# GA 26th Data Science Immersive Project 1

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This presentation contains 16 slides

# Scope

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# Background

Class size is one of the small number of variables in American K-12 education that are both thought to influence student learning legislative mandates on maximum class size have been very popular at the state level.  In recent decades, at least 24 states have mandated or incentivized class-size reduction (CSR). As small classes would be higher to maintain due to manpower costs (more teachers required) and infrastructure (more classrooms and separate facilities), a deeper study on whether CSR does indeed provide better student outcomes is required.

Teacher experience is used as an alternative to compare the effects of Teacher-Student Ratio on the measured SAT and ACT outcomes.

# Problem Statement

As a member of the California State Education Department deliberating whether mandate smaller class sizes or hire more experienced teachers. This project aims conduct a **preliminary study** to verify this hypothesis in California using data from the 2019 SAT & ACT from K12 test-takers to see if this relationship exists by comparing the

- Teacher-K12 Student Ratio
- Teacher's Teaching Experience (Average years of teaching experience and average years of teaching in the county)

of counties with students scoring above the SAT benchmark and ACT score of 21 in 2019 (hereby referred to as the measured outcomes)

# Datasets used

The following datasets were used in this project:

- 2019 ACT Scores in California by School
- 2019 SAT Scores in California by School
- 2018-2019 Certificated Staff Education Report: State of California Teachers: Shows the number of teachers per county by education level for counties in California in 2018-2019
- Certificated Staff Experience Report: State of California Teachers: Shows the average teacher years in service and teaching years in the county for counties in California in 2018-2019

# Methodology

1. Each dataset is imported and cleaned to address shortfalls in data quality
    a. Null values (certain counties do not provide outcomes information for <15 candidates)
    b. Inappropriate datatypes (e.g numbers with thousandth separator not stored as numerical values, and require conversion to process the data, numerical values with symbols)
2. Dataset streamlined to only contain columns of interest
3. All 4 datasets are merged to form 2 consolidated DataFrames for the SAT and ACT (sat_teachers, act_teachers)
4. Conduct analysis on sat_teachers and act_teachers to examine relationship between measured outcomes and Teacher-K12 Students Ratio & Average Teacher Experience

# DataFrames

Broadly, the DataFrames contain the following information

- Number of K12 students enrolled in the county
- Number of SAT/ACT test takers
- Average Teacher's years of service
- Average Teacher's years of teaching in county
- Teacher-K12 Student Ratio

**A total of 4 rows were dropped from the analysis due to data quality issues during cleaning, however, it should not have significant impact on our analysis moving ahead**

# Observation #1

**<u>Identical Min and Max Values</u>**

**SAT & ACT**

- The counties with the highest and lowest teacher-student ratio are Modoc (104.598%) and Mono (28.571%).
- The counties with the highest and lowest teacher average years of service are Calaveras (16 years) and Lake (10 years) .
- The counties with the highest and lowest teacher average years in county are Los Angeles (14 years) and Lake (7 years).

**Not surprising that findings are identical as they are from the same data source and we did not drop the columns dropped were not featured as min-max values**

# Observation #2

## ACT seems to be the easier test than the SAT

Counties that performed above the state average (12.98%) for students who met SAT benchmarks have the following means:

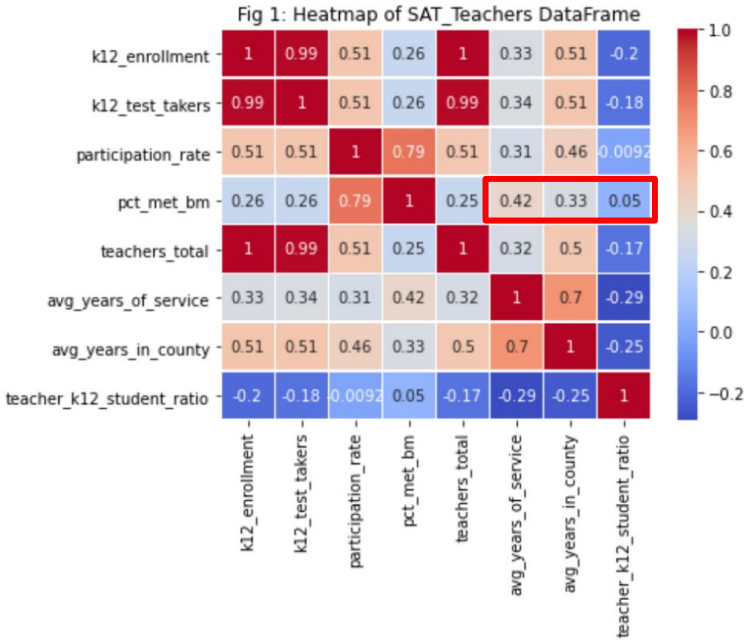
- Mean Teacher-K12 Student Ratio: 66.72
- Mean Years of Service: 13.68 years.
- Mean Years in County: 11.16 years.

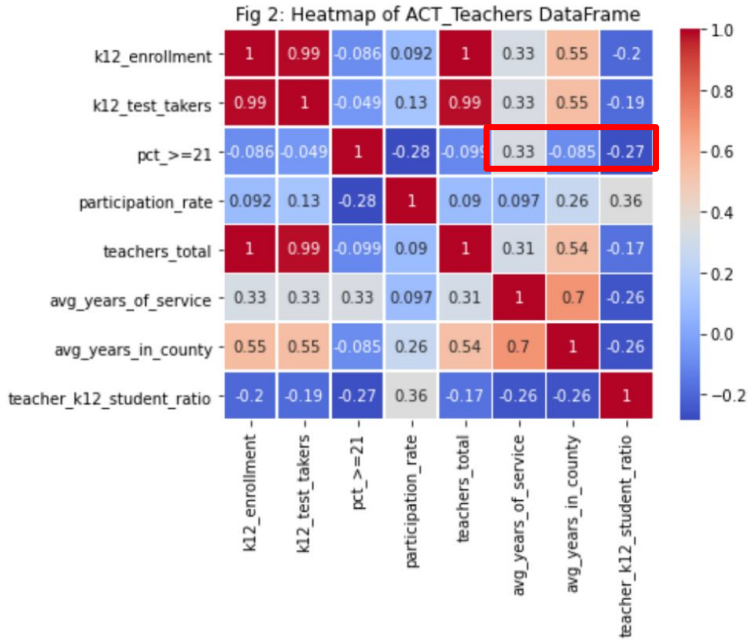
Counties that performed above the state average (56.76%) for students who scored >=21 marks for the ACT:

- Mean Teacher-K12 Student Ratio: 65.54
- Mean Years of Service: 13.32 years.
- Mean Years in County: 10.32 years.

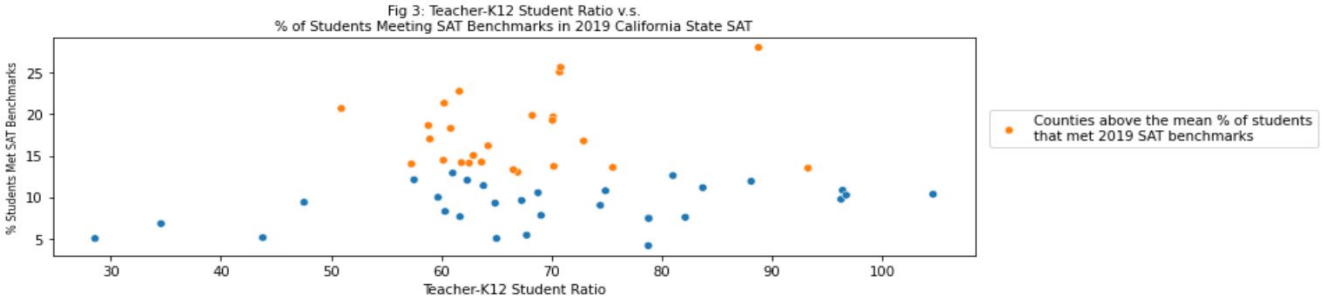
**Greater number of students met the ACT outcomes. Other metrics are similar**

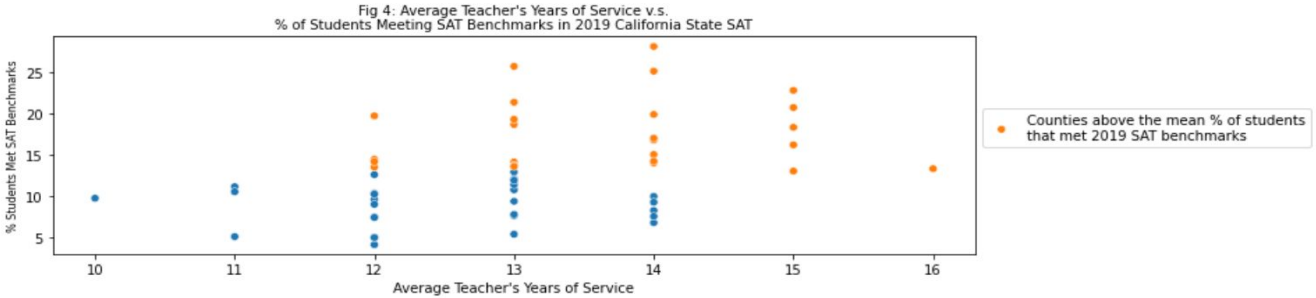
# Observation #3: Weak correlations

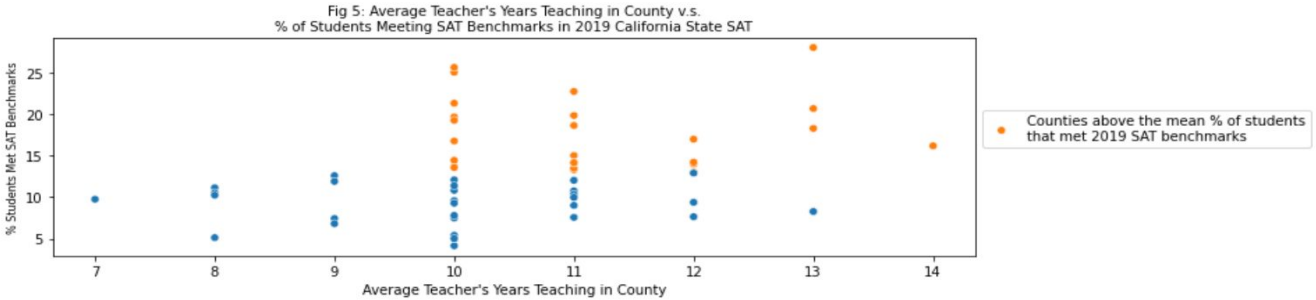



**Teacher-K12 Student Ratios had close to no correlation to the measured outcomes for the SAT and weak negative correlation with the measured outcome for the ACT while Average Teacher's Years of Service and Years Teaching in the County showed weak positive correlations in the measured outcomes in both tests in general.**




# Observation #4: Numbers to perform above the mean outcome

**To perform above mean outcome of the SAT,**

- **Teacher-K12 Student Ratio of between 50%-75%**
- **Average Teacher's Years of Service >= 12**
- **Average Years of Teaching in County >= 10**

Fig 6: Teacher-K12 Student Ratio v.s.
% of Students Scoring Above 21 Marks in 2019 California State ACT

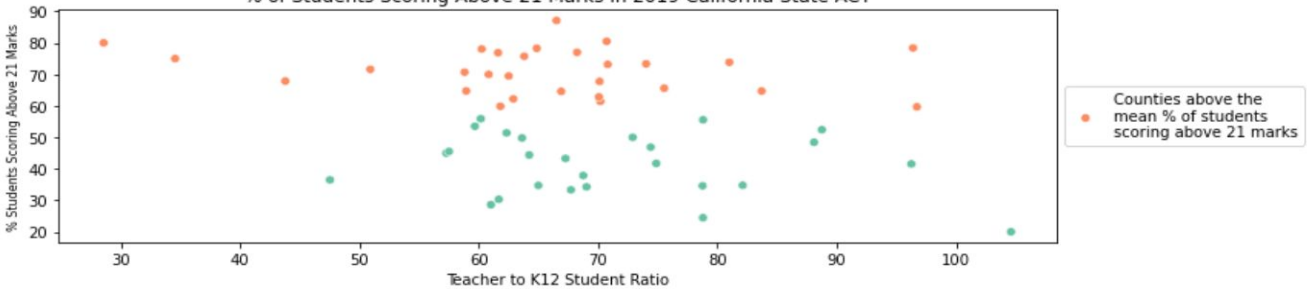



Fig 7: Average Teacher's Years of Service v.s.
% of Students Scoring Above 21 Marks in 2019 California State ACT

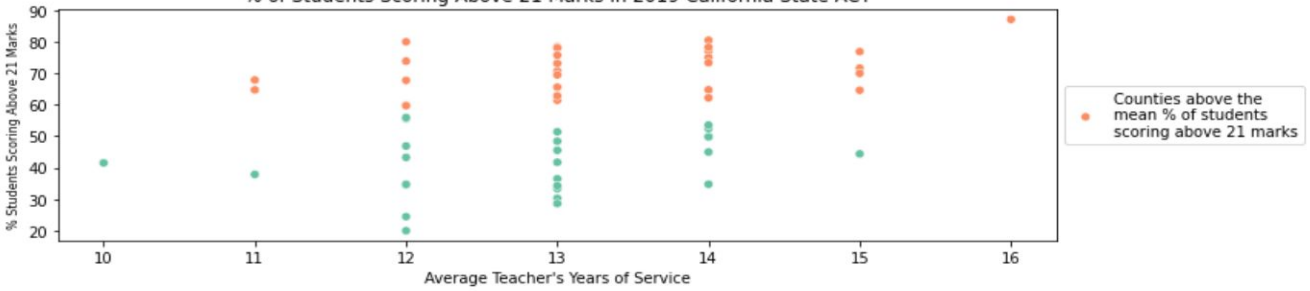
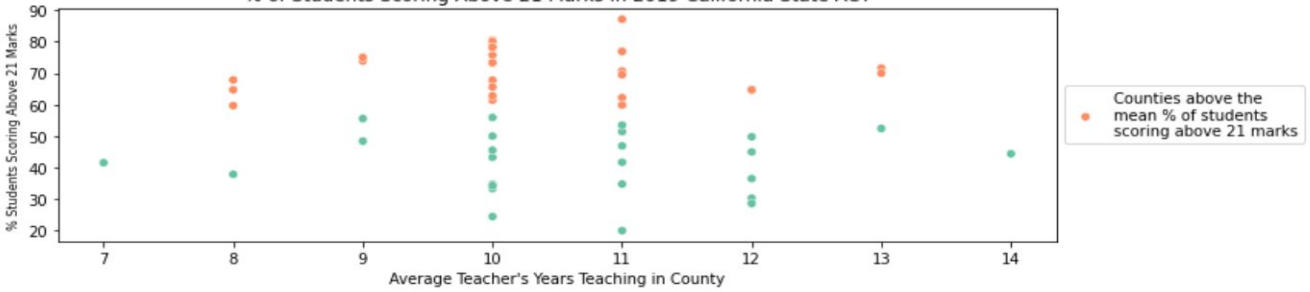



Fig 8: Average Teacher's Years Teaching in County v.s.
% of Students Scoring Above 21 Marks in 2019 California State ACT




# Observation #4: Numbers to perform above the mean outcome

**To perform above mean outcome of the ACT,**

- **Teacher-K12 Student Ratio of between 58%-73%**
- **Average Teacher's Years of Service >= 11**
- **Average Years of Teaching in County >= 8**

# Observation #5:
# Lower Teacher-K12 Student Ratio demonstrated better ACT outcomes

Fig 9: Teacher-K12 Student Ratio v.s.
% of Students Meeting SAT Benchmarks in
2019 California State SAT

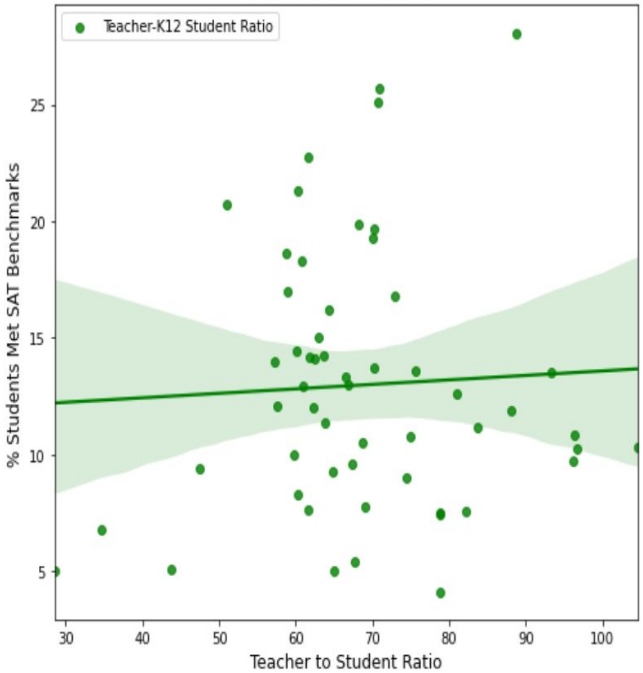
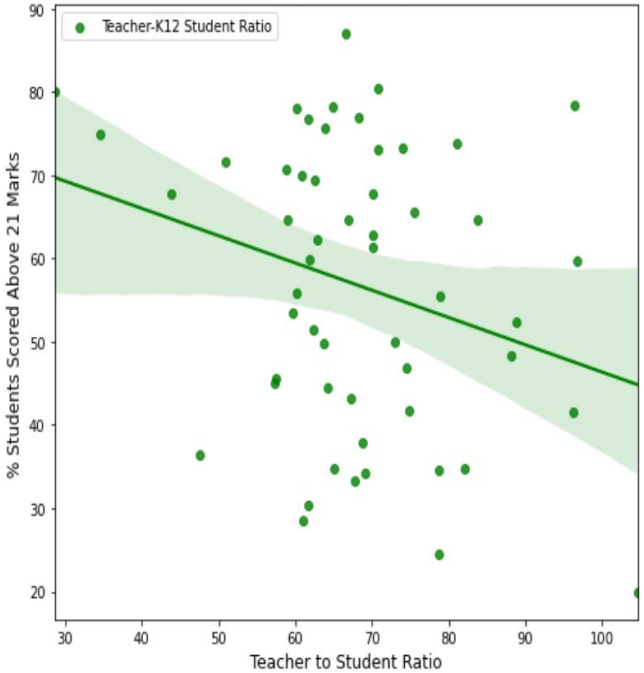



Fig 10: Teacher-K12 Student Ratio v.s.
% of Students Scoring Above 21 Marks in
2019 California State ACT




**There is very little change in outcomes for a decrease in teacher-k12 student ratio for the SAT, evidenced by the almost flat linear regression slope.**

**A smaller teacher-k12 student ratio is observed to lead better outcomes for the ACT, evidenced by the decreasing linear regression slope.**

**This may be because the ACT has more subjects and may benefit more from focused attention from teachers.**

# Observation #6:
# Greater teacher experience demonstrated better ACT and SAT outcomes (In general)

Fig 11: Avg Years of Service & Teaching in County v.s. % of Students Meeting SAT Benchmarks in 2019 California State SAT

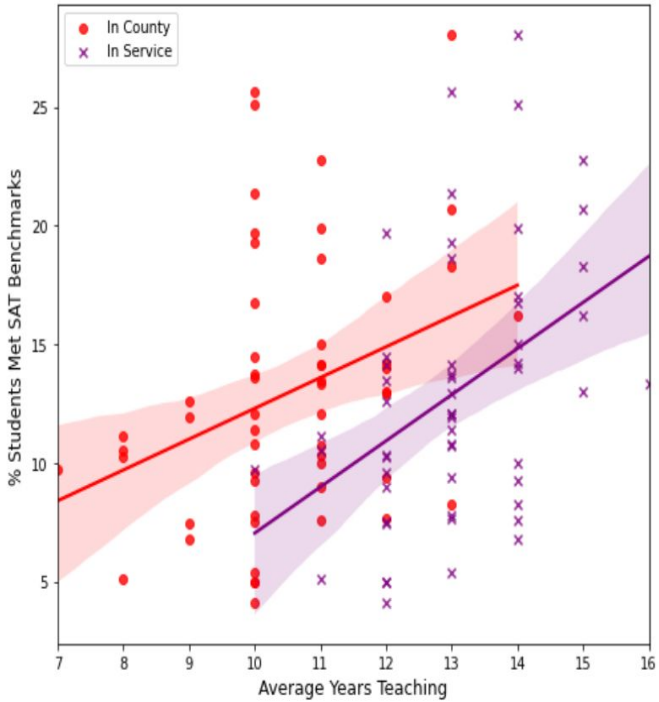
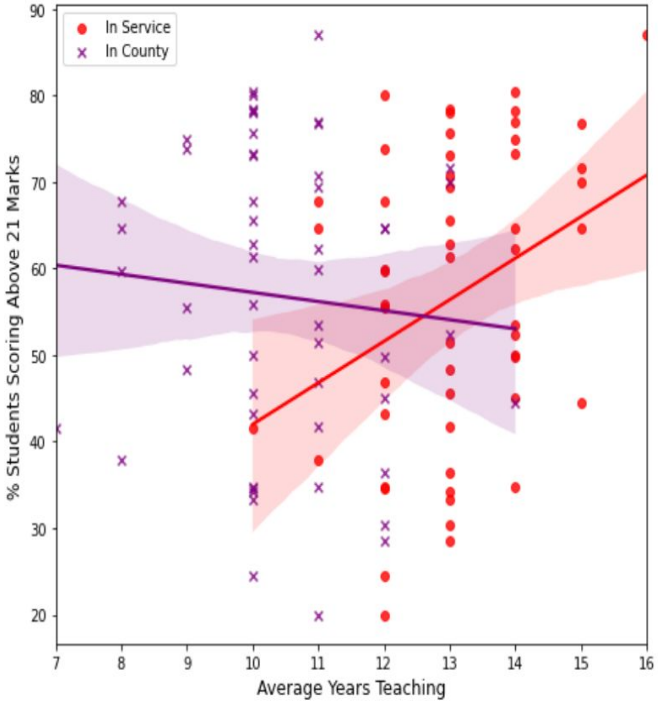



Fig 12: Avg Years of Service & Teaching in County v.s. % of Students Scoring Above 21 Marks in 2019 California State ACT




**Better ACT and SAT outcomes follow the greater the amount of experience the teacher has in service and teaching in general.**

**A negative relationship is observed for average teacher years in county for the ACT while a positive one is observed for the average years in service.**

**This may be an outlier observation as we are only taking a 1 year snapshot in 2018-2019**

# Conclusion & Recommendation

There is **insufficient evidence** to show that lower Teacher-K12 Student Ratios will positively affect SAT and ACT outcomes as no correlation was observed for the SAT while a weak negative correlation was observed for the ACT.

There is **weak evidence** that teachers with greater experience teaching in the county and in the teaching profession will positively affect the SAT and ACT outcomes as weak positive correlations were observed for the SAT and ACT.

**Recommendation**

As a member of the California Education Department, my preliminary recommendation would be for the **state to hire more experienced teachers (with at least 8 years of experience teaching in the county or 11 years of experience overall)** rather than trying to decrease the Teacher-K12 Student Ratio as teaching experience has shown to improve SAT and ACT outcomes compared to Teacher-K12 Student Ratios.

# Way Ahead

More granular data is needed to drill down to the schools in California that require additional support. Access to the data below at the district/school level will be helpful for deeper analysis:

- Teacher Experience
- Number of Teachers Teaching K12 Classes (Numbers used in this study is the total number of teachers teaching at all levels, it would be more accurate to calculate the K12 Teachers-K12 Student Ratio)
- Raw SAT and ACT Scores at the school level to calculate scores instead of meeting certain benchmarks