

Introduction

This study investigates the relationship between household income and kindergarten students' academic performance. Focusing on reading, math, and general knowledge, we assess how economic conditions at home impact educational success in the classroom (1998-1999). This study seeks to uncover patterns and offer insights that can inform policies and practices aimed at promoting educational equity.

Research Questions:

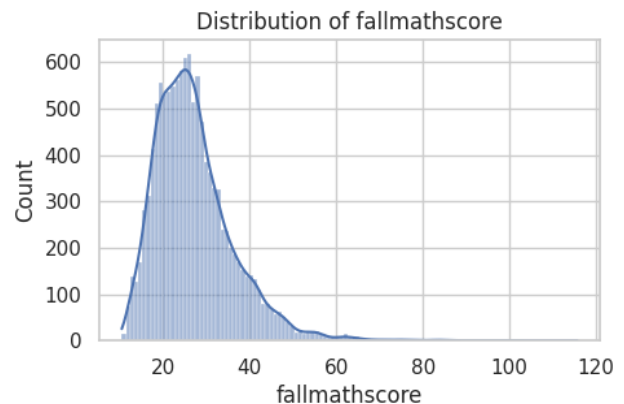
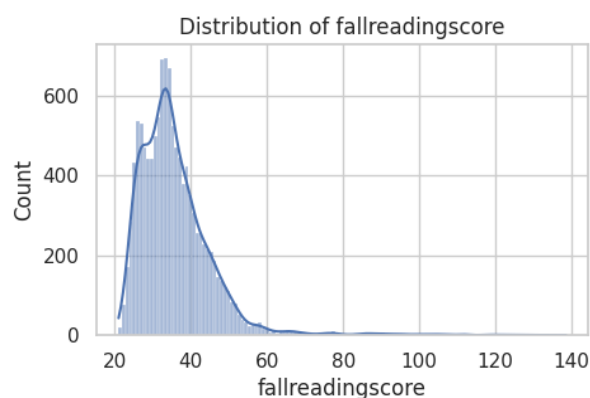
- How does household income influence student performance in reading, math, and general knowledge during the fall and spring terms?
- Are there significant changes in the relationship between income levels and student scores from the fall to the spring term, suggesting developmental trends or the impact of educational interventions?

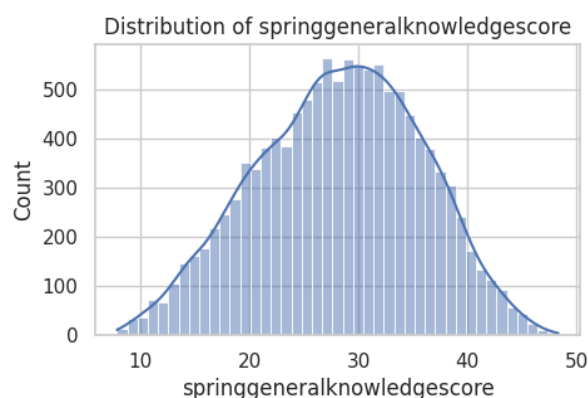
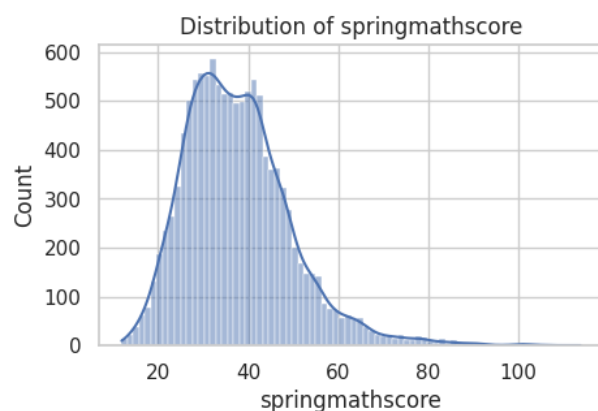
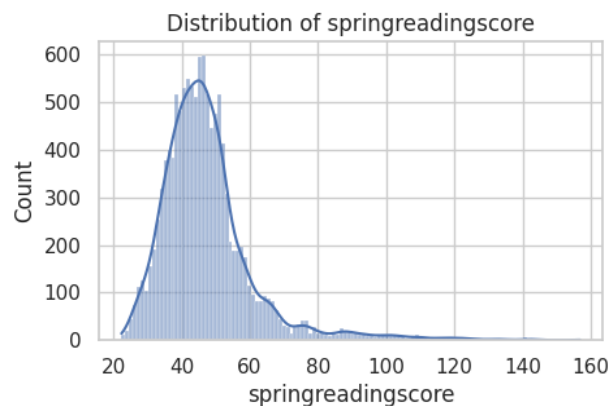
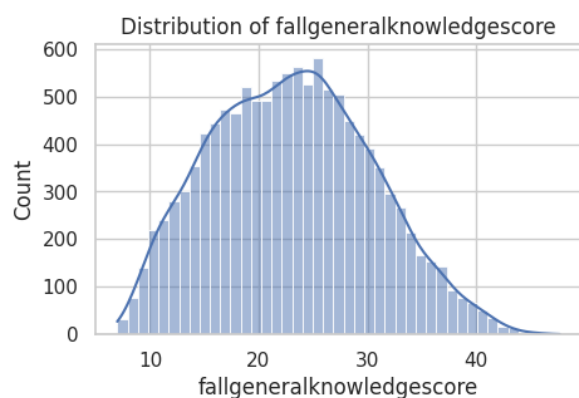
Exploratory Data Analysis

The Exploratory Data Analysis commenced with a thorough examination of the dataset consisting of students' scores across various disciplines measured during the fall and spring terms. Histograms were employed to delineate the distribution of scores, offering a visual interpretation of their spread and central tendencies.

Histogram Analysis:

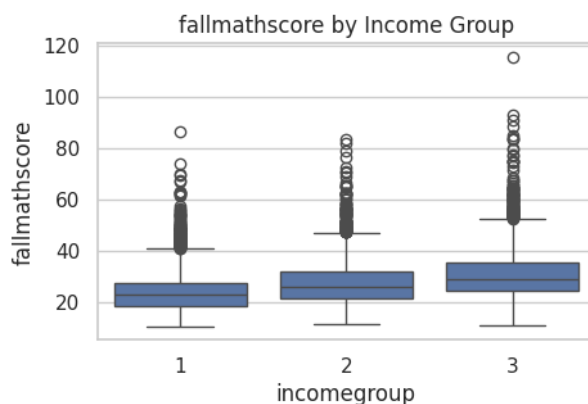
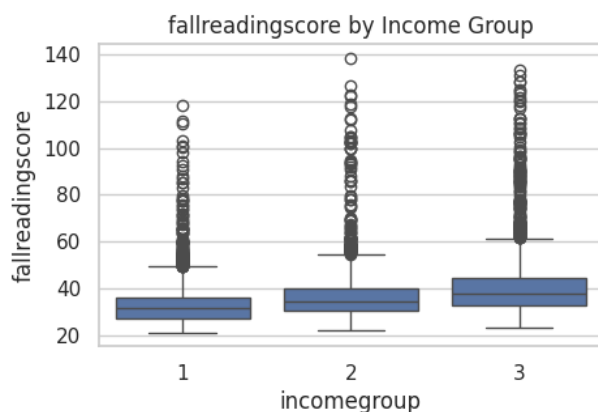
Histograms revealed right-skewed distributions for both reading and math scores, suggesting a concentration of students with scores below the average. General knowledge scores displayed a more balanced distribution, yet with a similar rightward skewness. Moving into the spring term, it showed a shift towards higher achievements, with reading and math distributions indicating an overall improvement. The distribution of general knowledge scores appeared more symmetrical, reflecting consistent academic growth over the year.

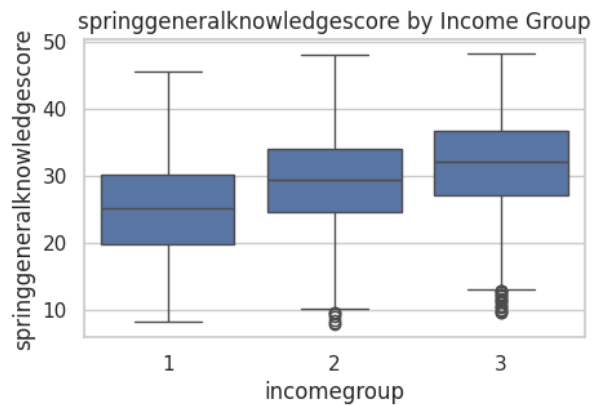
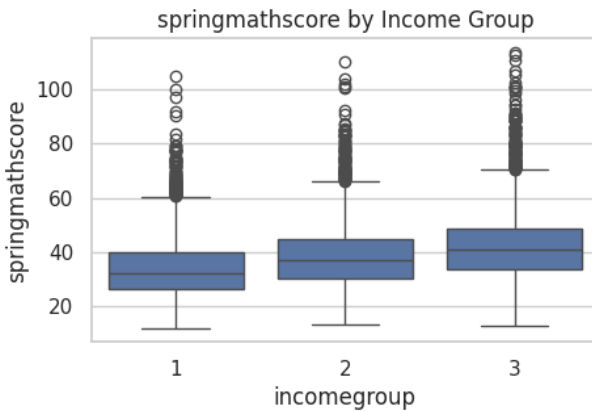
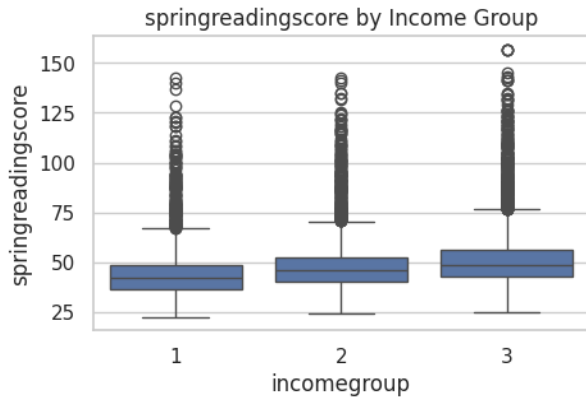
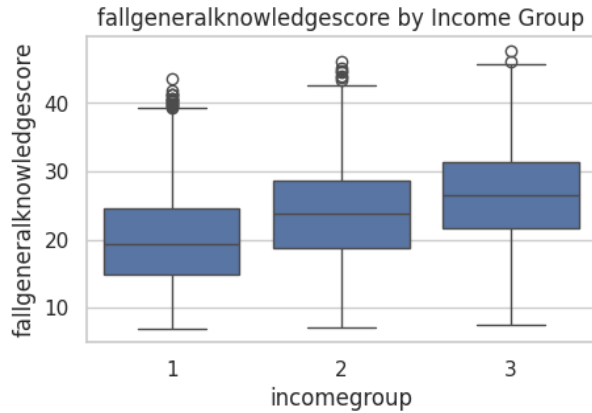




Boxplot Analysis:

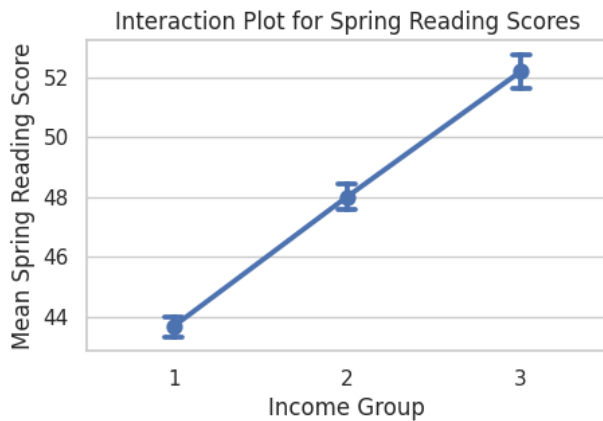
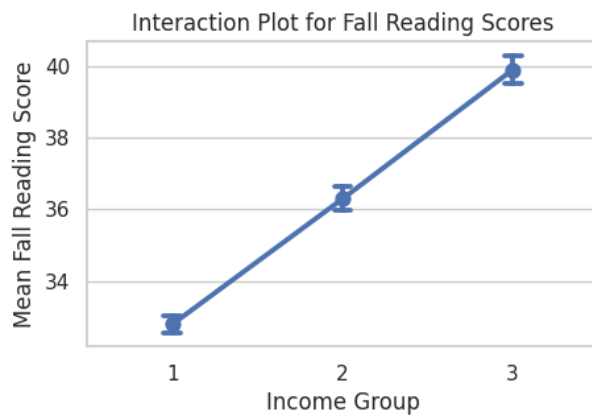
The box plot visualizations offered an insightful look at the score distributions across income groups for both fall and spring terms. The fall term scores presented a range of performances, with higher-income groups typically achieving higher scores. By spring, scores across all groups improved, with box plots indicating a rise in median scores.

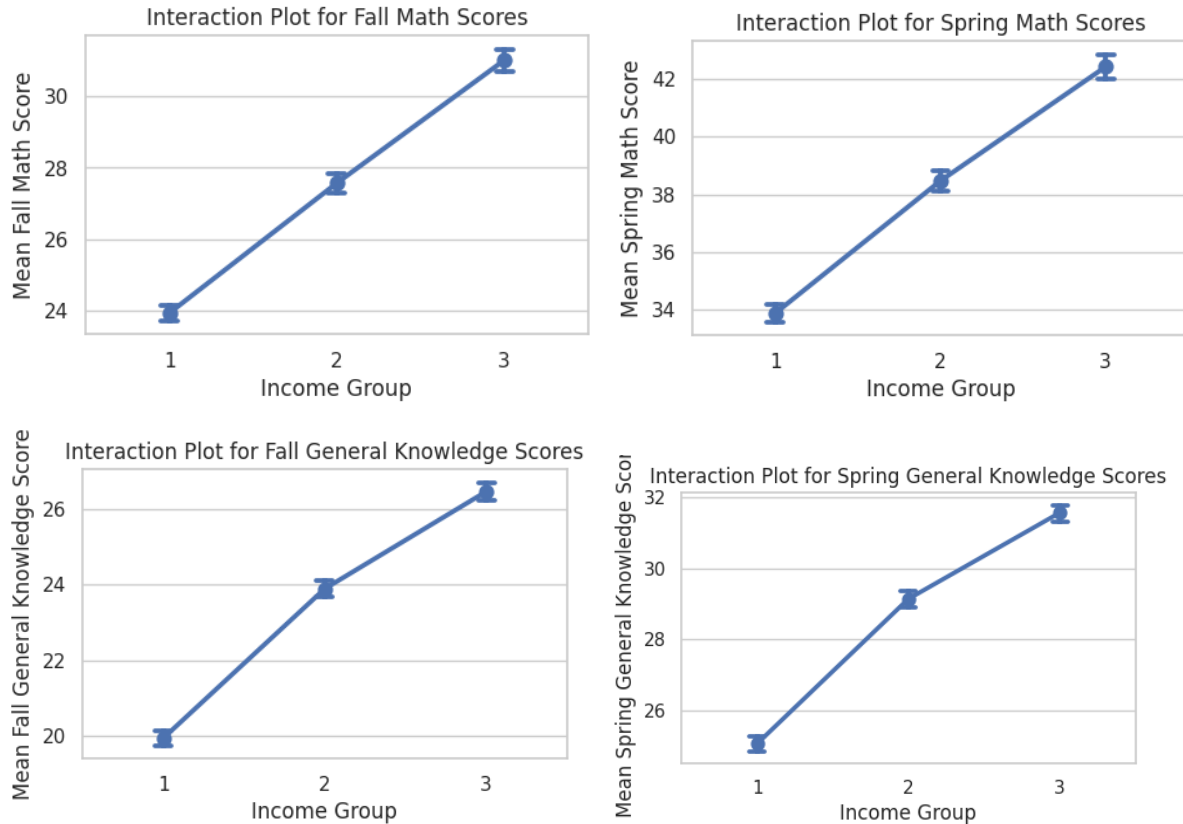




Interaction Plots Analysis

The interaction plots demonstrate a clear positive correlation between income groups and academic performance in reading, math, and general knowledge. Higher-income groups consistently showed better scores, with this effect becoming more pronounced from fall to spring terms. The persistent upward trend across all subjects underscores the potential influence of socioeconomic status on educational attainment, highlighting an area ripe for policy intervention.





ANCOVA Results

The Analysis of Covariance (ANCOVA) was performed to discern the impact of household income on students' academic scores, controlling for their baseline scores in the fall. The results are compelling, indicating that household income has a significant effect on the scores across all subjects.

Reading Scores:

The ANCOVA for fall reading scores revealed a significant relationship between household income and reading achievement ($F(1, 11930) = 10.6886$, $p = 0.00108$). Notably, the fall reading scores as a covariate had a profound impact ($F(1, 11930) = 24116.1857$, $p < 0.00001$), underscoring the predictive value of initial performance.

Table 1: ANCOVA Results for the Effect of Household Income on Fall Reading Scores

	Sum of Squares	df	F-value	p-value
Total Household Income	6.7596e+02	1	10.6886	0.00108
Fall Reading Score	1.5251e+06	1	24116.1857	< 0.00001
Residual	7.5446e+05	11930		

Math Scores:

Similarly, household income significantly affected fall math scores ($F(1, 11930) = 57.9519, p < 0.00001$). Baseline math scores were also highly significant ($F(1, 11930) = 21745.6753, p < 0.00001$), confirming the strong influence of initial math skills on subsequent performance.

Table 2: ANCOVA Results for the Effect of Household Income on Fall Math Scores

	Sum of Squares	df	F-value	p-value
Total Household Income	2.6743e+03	1	57.9519	2.8882e-14
Fall Math Score	1.0035e+06	1	21745.6753	< 0.00001
Residual	5.5054e+05	11930		

General Knowledge Scores:

The effect of household income on general knowledge scores was particularly striking ($F(1, 11930) = 120.7980, p < 0.00001$). The covariate, fall general knowledge scores, exhibited an overwhelming effect ($F(1, 11930) = 26462.8230, p < 0.00001$), indicating that early knowledge acquisition is critical for future learning.

Table 3: ANCOVA Results for the Effect of Household Income on Fall General Knowledge Scores

	Sum of Squares	df	F-value	p-value
Total Household Income	1863.4451	1	120.7980	5.7613e-28
Fall General Knowledge Score	408218.7447	1	26462.8230	< 0.00001
Residual	184033.6393	11930		

These findings suggest that socioeconomic factors, as represented by household income, have a substantial impact on educational outcomes. Additionally, the strong relationship between fall and spring scores points to the importance of early academic support, especially for students from lower-income households.

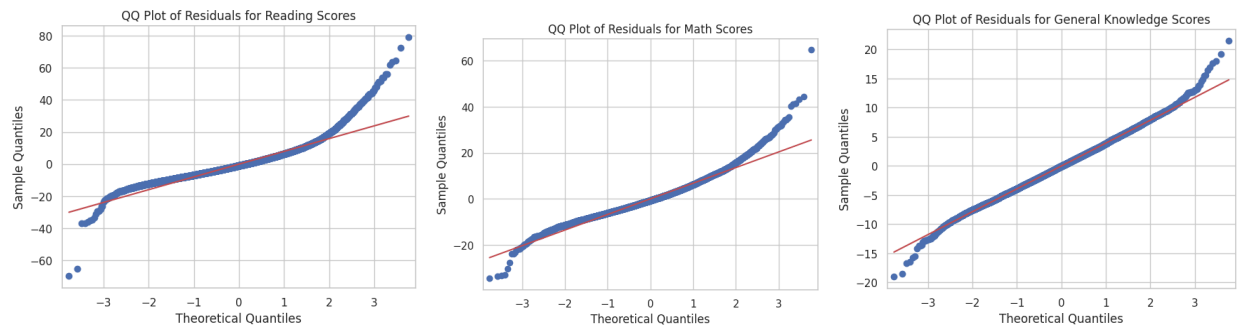
Assumption Testing

It's critical to test certain assumptions to ensure the validity of the model's results, we focused on the normality of residuals. The residuals from the models predicting spring scores based on fall scores and total household income were assessed using Quantile-Quantile (QQ) plots.

The QQ plots for reading, math, and general knowledge scores each exhibited a pattern where the majority of points followed the red reference line but with deviations at both ends of the

distribution. This suggests that while residuals are mostly normally distributed, there are outliers or extreme values, particularly in the tails.

The Reading Scores plot displayed a slight departure from normality in the higher quantiles, indicating that the reading score residuals have a few outliers with exceptionally high scores. The residuals for math scores showed a more pronounced curvature, suggesting heavier tails than a normal distribution would exhibit. This pattern indicates potential skewness or kurtosis in the math score residuals. Similar to reading scores, the plot for general knowledge showed slight deviations at the extremities, signalling the presence of outliers.



Conclusion

This study examined how household income levels correlate with the academic achievements of kindergarten students, providing clear evidence of disparities in educational outcomes. The data indicates a consistent trend: students from wealthier backgrounds generally achieve higher scores in reading, mathematics, and general knowledge. These findings raise important questions about the role of economic status in educational equity and suggest a need for strategies that support students who may be economically disadvantaged.

The ANCOVA results indicate that income's influence is both significant and persistent. This influence is a reminder of the broader social determinants that contribute to academic success and calls for an educational system that addresses these foundational disparities.

We must also acknowledge the limitations of our study, particularly in the distribution of residuals that signal potential deviations from normality. These deviations show the complexities of educational data and suggest caution in the interpretation of our findings.

In sum, the findings contribute to a crucial dialogue on educational access and quality. As we move forward, it is imperative to consider socioeconomic factors in the development of educational policy and practice, aiming to create a more level playing field for all learners.