

# Socioeconomic Influence on Educational Progress: An Analysis of Reading and Math Score Dynamics

## Introduction:

Education is the cornerstone of personal development and societal advancement. However, disparities in educational outcomes are a persistent challenge that educators and policymakers strive to address. The role of socioeconomic status (SES) in educational attainment has been a subject of considerable research, often highlighting a correlation between higher household incomes and better academic performance. This study aims to delve into the dynamics of this relationship by examining how changes in reading and math scores from fall to spring are influenced by income levels among kindergarten students.

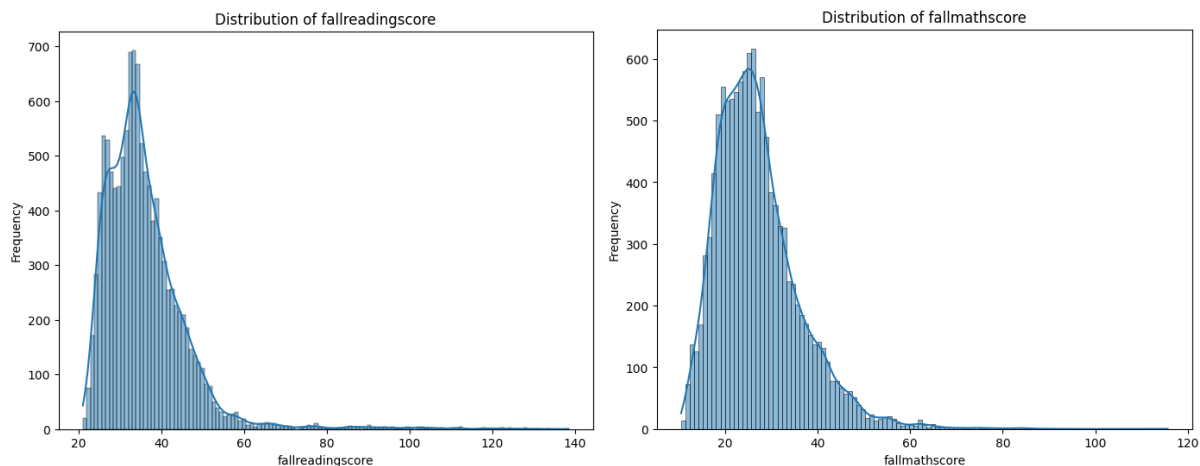
## Research Question:

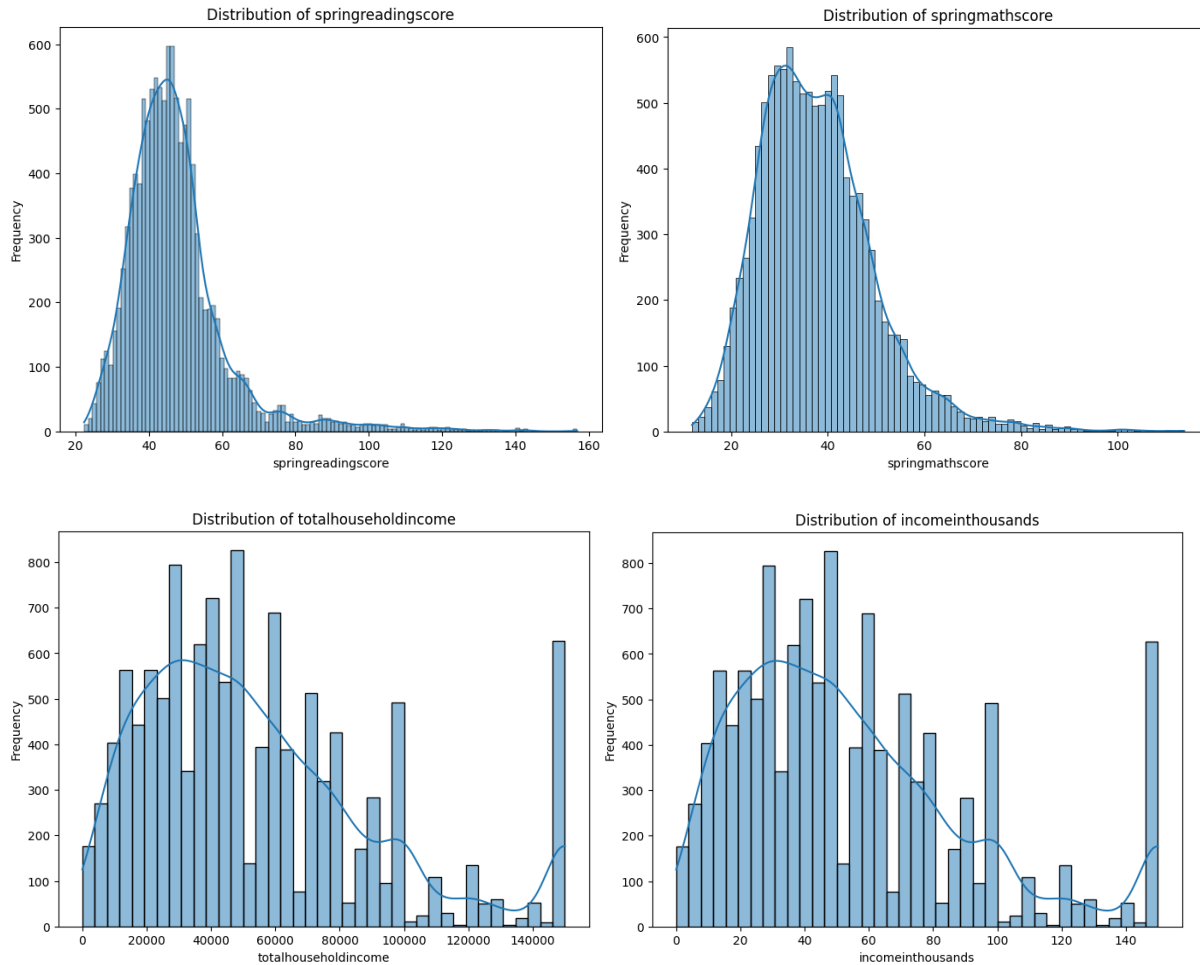
- How do changes in reading and math scores from fall to spring differ among students from varying income groups?*
- To what extent does household income interact with initial academic performance to influence these changes?*

This research seeks to not only quantify the relationship between SES and academic progress but also to uncover the nuanced ways in which initial academic standings may moderate this relationship. By analyzing score changes across income groups, the study provides insights into the broader implications of income disparities and offers a foundation for discussing targeted interventions.

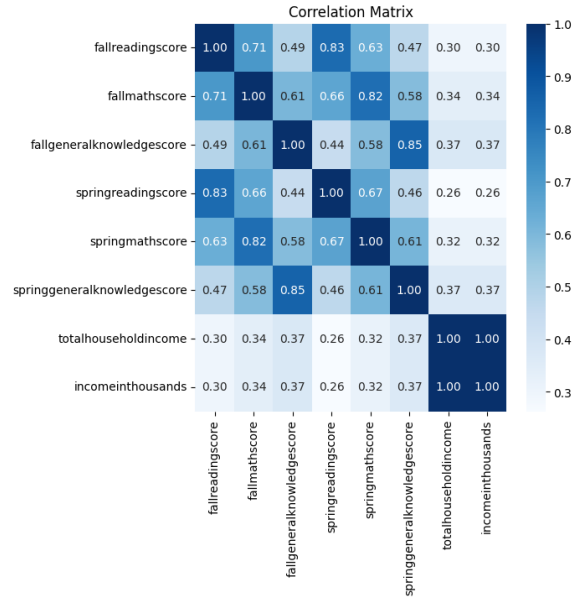
## Exploratory data analysis

### Histograms for scores and income

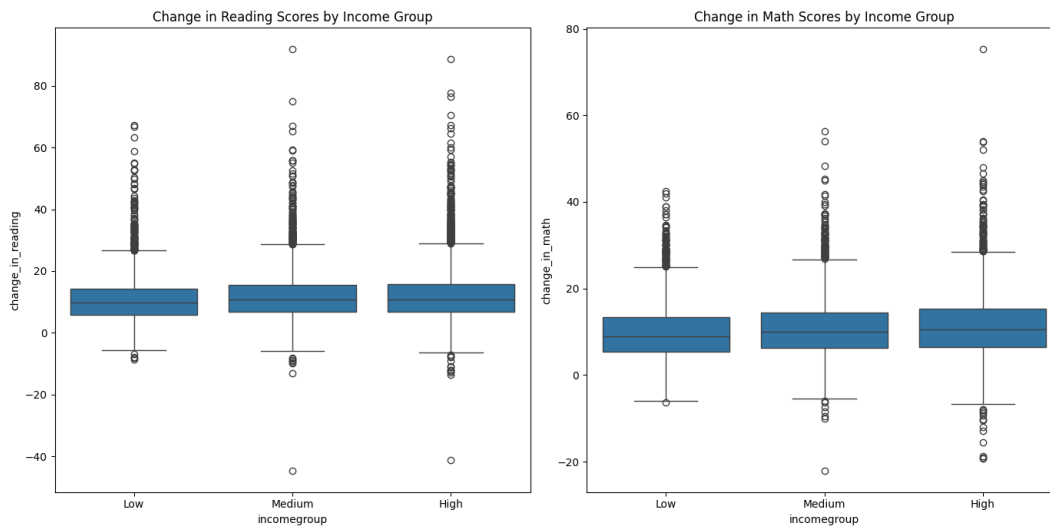




- The fall scores in reading and math are left-skewed, indicating higher performance among a majority of students, with this trend continuing, albeit less pronouncedly, into the spring. In contrast, the income distributions are right-skewed, reflecting a greater number of households with lower incomes and fewer with higher incomes.
- This economic pattern, coupled with the academic performance data, suggests that while students generally show progress over the academic year, socioeconomic factors might play a significant role in educational outcomes.
- The skewness in the scores may imply a ceiling effect where many students are achieving high marks, yet it's the income data that might hold the key to understanding disparities in the magnitude of academic growth among students from different socioeconomic backgrounds.



The correlations indicate a strong relationship between students' performance across different testing periods and subjects, with higher scores in one tending to be associated with higher scores in another. The relationship between household income and academic performance is present but less pronounced, suggesting that while income may have some influence, it's not the sole factor in academic success. General knowledge correlates with both reading and math scores, hinting at a broader relationship between overall knowledge and subject-specific performance.



The boxplots reveal variations in reading and math score changes from fall to spring across different income groups. In both subjects, all income groups exhibit a wide range of changes, with many outliers indicating significant increases or decreases in scores. However, there is no consistent pattern of difference between the income groups, suggesting that income level alone may not be a definitive factor in the magnitude of score changes over the academic year. The

median changes in scores remain relatively close to zero, indicating stable performance for the median student in each group.

### **ANCOVA tests results**

This research conducted at least 4 different ANCOVA tests

1. ANCOVA for change in reading scores with income group as the factor and fall reading score as the covariate.
2. ANCOVA for change in math scores with income group as the factor and fall math score as the covariate.
3. ANCOVA with an interaction term for change in reading scores using total household income and fall reading score.
4. ANCOVA with an interaction term for change in math scores using total household income and fall math score.

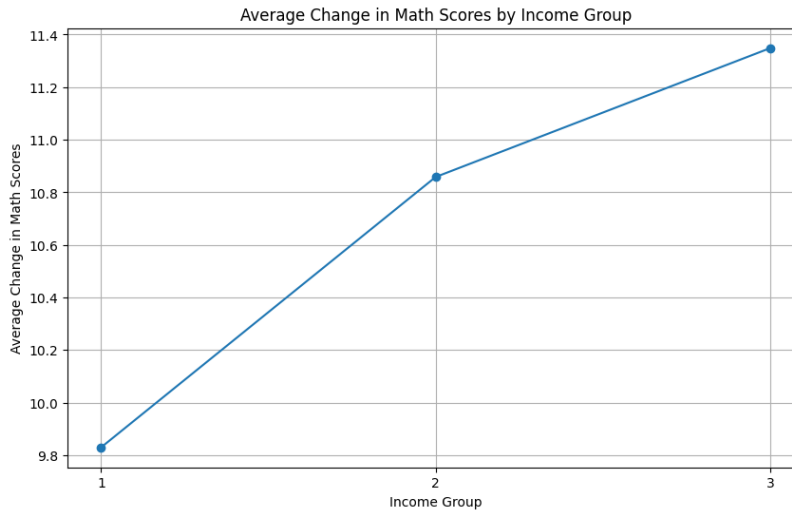
the ANCOVA analyses suggest a few key findings. For reading scores, both income group and fall reading scores show a significant effect on the change in reading scores from fall to spring. The F-value is substantial for fall reading scores, implying a strong effect, while the income group shows a moderate effect. The interaction between income group and fall reading scores is also significant, indicating that the relationship between fall reading scores and the change in reading scores may differ across income groups.

For math scores, again, both income group and fall math scores significantly affect the change in math scores from fall to spring. The effect of fall math scores is particularly pronounced, as reflected by the high F-value, suggesting that initial math score is a strong predictor of score change. There is a significant interaction effect between income group and fall math scores, which implies that the impact of initial math scores on score change varies by income group.

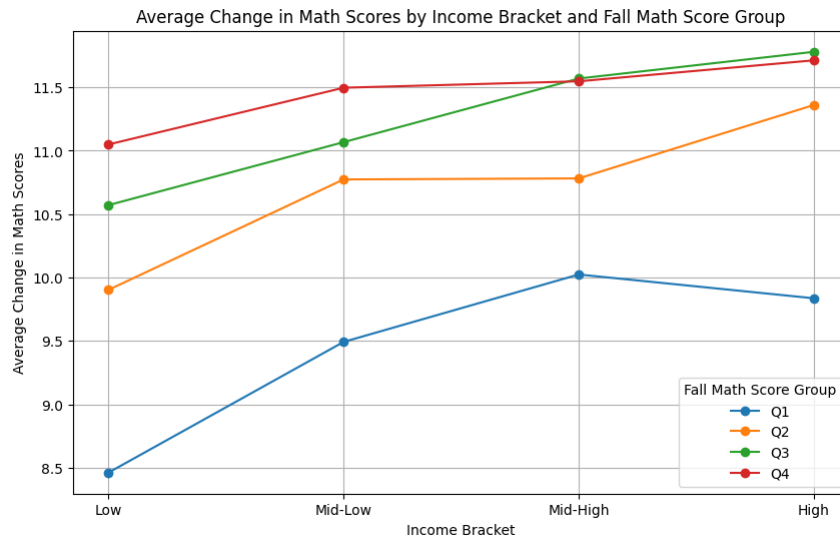
The Shapiro-Wilk test results indicate that the assumption of normality is violated for all score distributions, as all p-values are below the typical alpha level of 0.05. Additionally, the Levene's test suggests that the assumption of homogeneity of variances is violated ( $p < 0.05$ ), cautioning against potential issues with the ANCOVA results. Despite the significance of the ANCOVA results, the violations of these assumptions may necessitate further analysis or transformation of the data before confidently interpreting these effects.

In summary, while initial scores and income groups are important predictors of score changes, the assumptions underlying ANCOVA are not fully met, which should be taken into account in any interpretation of the results.

## Interaction Plots

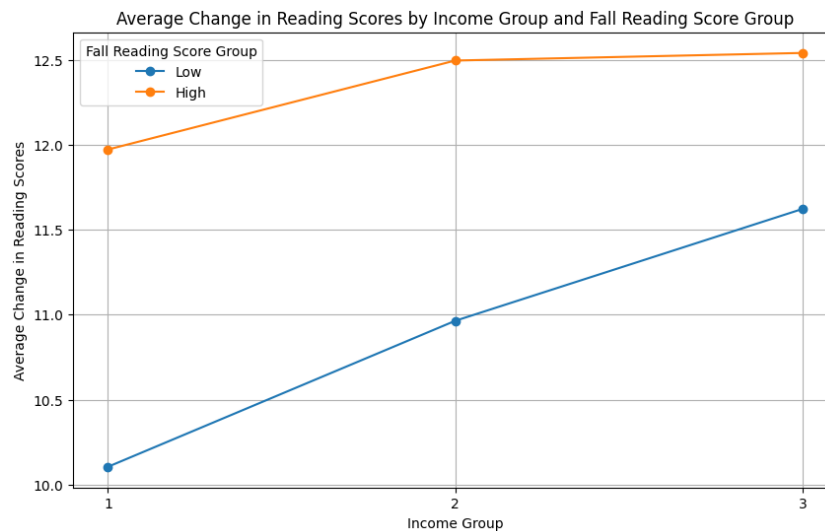


The "Average Change in Math Scores by Income Group" line chart shows a positive trend, where higher income groups correspond to larger average increases in math scores over time. This suggests a possible advantage for students from higher-income backgrounds in academic progress in math.



1. There is a positive trend in all income brackets as we move from Q1 to Q4, suggesting that students with higher fall math scores tend to have a larger increase in their scores, regardless of their income bracket. Students in the lowest fall math score group (Q1) show the least amount of change across all income brackets.
2. The gap between the highest and lowest fall score groups (Q4 and Q1) seems to increase as the income bracket goes from low to high. This could indicate that higher income may amplify the advantage of having a high initial score.

3. The slope of the line for the Q4 group is steeper than the others, especially as income increases, suggesting that students with the highest fall scores in higher-income brackets may experience the greatest increase in scores.
4. Students in higher income brackets show an overall higher average change in scores, particularly those who had higher scores in the fall. This could imply that wealthier students have more resources or opportunities that contribute to their learning gains over the school year.



The plot shows the average change in reading scores from fall to spring, categorized by income group and initial reading score levels. For both low and high initial reading score groups, as income increases, the average change in reading scores also increases. However, the group with initially high reading scores shows a relatively flat trend, suggesting that higher initial reading performance may not vary as much with income level. Conversely, the low score group exhibits a more pronounced positive slope, indicating that increases in income might be more strongly associated with improvements in reading scores for this group.

### Conclusion

The exploratory data analysis (EDA) suggested a wide scatter of changes in reading and math scores across income groups, with no immediate evidence of a strong correlation between household income and score changes. However, subsequent ANCOVA analysis revealed a nuanced dynamic: household income does indeed interact with initial academic performance, significantly influencing the changes in scores from fall to spring. This interaction highlights the complex relationship between socioeconomic status and educational outcomes, indicating that while income alone may not be a clear-cut predictor of academic progress, it certainly plays a role when considered alongside a student's initial academic abilities.