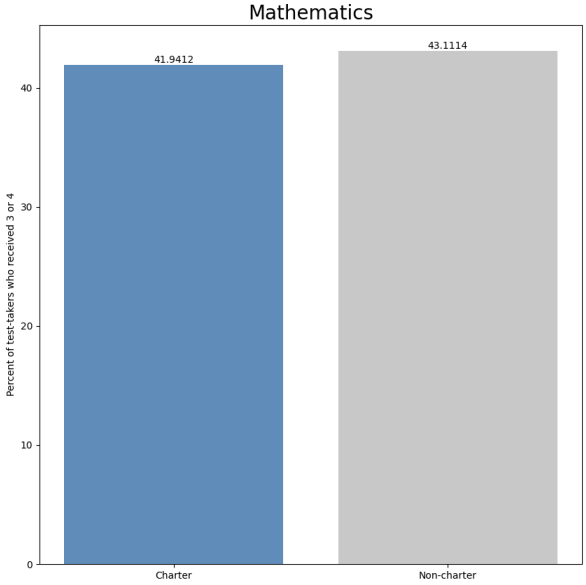
The z-values are as follows:

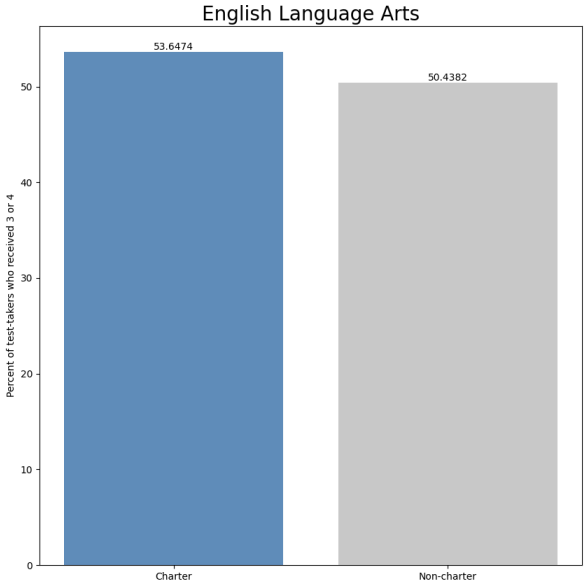
- Math: -8.35
- English: 4.43

The magnitude of both these two values exceed our critical z-value, which is 1.96 at the significance level of 0.05. Therefore, there is a statistically significant difference between the performance of charter and non-charter schools.

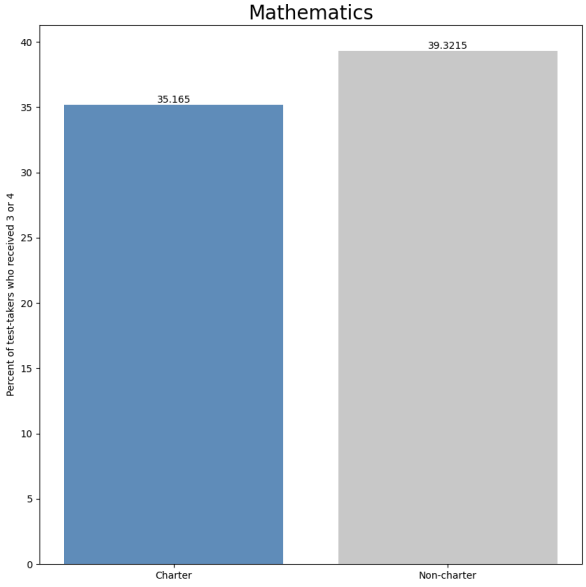
To examine this aspect of charter vs non-charter schools more closely, we can analyze the data for elementary schools, middle schools, and high schools separately. The visualization of the results is shown below.

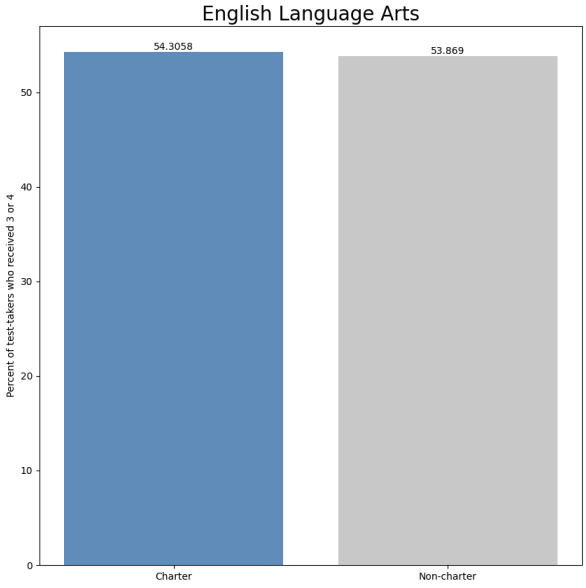
Elementary School



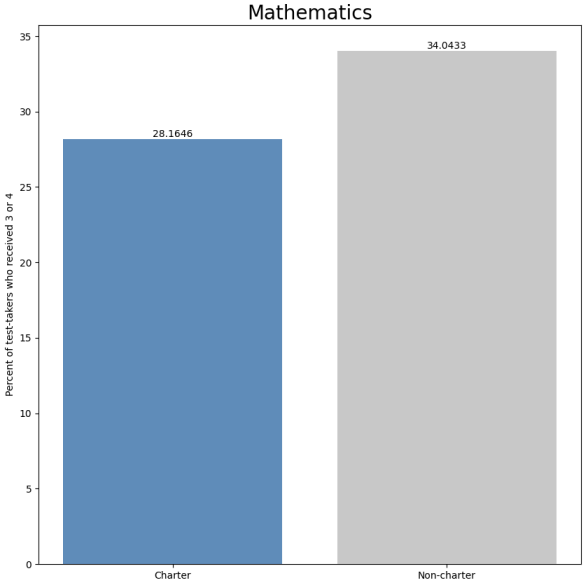


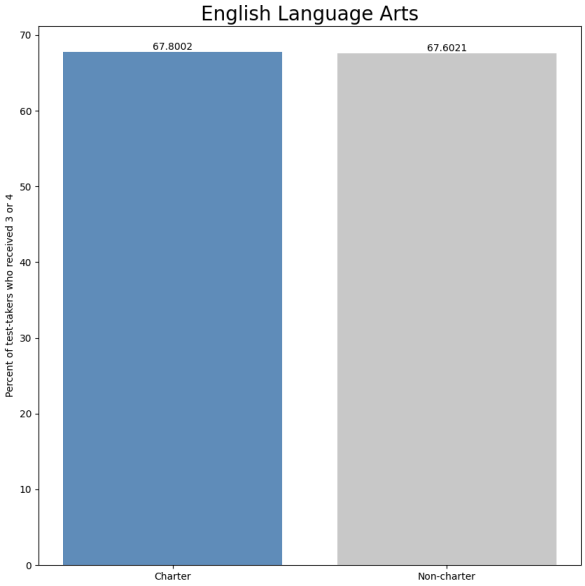
Middle School


Mathematics
Percent of test-takers who received 3 or 4
35.165
39.3215
Charter
Non-charter


English Language Arts
Percent of test-takers who received 3 or 4
54.3058
53.869
Charter
Non-charter

High School

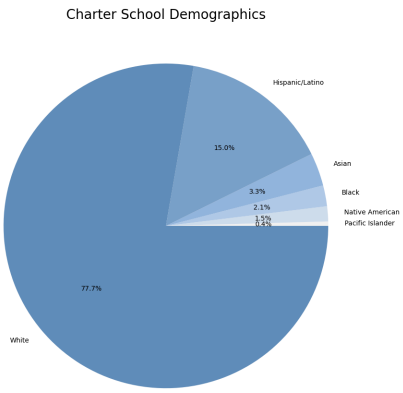


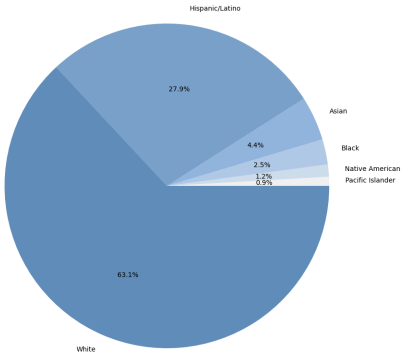


The bar graphs above show that the general trend remains the same for all schools, with non-charter schools performing better at Mathematics and charter schools at English Language Arts. Interestingly, we can also see that for Math, the difference between charter and non-charter school test performance increases from elementary to high school (with non-charter schools in the lead). For English, the difference in performance decreases (with charter schools in the lead).

Next, let's take a look at student performance data for charter vs non-charter school taking racial demographics into account.

It's helpful to examine the racial breakdown of all schools. Using the Schools Membership Data, the following pie charts are created:





It is clear that the majority of Oregon students are *White*, followed by *Hispanic/Latino*, *Asian*, *Black/African American*, *American Indian/Alaska Native*, and *Native Hawaiian/Pacific Islander*.

Upon a closer look, we can see that charter schools have a larger *White* majority and smaller racial minority students compared to non-charter counterparts. This indicates that non-charter schools have more racial diversity than charter schools.

Now let us take a look at the performance of charter vs non-charter students taking their race into account.

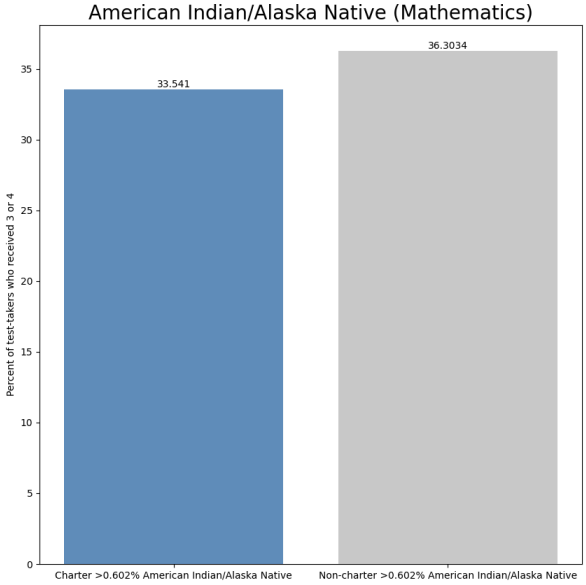
For each race, we will separate schools into 2 groups and analyze the performance data of students in each group:

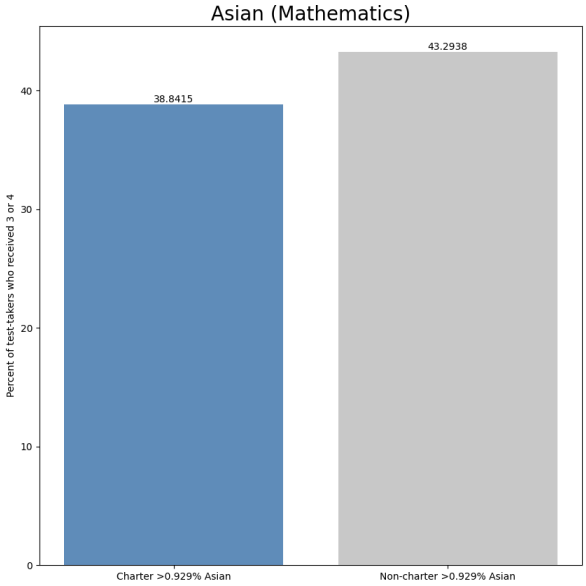
1. Charter schools with more than median percent of demographic group
2. Non-charter schools with more than median percent of demographic group

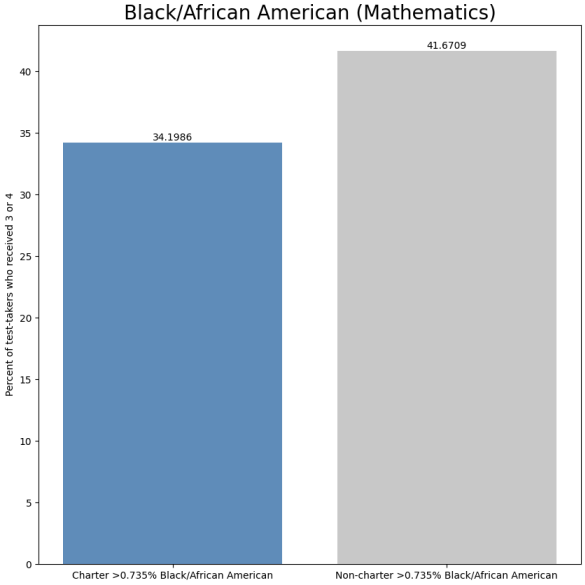
For instance, the median percent of *White* students in all schools is 0.683, or ~68.3%. We will group together all charter schools with more than 68.3% *White* students and find what percent of these students received 3 or 4. Then we will do the same for non-charter schools.

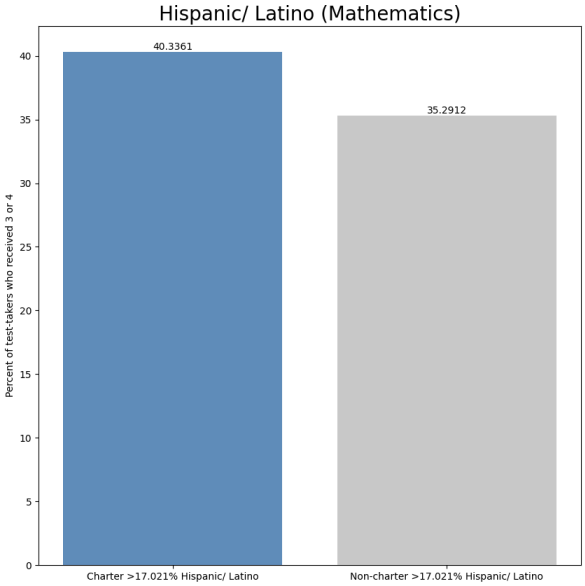
The results are presented in the charts below.

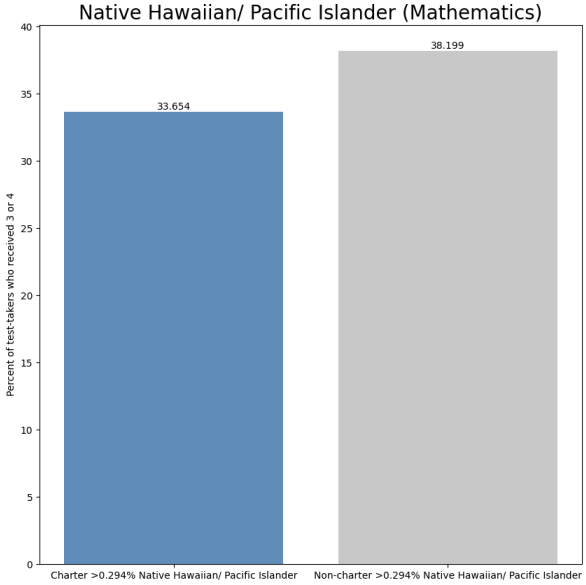
Mathematics

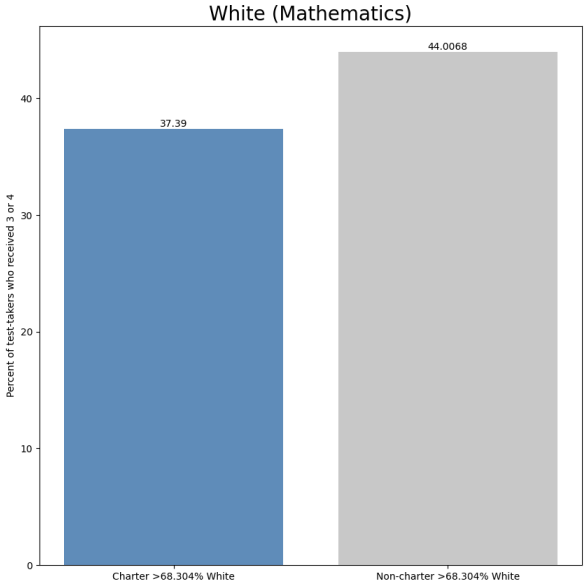

American Indian/Alaska Native (Mathematics)
Percent of test-takers who received 3 or 4
0
5
10
15
20
25
30
35
33.541
36.3034
Charter >0.602% American Indian/Alaska Native
Non-charter >0.602% American Indian/Alaska Native


Asian (Mathematics)
Percent of test-takers who received 3 or 4
0
10
20
30
40
38.8415
43.2938
Charter >0.929% Asian
Non-charter >0.929% Asian

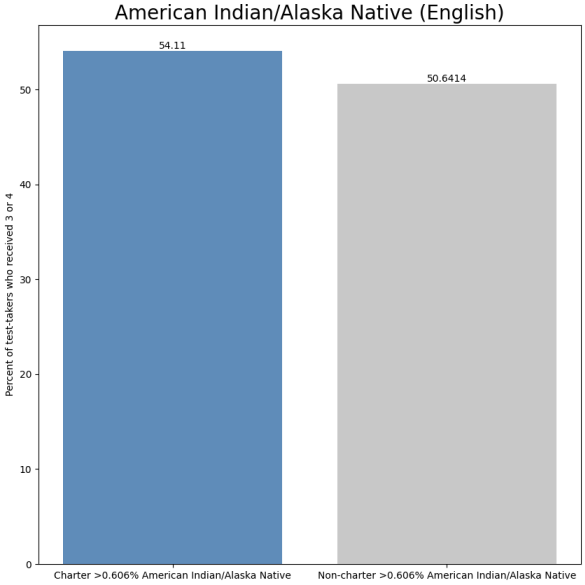

Black/African American (Mathematics)
Percent of test-takers who received 3 or 4
0
5
10
15
20
25
30
35
40
34.1986
41.6709
Charter >0.735% Black/African American
Non-charter >0.735% Black/African American

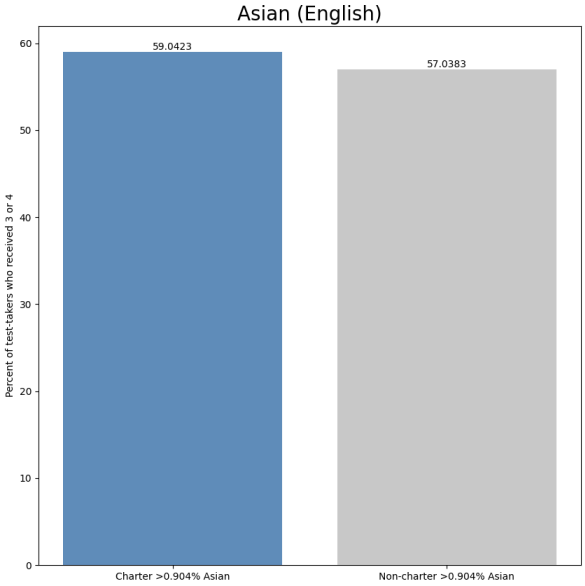

Hispanic/ Latino (Mathematics)
Percent of test-takers who received 3 or 4
0
5
10
15
20
25
30
35
40
40.3361
35.2912
Charter >17.021% Hispanic/ Latino
Non-charter >17.021% Hispanic/ Latino

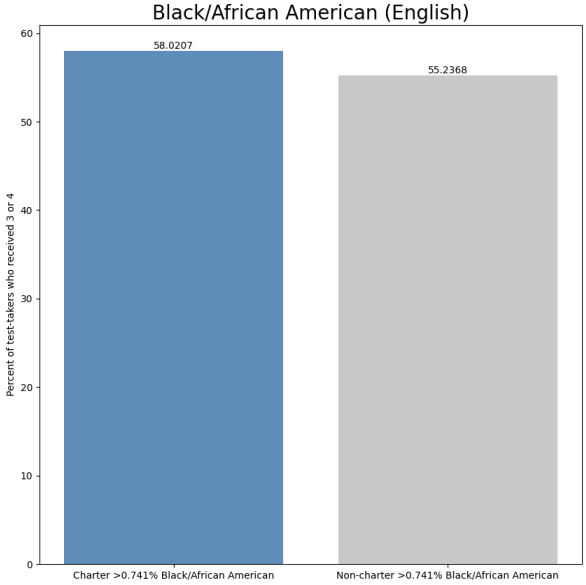


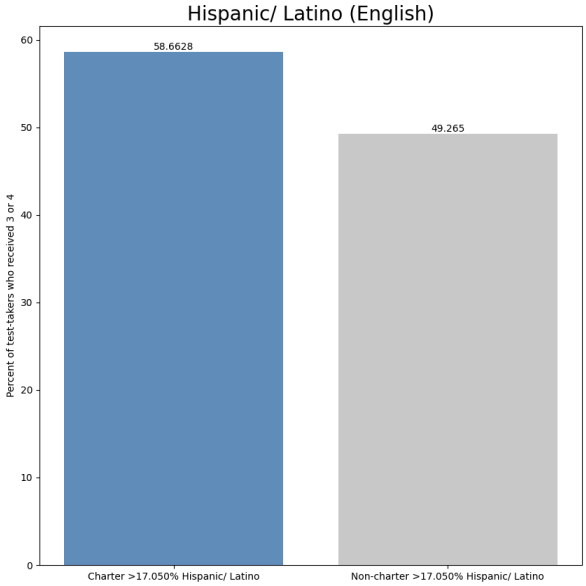


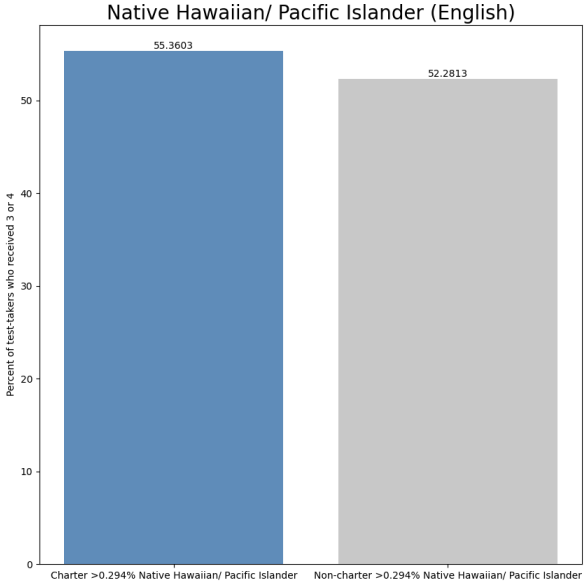
English Language Arts

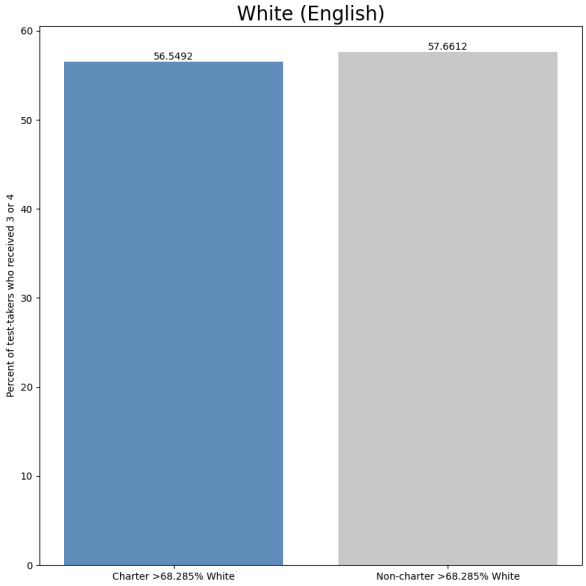

American Indian/Alaska Native (English)
54.11
50.6414
Percent of test-takers who received 3 or 4
0
10
20
30
40
50
Charter >0.606% American Indian/Alaska Native
Non-charter >0.606% American Indian/Alaska Native


Asian (English)
59.0423
57.0383
Percent of test-takers who received 3 or 4
0
10
20
30
40
50
60
Charter >0.904% Asian
Non-charter >0.904% Asian


Black/African American (English)
Percent of test-takers who received 3 or 4
0
10
20
30
40
50
60
58.0207
55.2368
Charter >0.741% Black/African American
Non-charter >0.741% Black/African American


Hispanic/ Latino (English)
Percent of test-takers who received 3 or 4
0
10
20
30
40
50
60
58.6628
49.265
Charter >17.050% Hispanic/ Latino
Non-charter >17.050% Hispanic/ Latino

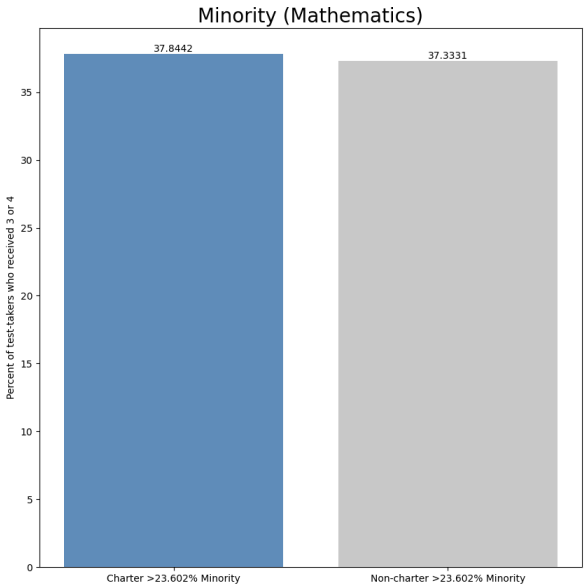


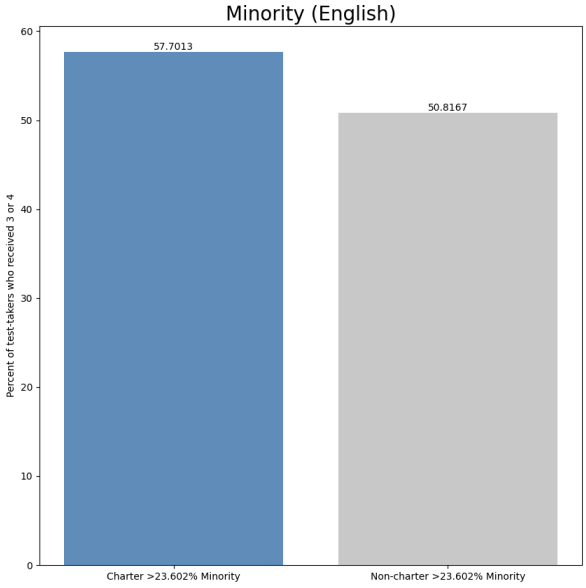


We can see that non-charter school students tend to do better on the math assessment than their charter school counterparts, with the exception of *Hispanic/Latino* students, whose scores are higher in charter schools.

The results for English Language Arts is quite the opposite, with charter school students scoring higher, with the exception of *White* students, whose scores are marginally higher in non-charter schools.

To take a closer look at the performance of students of minority races, let's analyze the percent of non-*White* students receiving 3s or 4s.





The graph shows that charter schools with more racial minority students tend to score higher on statewide assessments than their non-charter counterparts for both subjects. The difference for Math is quite low while the difference is higher for English.

Conclusions

Significance of Findings

To conclude this research on Oregon charter schools, let us first discuss the significance of the findings.

Our analysis indicates that the type of school (charter vs non-charter) a student goes to has a statistically significant impact on how they score on standardized assessments. From our data, non-charter schools generally scored higher on Mathematics and charter schools scored higher on English Language Arts.

The analysis on grade levels and state testing scores suggests that the performance of non-charter schools relative to charter schools increases with the grade level of students. For Math, the performance lead that non-charter schools have over charter schools gradually increases from lower grades to higher grades. For English, the performance lead of charter schools decreases by ~16 times from elementary school to high school.

The visualization of charter and non-charter school racial demographics shows that non-charter schools are more racially diverse.

The analysis on charter vs non-charter school performance with school demographic taken into account tells us that charter schools with more racial minorities appear to score higher on statewide assessments than non-charter schools.

Data Limitations and Further Research Directions

All data analytical research is limited by the amount of data available at the time of the research.

For instance, there is no available data regarding student performance at charter and non-charter schools categorized by their racial demographics. Therefore, this research had to infer student performance by demographics using school membership data.

It would also be beneficial to use data designed to be used in research such as this one so that causal inferences can be drawn more accurately.

In this study on Oregon charter schools, several datasets are used to provide a holistic understanding of the subject. Future research regarding this topic could study charter schools in finer details instead of the comprehensive approach this research took. Funding distribution data and data on the nature of each school (number of courses offered, length of school day, etc) could be used in order to better understand what might have caused the differences in student performance.

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