Athens University of Economics and Business

Master of Science (MSc) in Business Analytics

Business Analytics Practicum II - FT

-Project I -

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Contents

1. Introduction

This project utilizes the Programme for International Student Assessment (PISA) 2018 dataset, alongside economic data from the World Economic Outlook Database, to analyze global educational outcomes. Focusing on Greece, the study examines the impact of socio-economic factors like parental education and GDP per capita on student performance and explores gender disparities.

2. Pisa dataset Variables

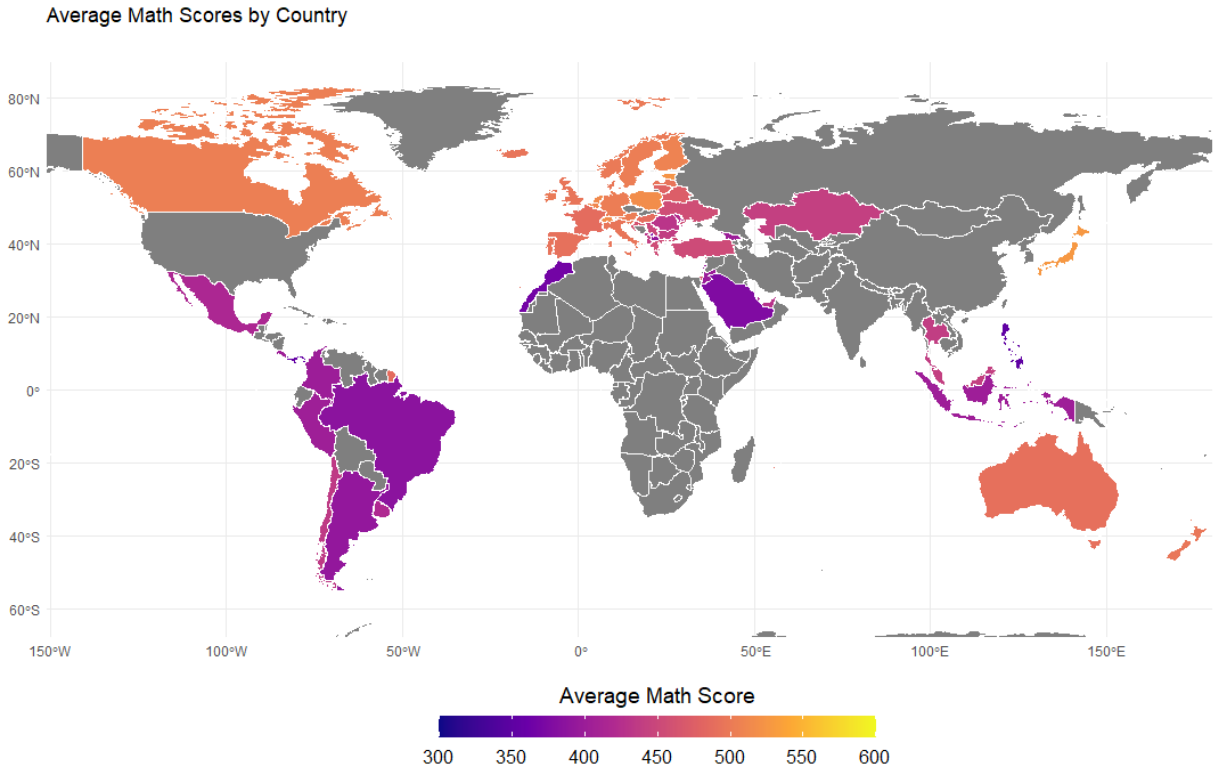
Meaning of Pisa 2018 selected variables:

Variable	Meaning	More explanation of meaning
CNTRYID	Country ID	
CNT	Country name	
CNTSCHID	School ID	
CNTSTUID	Student ID	
ST001D01T	Grade level	The grade level of the student categorized into levels such as "Grade 7", "Grade 8", etc. It shows the grade in which the student was enrolled at the time of the assessment.
ST003D02T	Month of birth	The birth month of the student, categorized into months ("January", "February", etc.).
ST003D03T	Year of birth	The birth year of the student, categorized into specific years like "2001", "2002", etc.
ST004D01T	Gender	The gender of the student, categorized into "Female" and "Male".
ST005Q01TA	Mother's education level	An educational attainment level of the student's mother, categorized into levels like "ISCED level 3A", etc.
ST007Q01TA	Father's education level	An educational attainment level of the student's father, similarly categorized with the mother's level. It shows the highest level of education completed by the student's father.
MATH	Math score	A numeric score representing the student's performance in mathematics.
READ	Reading score	A numeric score representing the student's performance in reading
SCIE	Science score	A numeric score representing the student's performance in science
GLCM	an academic performance measures.	A composite or general score combining multiple subjects

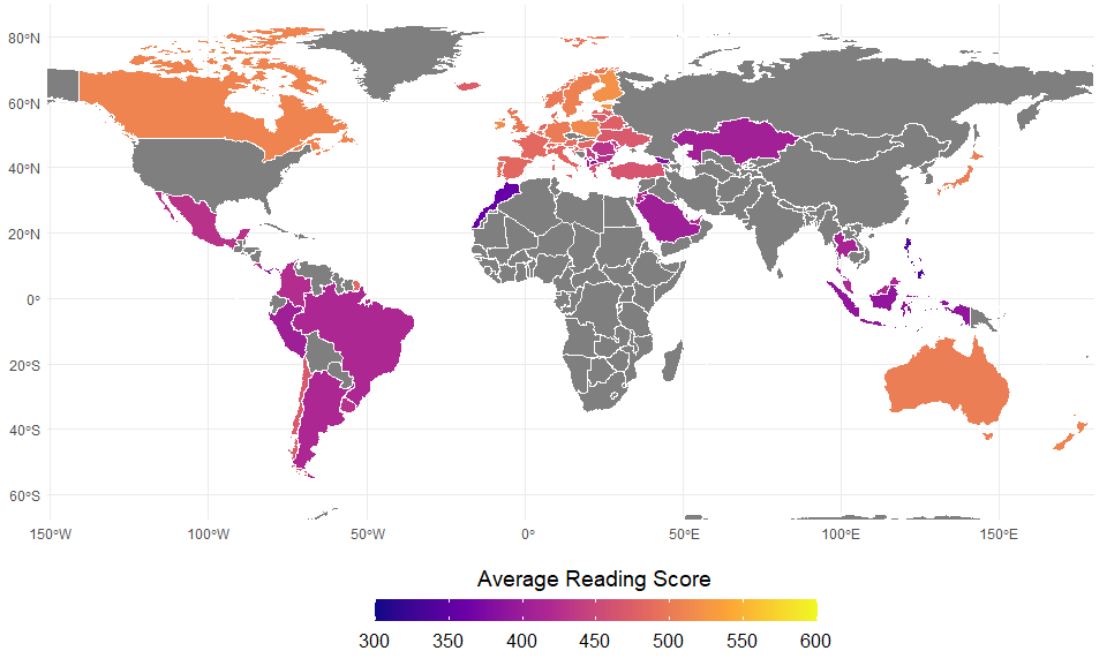
3. Comparative International Analysis for Greece

At first, we will compare Greece's performance to that of other countries, offering a perspective on where Greece stands internationally.

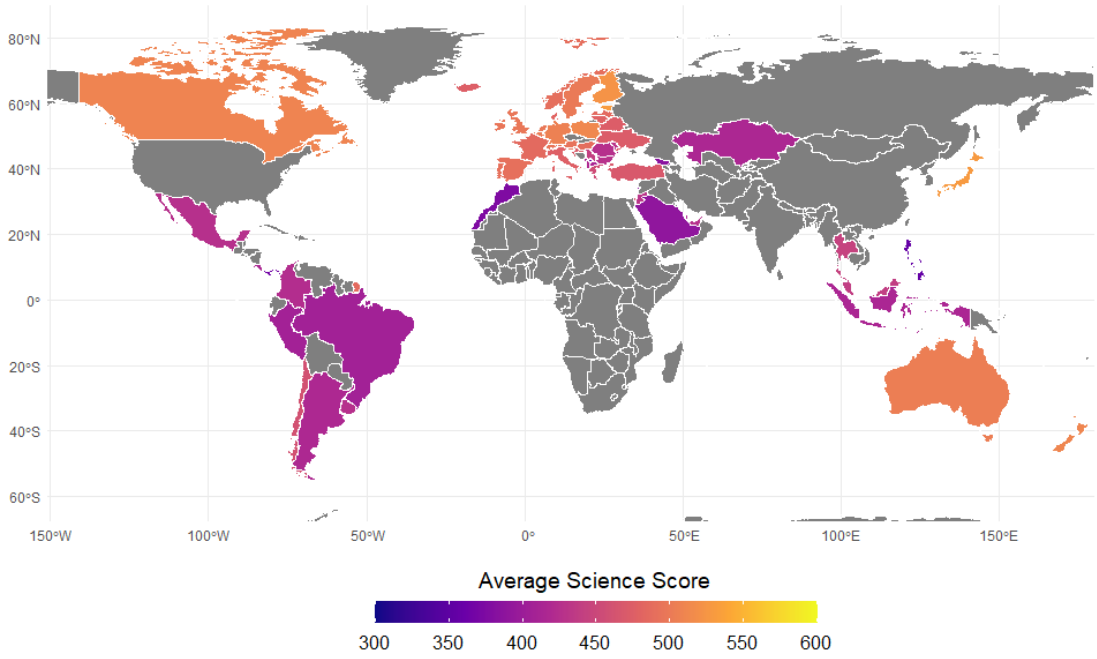
Map of Average Scores by Country in Math, Reading and Science



Average Reading Scores by Country



Average Science Scores by Country



The three maps show average scores in math, reading, and science by country.

Math Scores: Greece appears in the middle range of math scores, colored similarly to many European countries. Its score isn't among the top countries like those in East Asia, which show deeper shades showing higher scores.

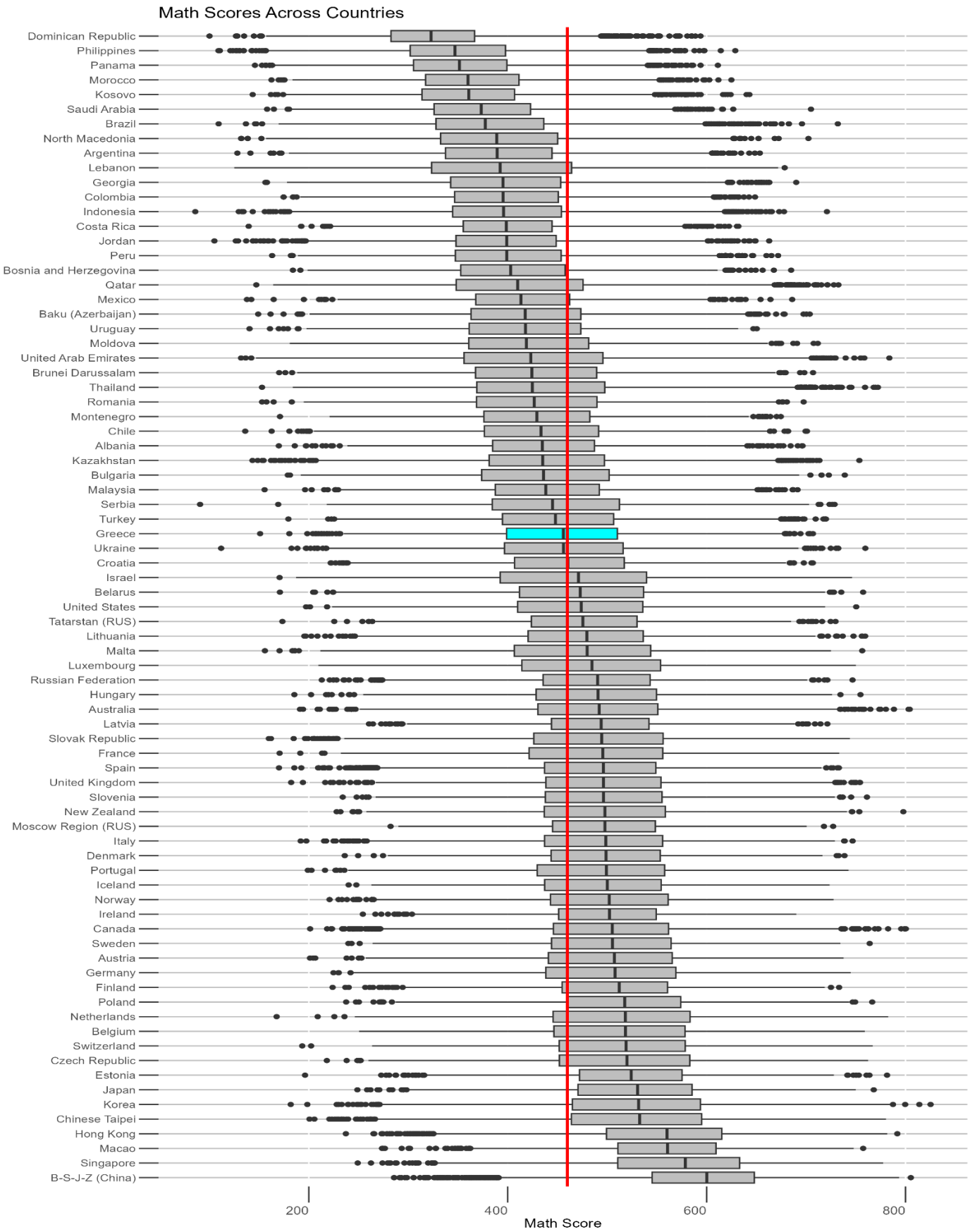
Reading Scores: Greece's performance in reading is also moderate, marked by a color that places it in the average range compared to other global scores. It does not reach the highs seen in the darker shades of countries like Finland or Singapore, but it is also not among the lowest.

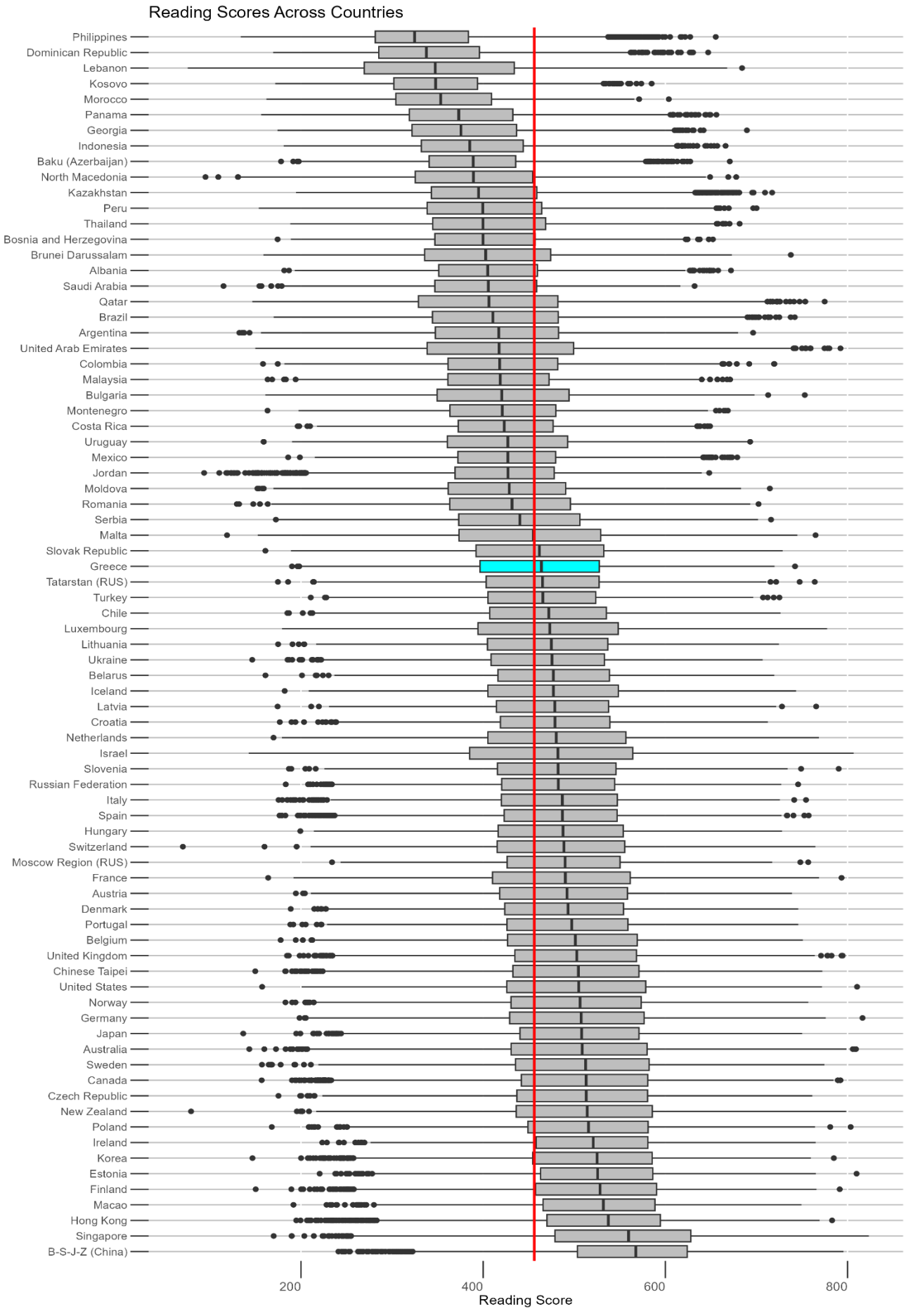
Science Scores: In science, Greece again shows a middle-range performance, indicated by a similar shade to its math and reading scores. It neither excels nor falls behind significantly, maintaining a steady mid-tier position globally.

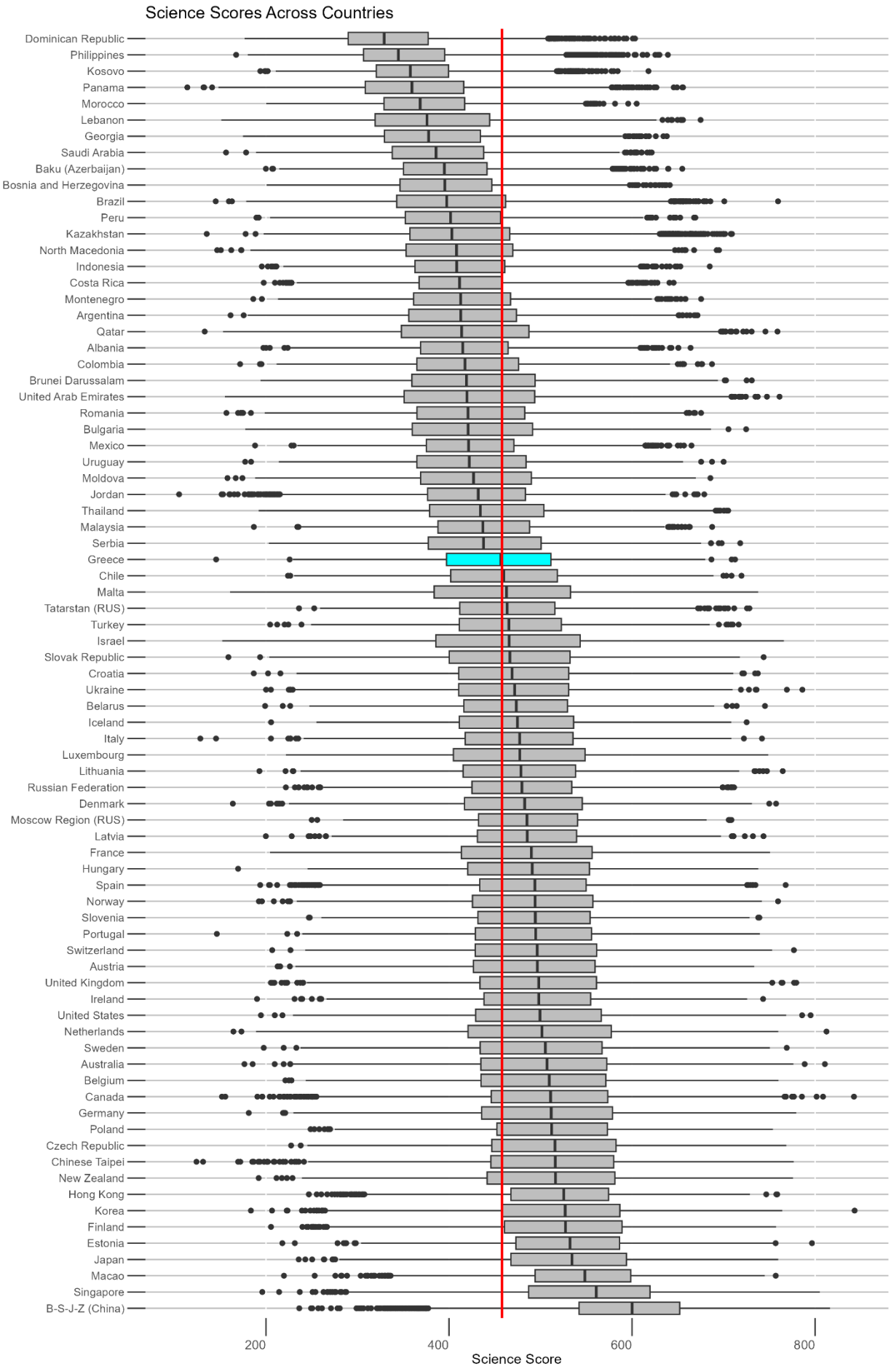
Across all three subjects Greece's educational performance is consistently average, without extreme highs or lows. The uniformity in scoring suggests a balanced educational system, but with potential for improvement to reach top-performing countries.

Boxplot of Math, Reading and Science Scores by Country

Compares reading scores across multiple countries to position Greece within an international context.




Reading Scores Across Countries
Philippines
Dominican Republic
Lebanon
Kosovo
Morocco
Panama
Georgia
Indonesia
Baku (Azerbaijan)
North Macedonia
Kazakhstan
Peru
Thailand
Bosnia and Herzegovina
Brunei Darussalam
Albania
Saudi Arabia
Qatar
Brazil
Argentina
United Arab Emirates
Colombia
Malaysia
Bulgaria
Montenegro
Costa Rica
Uruguay
Mexico
Jordan
Moldova
Romania
Serbia
Malta
Slovak Republic
Greece
Tatarstan (RUS)
Turkey
Chile
Luxembourg
Lithuania
Ukraine
Belarus
Iceland
Latvia
Croatia
Netherlands
Israel
Slovenia
Russian Federation
Italy
Spain
Hungary
Switzerland
Moscow Region (RUS)
France
Austria
Denmark
Portugal
Belgium
United Kingdom
Chinese Taipei
United States
Norway
Germany
Japan
Australia
Sweden
Canada
Czech Republic
New Zealand
Poland
Ireland
Korea
Estonia
Finland
Macao
Hong Kong
Singapore
B-S-J-Z (China)
200
400
600
800
Reading Score


Science Scores Across Countries
Dominican Republic
Philippines
Kosovo
Panama
Morocco
Lebanon
Georgia
Saudi Arabia
Baku (Azerbaijan)
Bosnia and Herzegovina
Brazil
Peru
Kazakhstan
North Macedonia
Indonesia
Costa Rica
Montenegro
Argentina
Qatar
Albania
Colombia
Brunei Darussalam
United Arab Emirates
Romania
Bulgaria
Mexico
Uruguay
Moldova
Jordan
Thailand
Malaysia
Serbia
Greece
Chile
Malta
Tatarstan (RUS)
Turkey
Israel
Slovak Republic
Croatia
Ukraine
Belarus
Iceland
Italy
Luxembourg
Lithuania
Russian Federation
Denmark
Moscow Region (RUS)
Latvia
France
Hungary
Spain
Norway
Slovenia
Portugal
Switzerland
Austria
United Kingdom
Ireland
United States
Netherlands
Sweden
Australia
Belgium
Canada
Germany
Poland
Czech Republic
Chinese Taipei
New Zealand
Hong Kong
Korea
Finland
Estonia
Japan
Macao
Singapore
B-S-J-Z (China)
200
400
600
800
Science Score

The three diagrams provide a detailed comparative analysis of math, reading, and science scores across countries, with a specific focus on Greece.

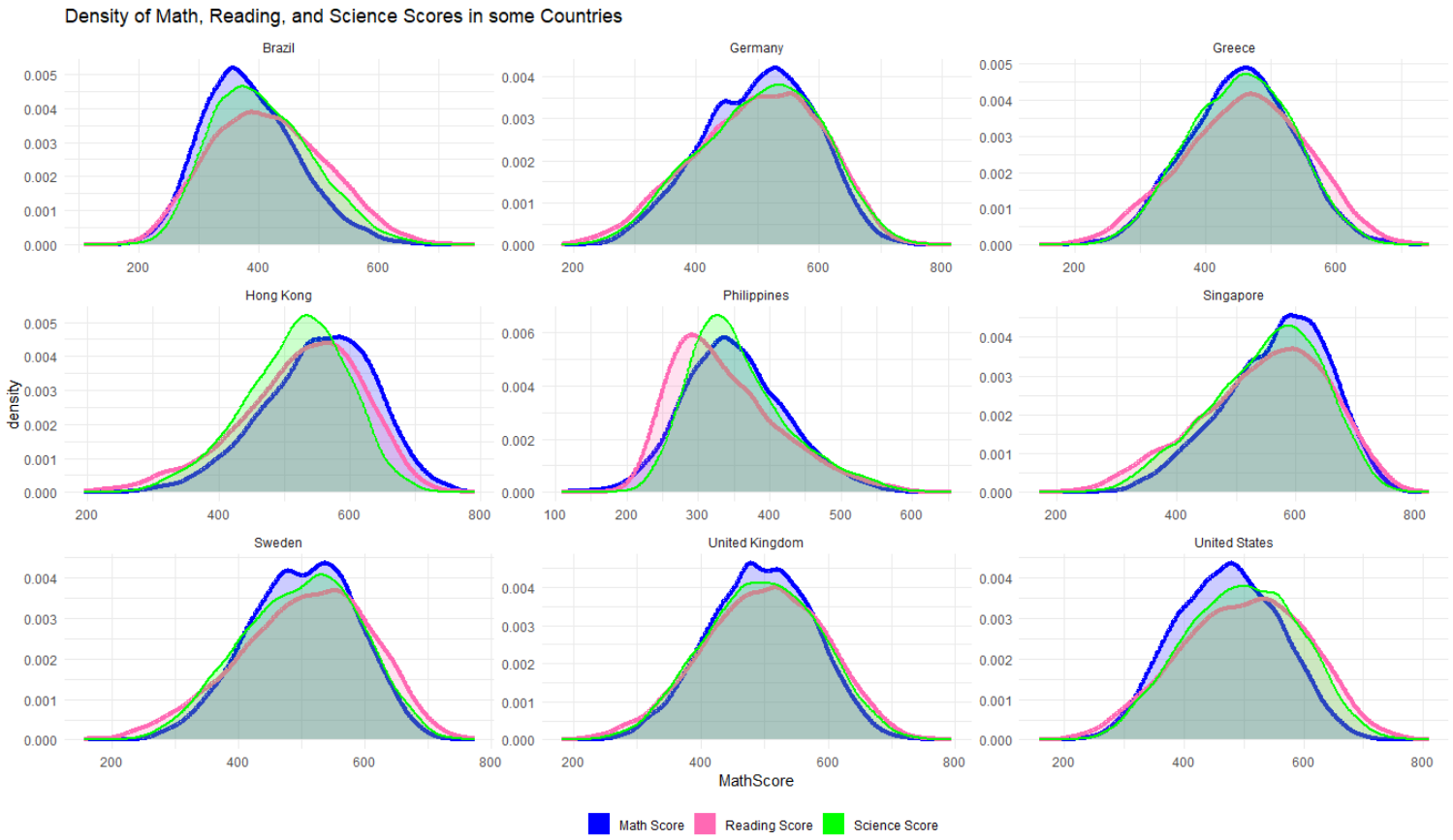
Math Scores: Greece is slightly below the global median, showed by the blue cyan line on the chart. Its position suggests that while not among the lower-performing countries, Greece's math scores are below the average compared to its global peers.

Reading Scores: Greece's performance in reading is slightly better than in math, as indicated by its position closer to the median red line. This places Greece near the middle of the global spectrum, suggesting a relatively average reading proficiency among students.

Science Scores: Similar to reading, Greece is positioned around the median for science scores. This shows a consistent performance across both reading and science, aligning Greece with the average international standards.

Across all three subjects, Greece maintains a position near the middle of the global rankings, with no significant deviations into either the upper or lower extremes. This uniformity shows the need for targeted educational policies that could help improve Greece's standing, especially in math where it lags slightly behind the other two subjects. These results could guide educational reforms focused on enhancing Greece's educational outcomes in comparison to global benchmarks.

Density Math, Reading, and Science Scores in some Countries



These density plots show the distribution of math, reading, and science scores across selected countries, including Greece.

Brazil: Scores in all three subjects are mostly concentrated around the lower mid-range, with relatively flat distributions showing a wider variation in student performance.

Hong Kong: Shows high performance in math and science with scores densely packed around higher values, showing strong outcomes especially in math. The reading scores are slightly lower but still well above many other countries.

Sweden: Exhibits very close performance across all three subjects with peaks around the mid to upper-mid range of the score spectrum.

Germany: Similar to Sweden, shows compact and high peaks in all subjects, showing consistent high performance across the board.

Philippines: The scores are spread out with a slightly lower peak in science, suggesting a broader variation in performance with a tilt towards lower outcomes.

United Kingdom: Shows a high level of consistency across all subjects with scores densely concentrated in the upper-mid range.

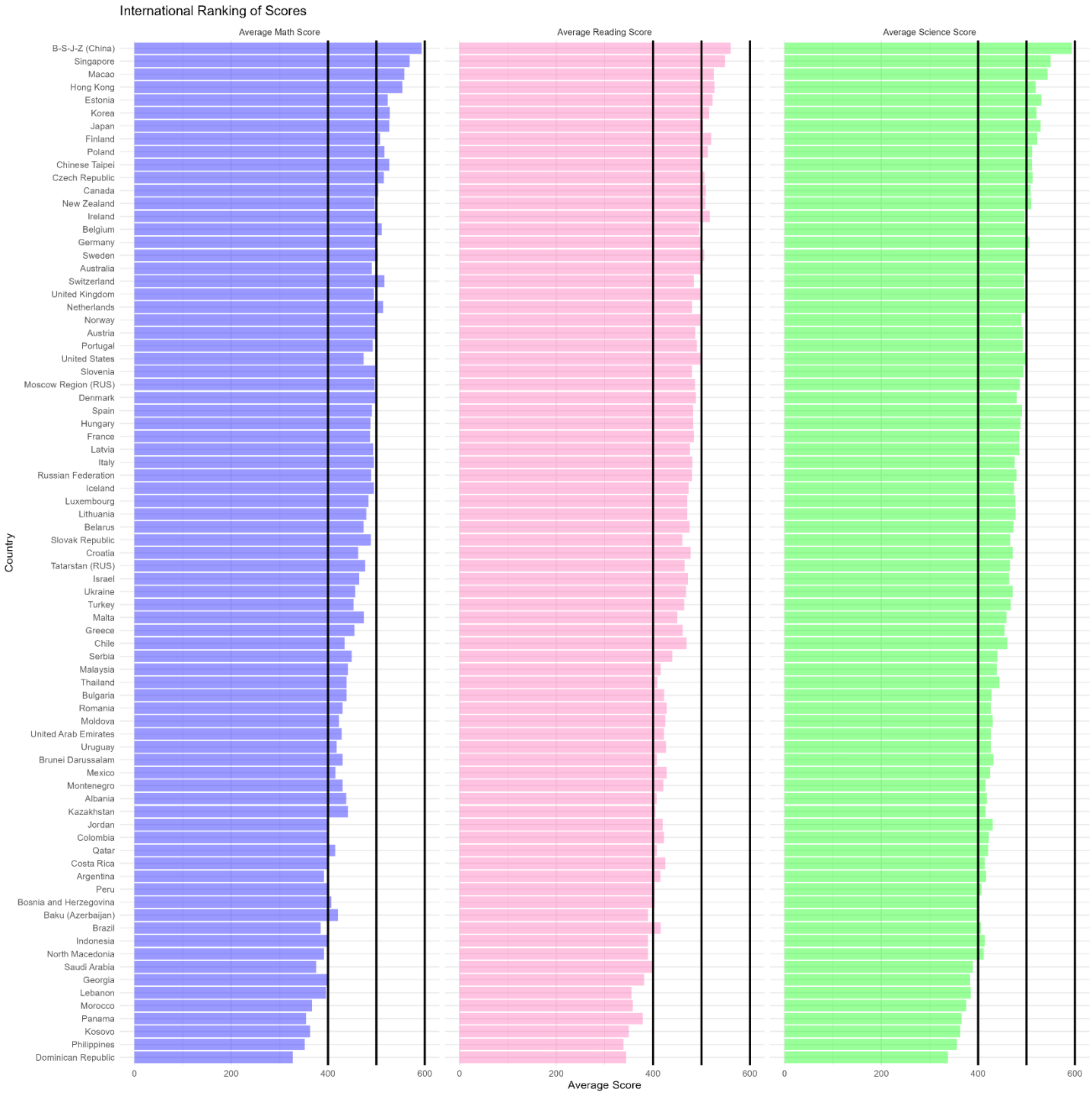
Greece: Features scores that peak in the middle range across all subjects, with a particularly close performance between math and science, suggesting a balanced educational output.

Singapore: Stands out with very high performance, particularly in math and science, with scores peaking sharply in the high range, which signifies a strong emphasis and success in these areas.

United States: Shows a broad distribution in math and science scores with peaks in the mid-range, while reading scores are slightly higher, showing variability in educational outcomes.

Countries like Singapore, Hong Kong, and Germany exhibit high and consistent performance across subjects, particularly in math and science. Greece, while not at the top, shows a balanced performance across all three disciplines with room for improvement to reach the level of top-performing countries. The plots also reveal the diversity in educational achievement globally, showing differences in curriculum strength and educational focus across countries.

Horizontal Bar Chart of International Ranking of Scores



These bar charts show the international ranking of average scores in math, reading, and science across various countries, represented by horizontal bar charts for each subject.

Countries like Singapore, Hong Kong, Macao, Korea, and Japan consistently appear at the top of the rankings across all three disciplines, showing their strong educational systems focused on science and mathematics.

Many Western and Eastern European countries, along with the United States and Australia, show good but not top-tier performances across the subjects, showing solid but varied educational outcomes.

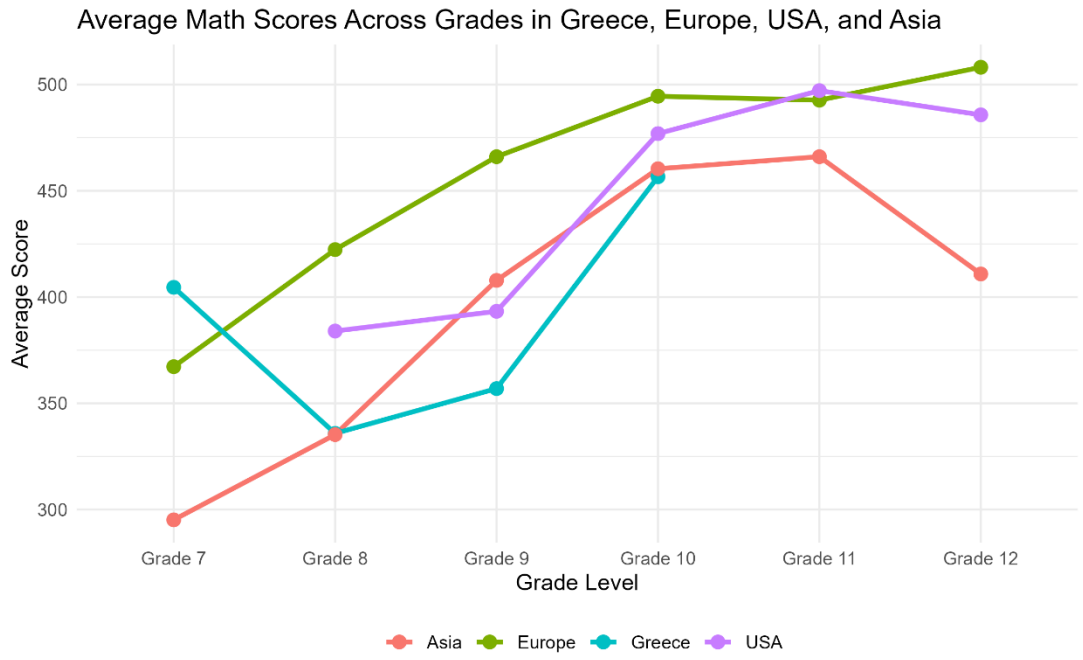
Countries in the lower rankings typically include nations from the Middle East, Latin America, and some parts of Southeast Asia, where educational systems might be facing challenges like lower funding or socio-political issues affecting education quality.

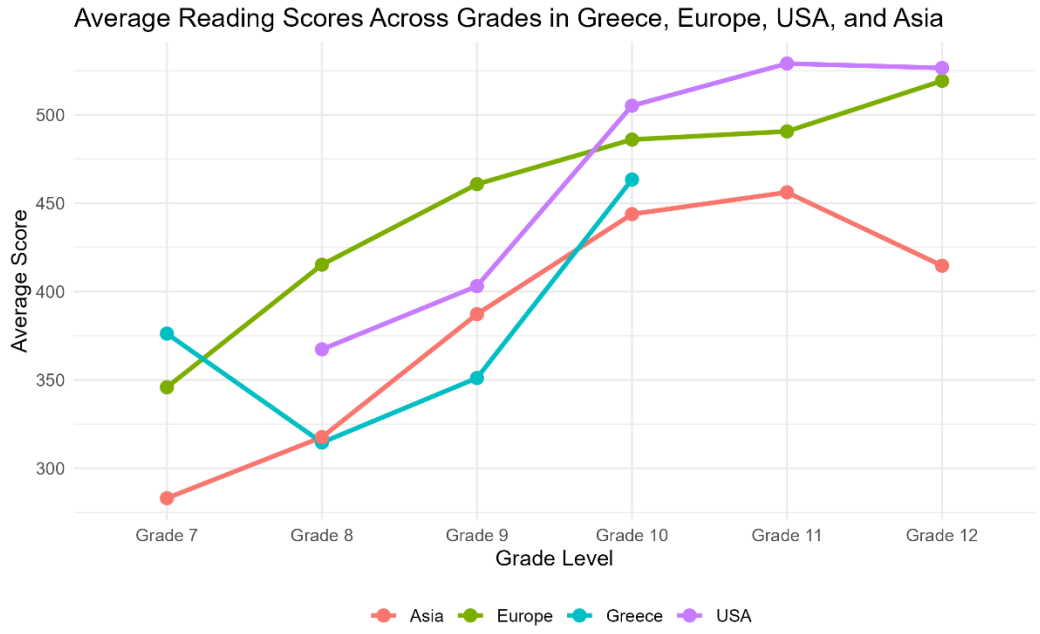
Math Scores: The highest math scores are concentrated in East Asian countries, showing a regional strength in mathematics education. European countries like Switzerland and Estonia also show strong performances.

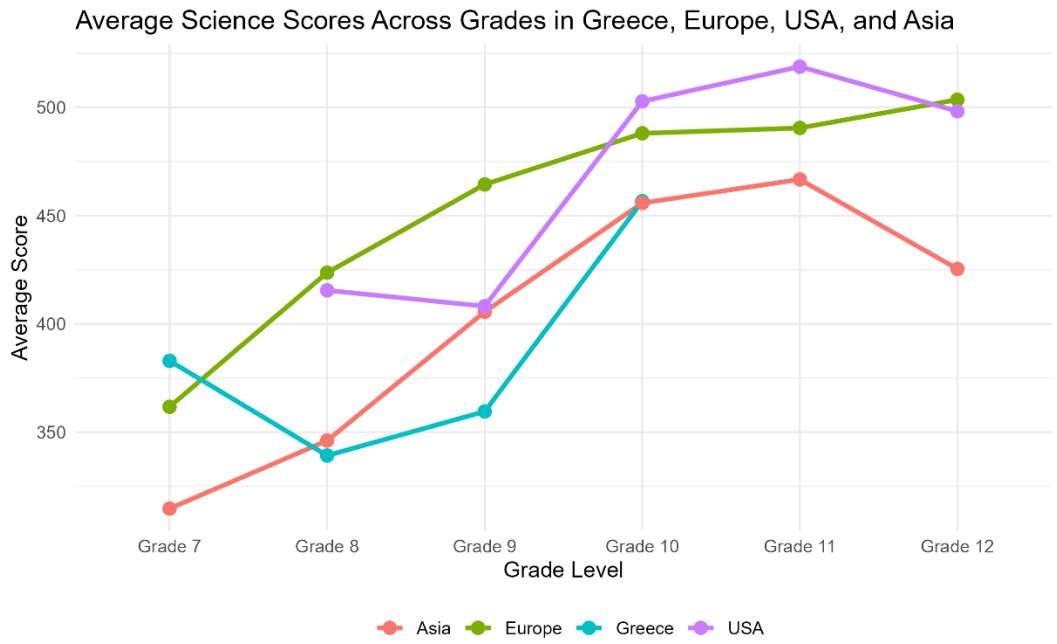
Reading Scores: While East Asian countries excel in math and science, European countries like Ireland, Finland, and Norway lead in reading scores. This suggests a strong emphasis on language and literature education in these regions.

Science Scores: Similar to math, the top science scores are predominantly from East Asian countries, demonstrating their comprehensive focus on STEM education.

Line Graph of Score Distributions for Reading Math Science Across Grades in Greece compare with Europe, Asia, USA







These diagrams show the average math, reading, and science scores across grades in Greece, Europe, USA, and Asia.

Math Scores:

Greece shows a noticeable improvement in math scores from Grade 7 to Grade 10, peaking around 450 and then experiencing a slight decline through Grades 11 and 12. Compared to Asia and the USA, Greece's peak scores are lower, showing a gap in math performance. Europe as a region shows a similar trend to Greece but maintains higher scores in the later grades.

Reading Scores:

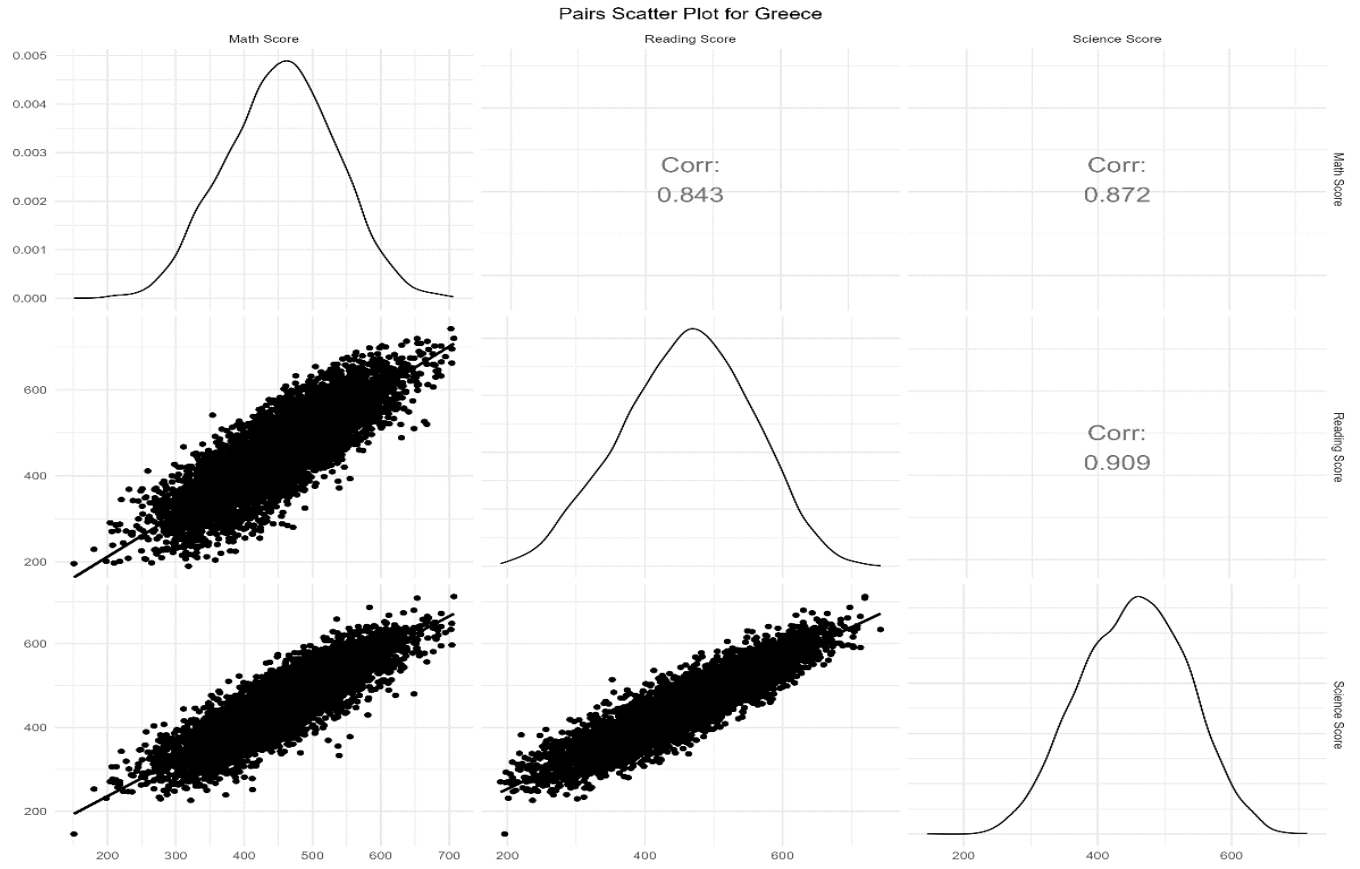
Greece's reading scores follow a similar upward trend, improving significantly from Grade 7 through Grade 9, then plateauing and slightly declining in Grade 12. Greece outperforms Asia in reading across most grades but remains below Europe and the USA, especially in the higher grades.

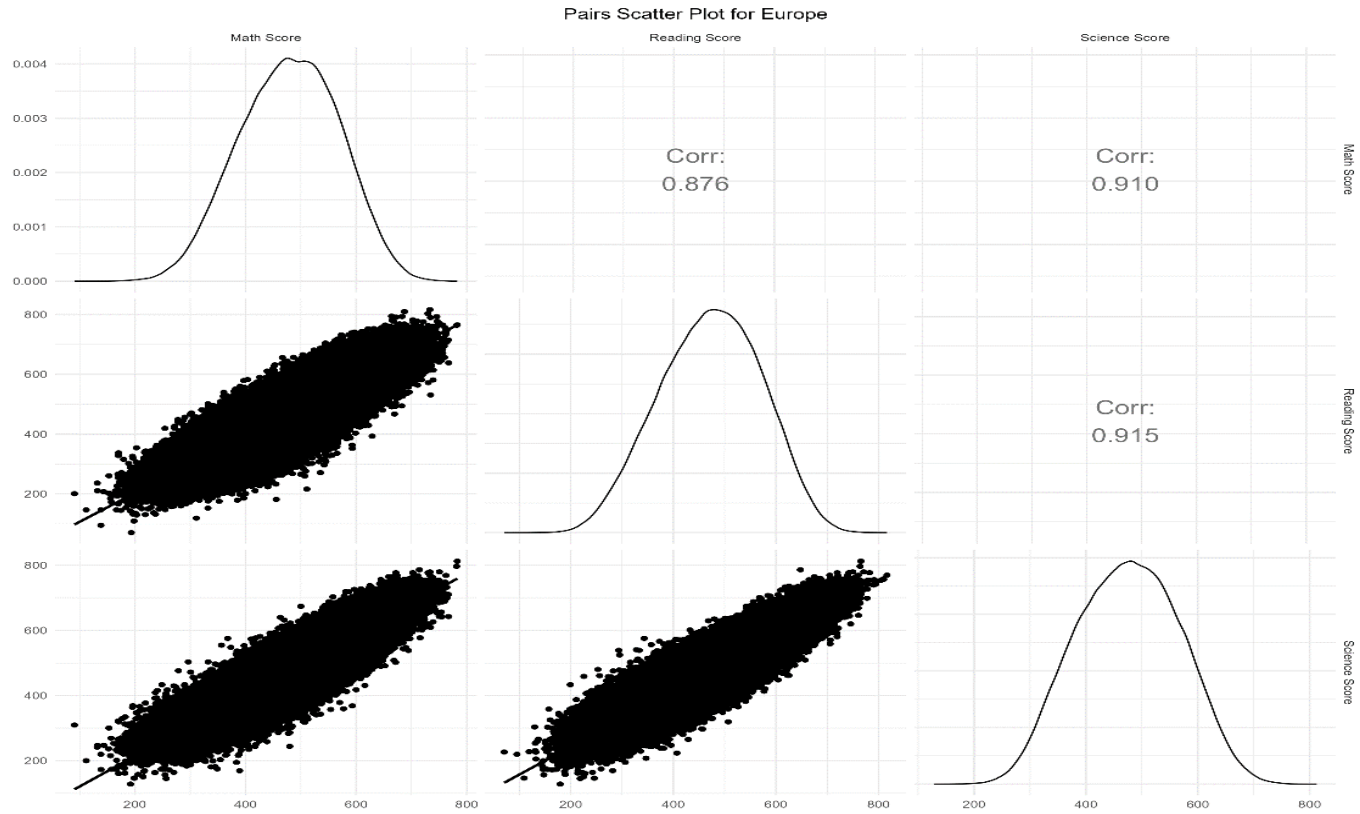
Science Scores:

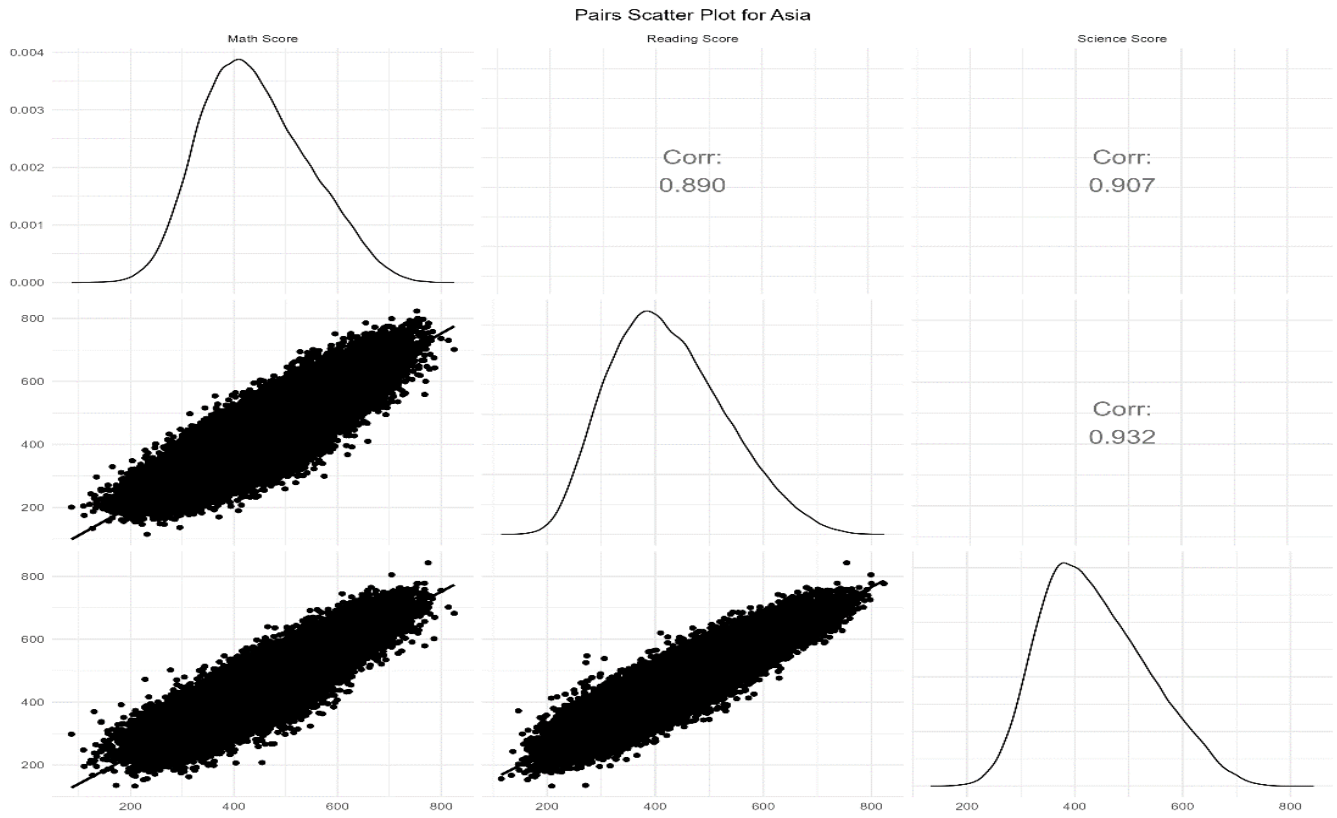
Greece exhibits a steady increase in science scores from Grade 7, peaking in Grade 10, similar to its math scores, before declining. The pattern in Greece closely mirrors the overall trend in Europe but at a consistently lower level. Again, Asia leads with the highest scores, especially in the upper grades, whereas the USA sees a decline similar to Greece.

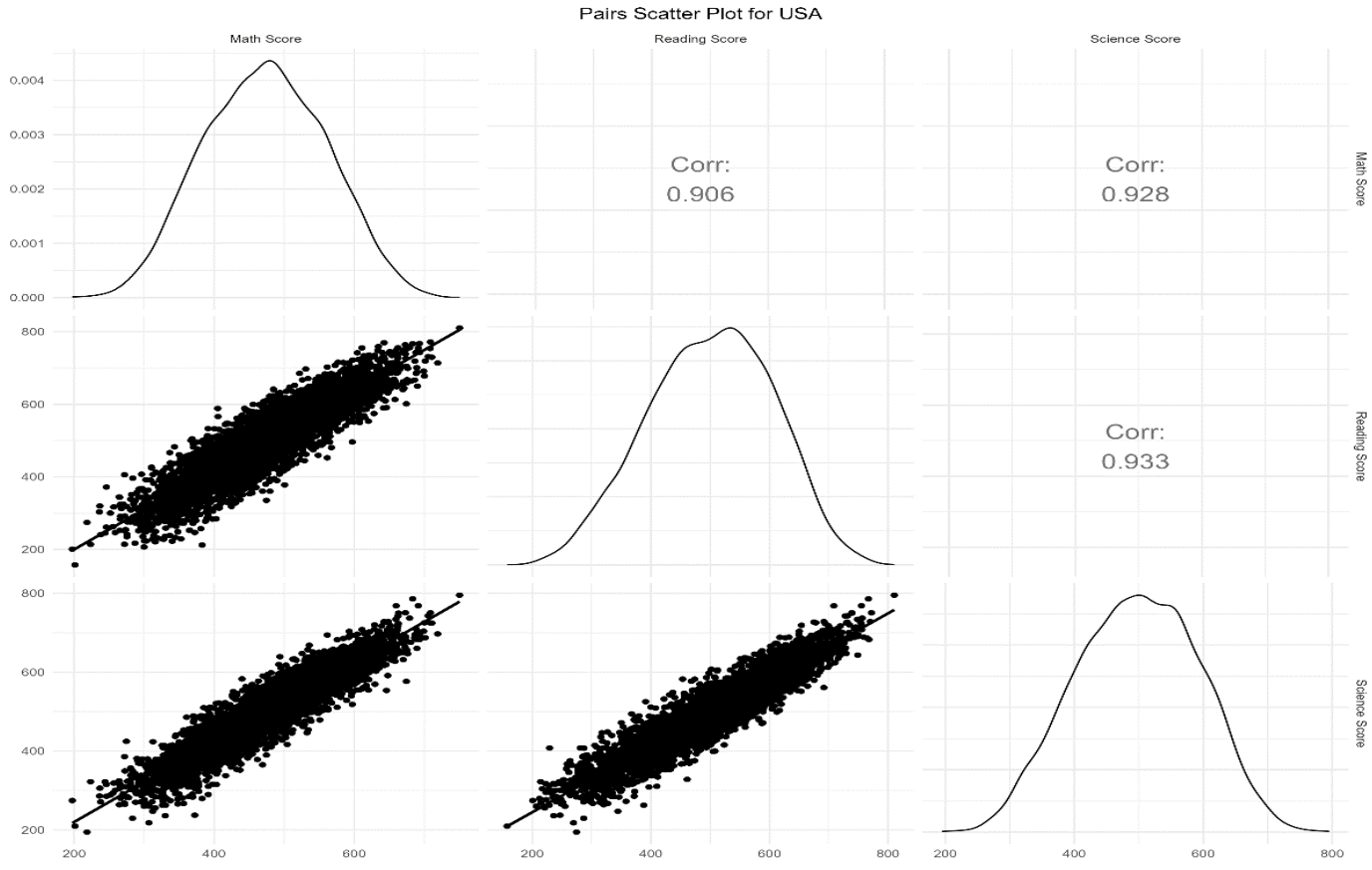
Greece demonstrates consistent improvement in educational outcomes from lower to middle grades across all subjects, with a peak around Grade 10. This suggests effective middle-grade educational strategies but shows a potential drop in engagement or effectiveness in the later high school years. While Greece competes closely with European averages and surpasses Asia in reading, it still lags behind in math and science, particularly against Asia.

Scatter Plots and Correlations of Math, Reading, and Science Scores Across Greece, Europe, Asia, and the USA






Pairs Scatter Plot for Asia
Math Score
Reading Score
Science Score
Corr:
0.890
Corr:
0.907
Corr:
0.932
Math Score
Reading Score
Science Score


Pairs Scatter Plot for USA
Math Score
Reading Score
Science Score
Corr:
0.906
Corr:
0.928
Corr:
0.933
Math Score
Reading Score
Science Score

The four diagrams are pairs scatter plots showing the relationship between math, reading, and science scores in Greece, Europe, Asia, and the USA. Each plot includes a correlation coefficient (Corr) that quantifies the degree of linear relationship between the scores in each subject.

Greece's Correlations:

Math and Reading: The correlation coefficient is 0.843, showing a strong positive relationship between math and reading scores in Greece. This suggests that students who perform well in math tend to also perform well in reading.

Math and Science: The correlation is slightly higher at 0.872, showing a very strong positive relationship, showing that skills or teaching methods that benefit math performance may also benefit science learning in Greece.

Reading and Science: The highest correlation in Greece, at 0.909, suggests an even stronger interdependence between reading and science scores. This could reflect a unified approach in teaching methods or curriculum structure that equally benefits reading and science proficiency.

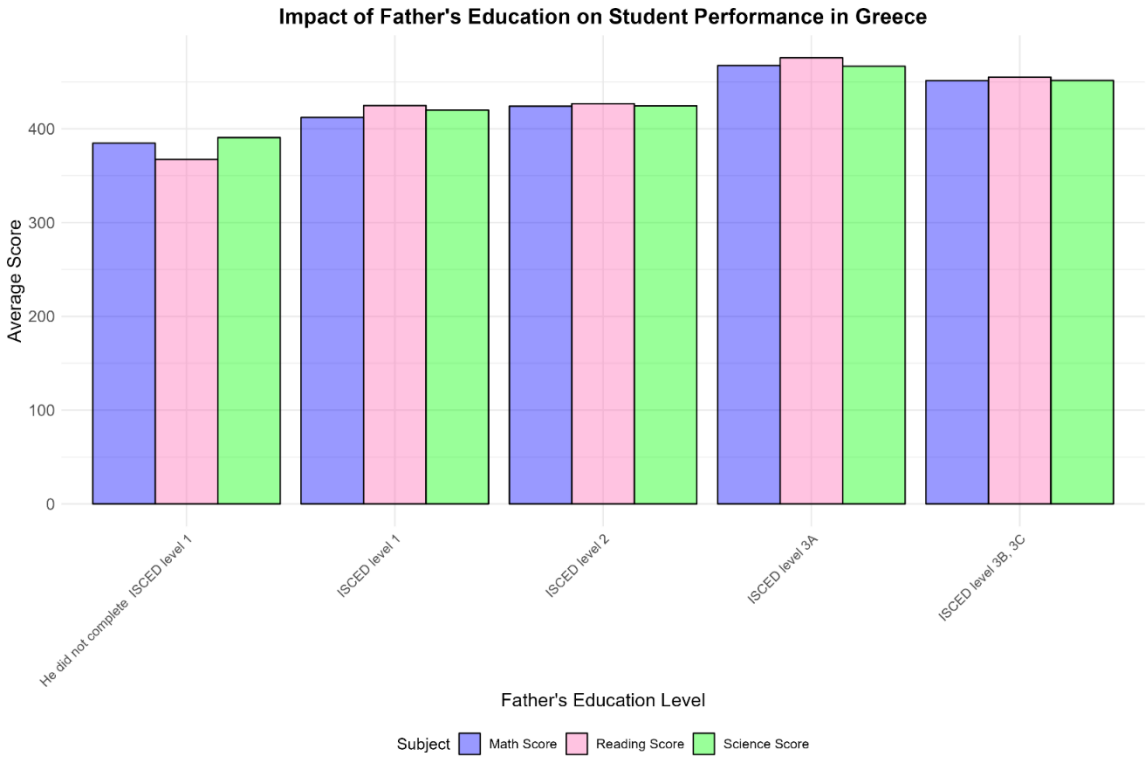
Europe: Shows slightly higher correlations than Greece between math and reading (0.876) and between math and science (0.910), but a similar correlation in reading and science (0.915). This shows a generally consistent pattern of score interrelationships across European countries.

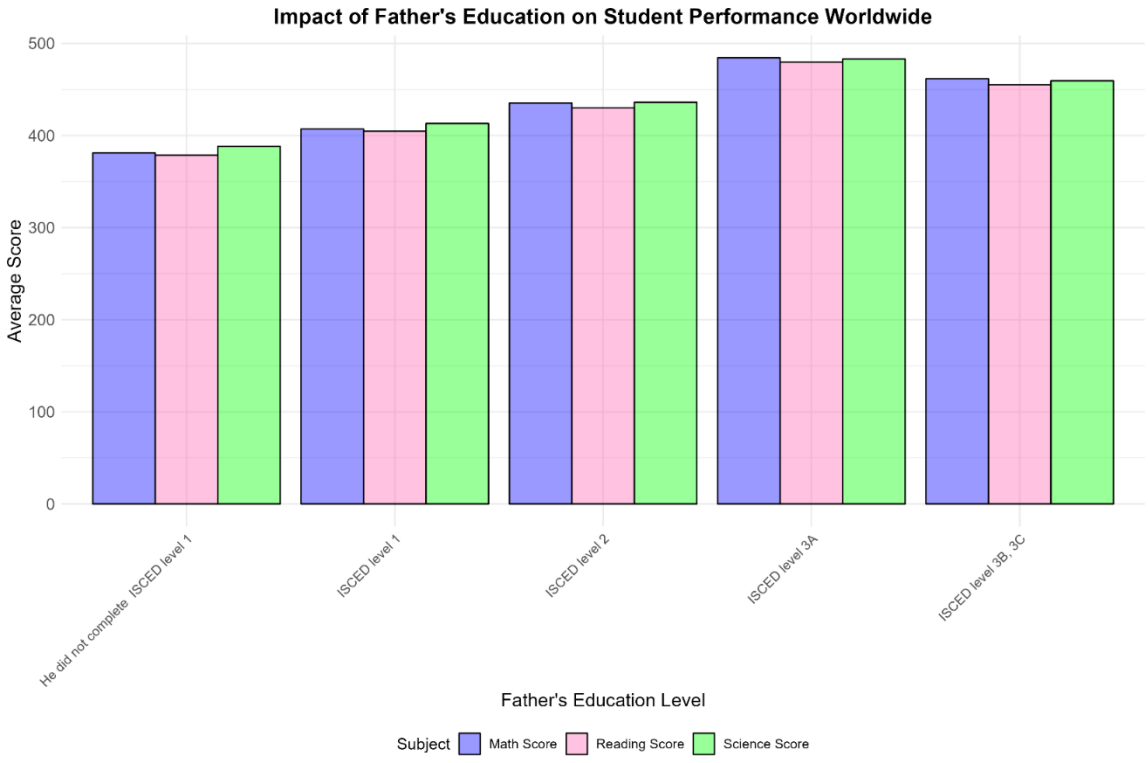
Asia: Shows the highest correlation coefficients among the regions, with all scores above 0.89. This reflects a possibly more uniform educational standard across these subjects or a high level of integrated teaching approaches that equally enhance performance across disciplines.

USA: The USA has correlations comparable to those in Greece, with very high interdependencies between the subjects, particularly between reading and science (0.933), which is slightly higher than Greece's.

Greece stands comparably well in terms of the relationships between subject scores when seen in the context of Europe and the USA, showing a balanced educational approach. However, it slightly lags behind Asia in terms of correlation, suggesting that Asia may have more integrated or effective teaching strategies that simultaneously boost performance across multiple subjects.

Bar chart of Impact of Father's Education on Student Performance in Math, Reading and Science in Greece and Worldwide





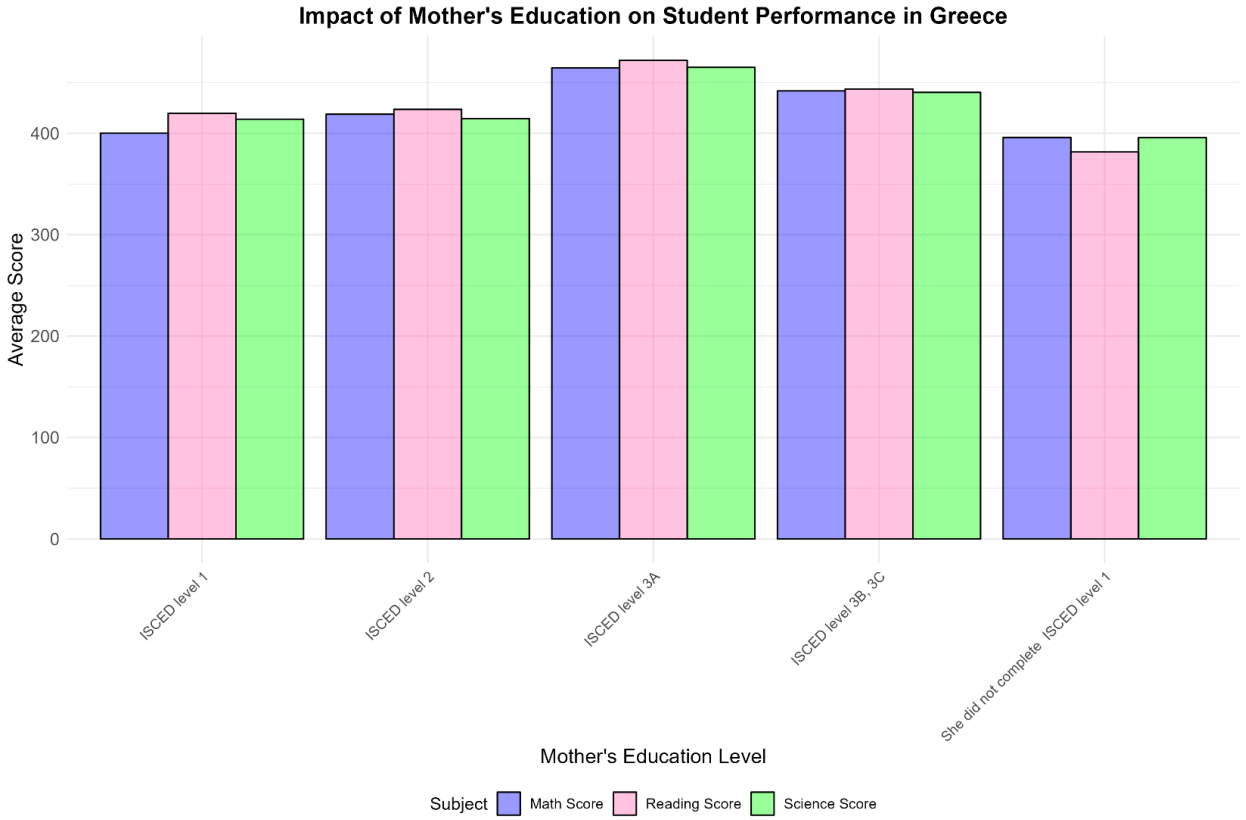
The diagrams compare the impact of fathers' education on student performance in Greece and worldwide, across three subjects: Math, Reading, and Science. The x-axis represents the education level of the father, categorized from 'He did not complete ISCED level 1' to 'ISCED level 3-3C', and the y-axis shows the average scores in the respective subjects.

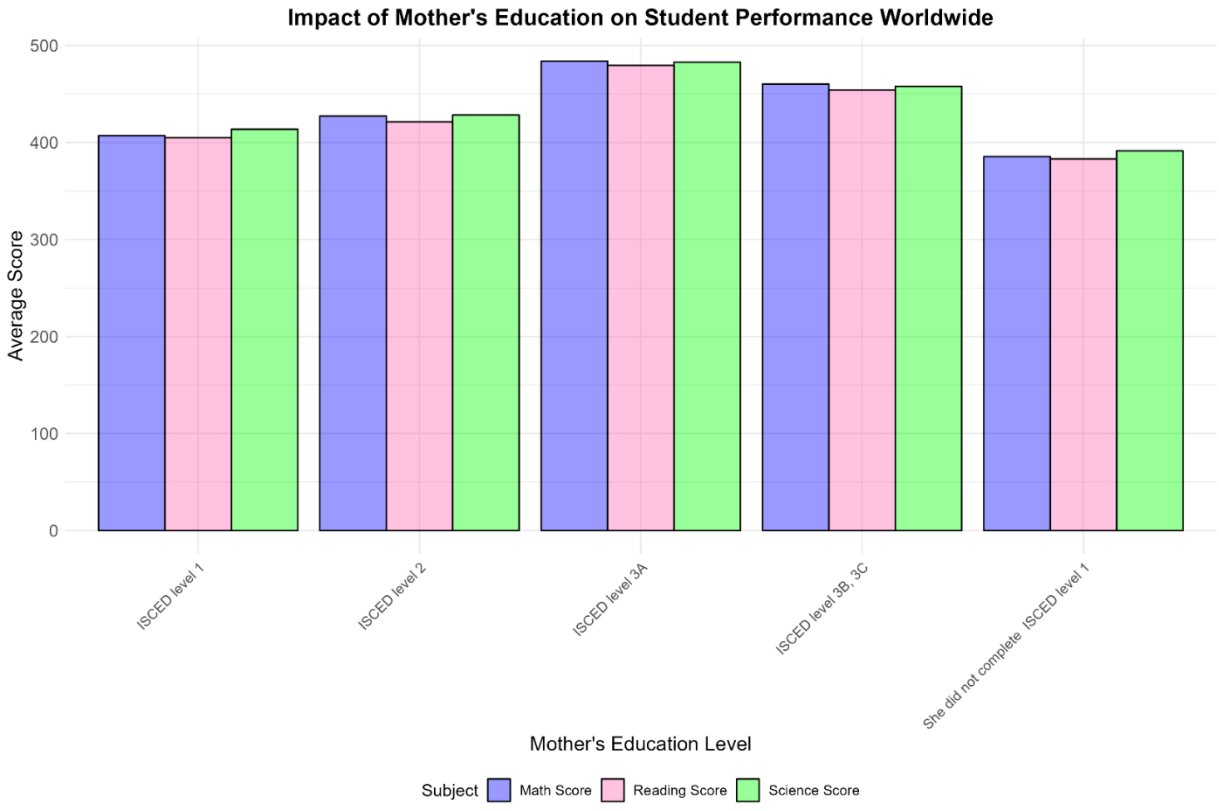
In Greece, there is a noticeable increase in student performance as the educational level of the father increases, across all three subjects. This trend is generally consistent with the global pattern, suggesting a positive correlation between the educational attainment of a parent and the academic performance of their children.

However, the effect seems slightly more pronounced in Greece for Science scores, where students whose fathers have higher education levels (ISCED level 3-3C) score particularly well compared to those whose fathers have the lowest educational levels. This trend is somewhat mirrored worldwide, though the differences between education levels appear less stark globally than in Greece.

The data show the significant role that parental education, particularly that of the father, can play in influencing educational outcomes in Greece and globally.

Bar chart of Impact of Mothers' Education on Student Performance in Math, Reading and Science in Greece and Worldwide





The bar graphs show the impact of mothers' education on student performance in math, reading, and science, both in Greece and worldwide. Here's a focused analysis on Greece:

Consistency Across Education Levels: Both graphs show that as the education level of the mother increases from ISCED level 1 to ISCED level 3A/3C, there is a general improvement in the average scores of students in math, reading, and science. This trend is evident in both the Greece-specific data and the worldwide data.

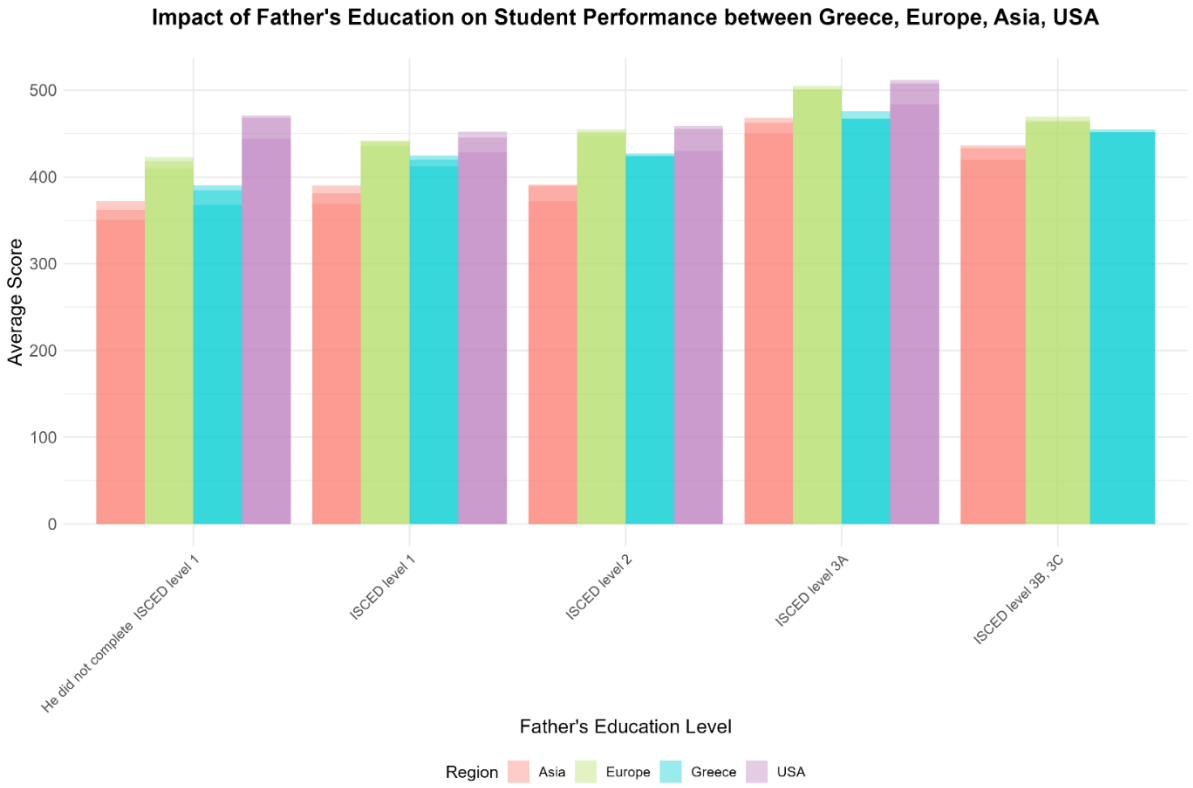
Comparison with Worldwide Trends: In Greece, the increase in scores from one educational level to the next is relatively consistent, with only slight variations in the magnitude of increase across different subjects. Comparatively, the worldwide data shows a more pronounced improvement as the level of mother's education increases. This suggests that globally, mother's education may have a more significant impact on student performance than observed within Greece.

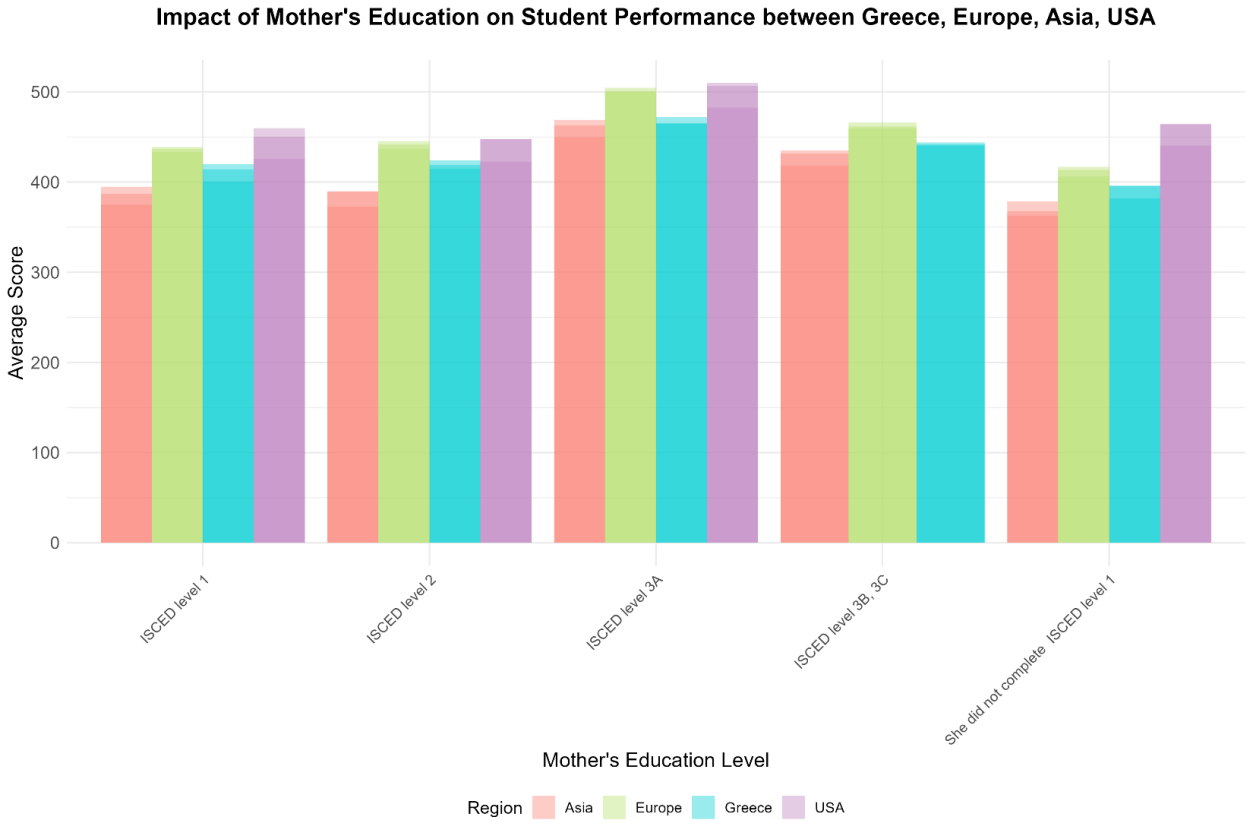
Math Scores: In both datasets, math scores improve as the education level of the mother increases. However, the improvement in scores from ISCED level 2 to ISCED level 3A/3C is less significant in Greece compared to the global trend.

Reading and Science Scores: Similar to math, improvements are noted in reading and science scores with higher educational levels of the mother. The patterns of improvement in Greece closely follow the worldwide trends, showing that the influence of maternal education on reading and science scores is similarly perceived across different regions.

In Greece, student performance consistently improves as the education level of the mother increases. This trend aligns with global observations, emphasizing the importance of parental education in influencing educational outcomes for children. The impact appears to be somewhat more moderate in Greece compared to some global averages, particularly in the higher education categories.

Bar chart of Impact of Father's and Mother's Education on Student Performance in Greece, Europe, Asia, United States Worldwide





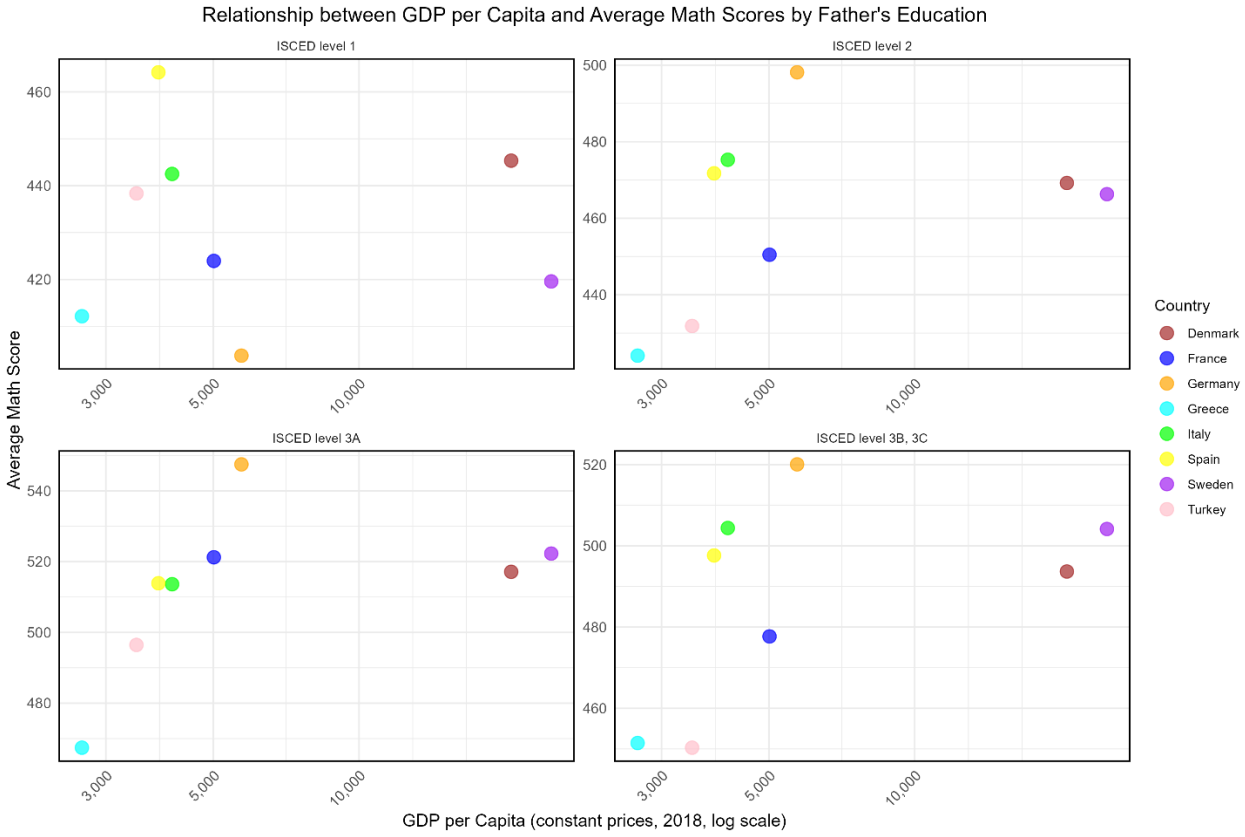
The two diagrams show the impact of fathers' and mothers' education levels on student performance across various regions, including Greece, Europe, Asia, and the USA.

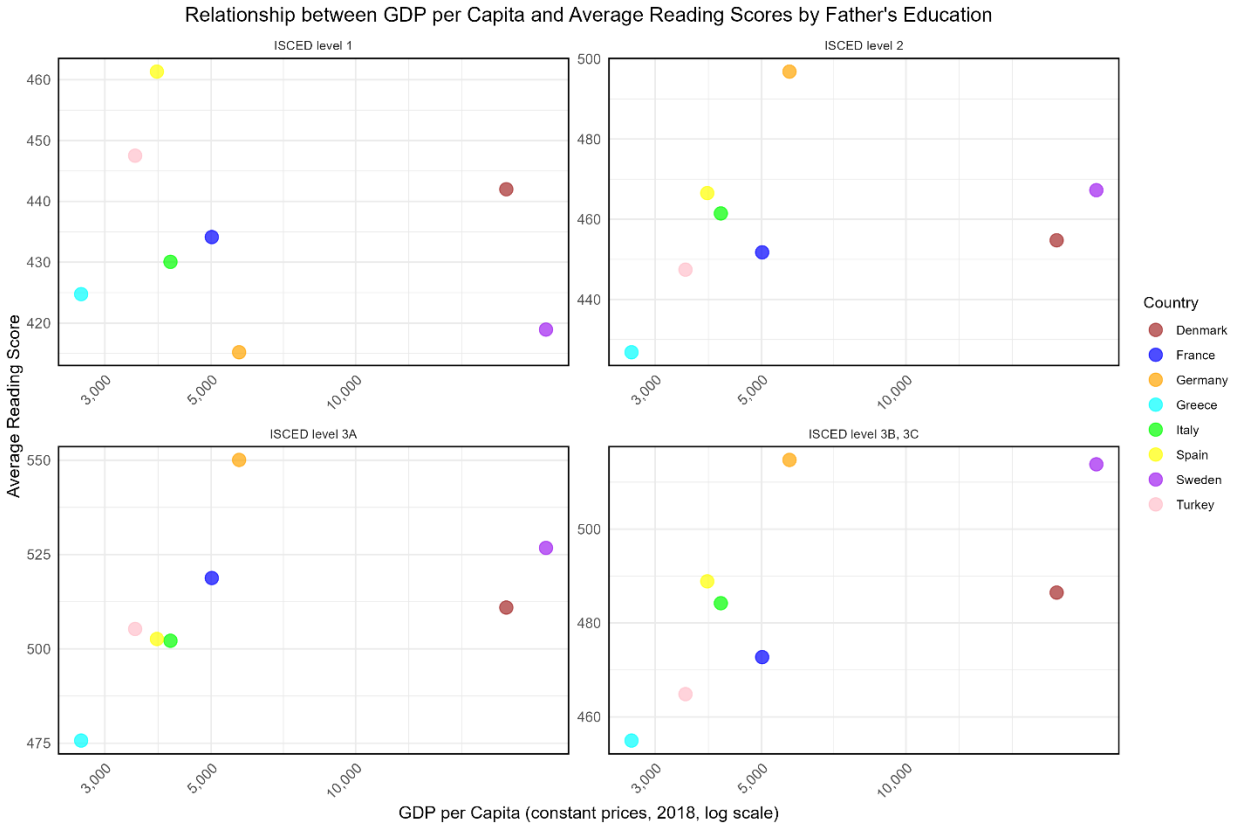
Father's Education Impact: The average scores for students increase as the education level of the father increases, with noticeable jumps from lower to higher educational levels across all subjects (Math, Reading, Science). Greece's scores are generally consistent with the trend observed globally, although the scores are slightly lower than the average in regions like the USA and Asia. However, they are comparable to the broader European averages.

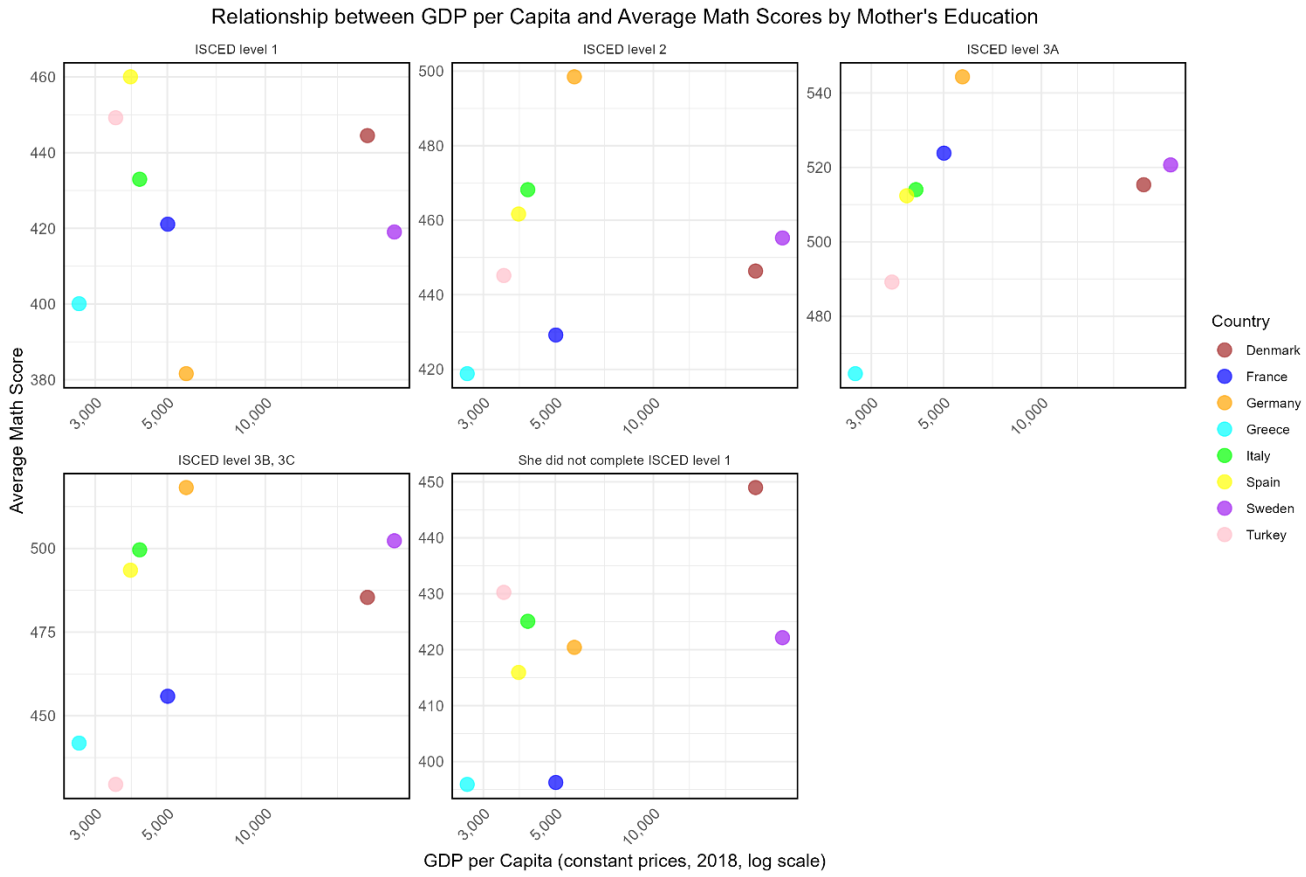
Mother's Education Impact: Similar to the paternal impact, the maternal education level also shows a positive correlation with higher student scores across all disciplines. Greek students exhibit a consistent trend where higher educational attainment by mothers correlates with better performance in academic subjects. The scores in Greece again slightly lag behind those of Asia and the USA but are very close to the European mean, especially at higher education levels.

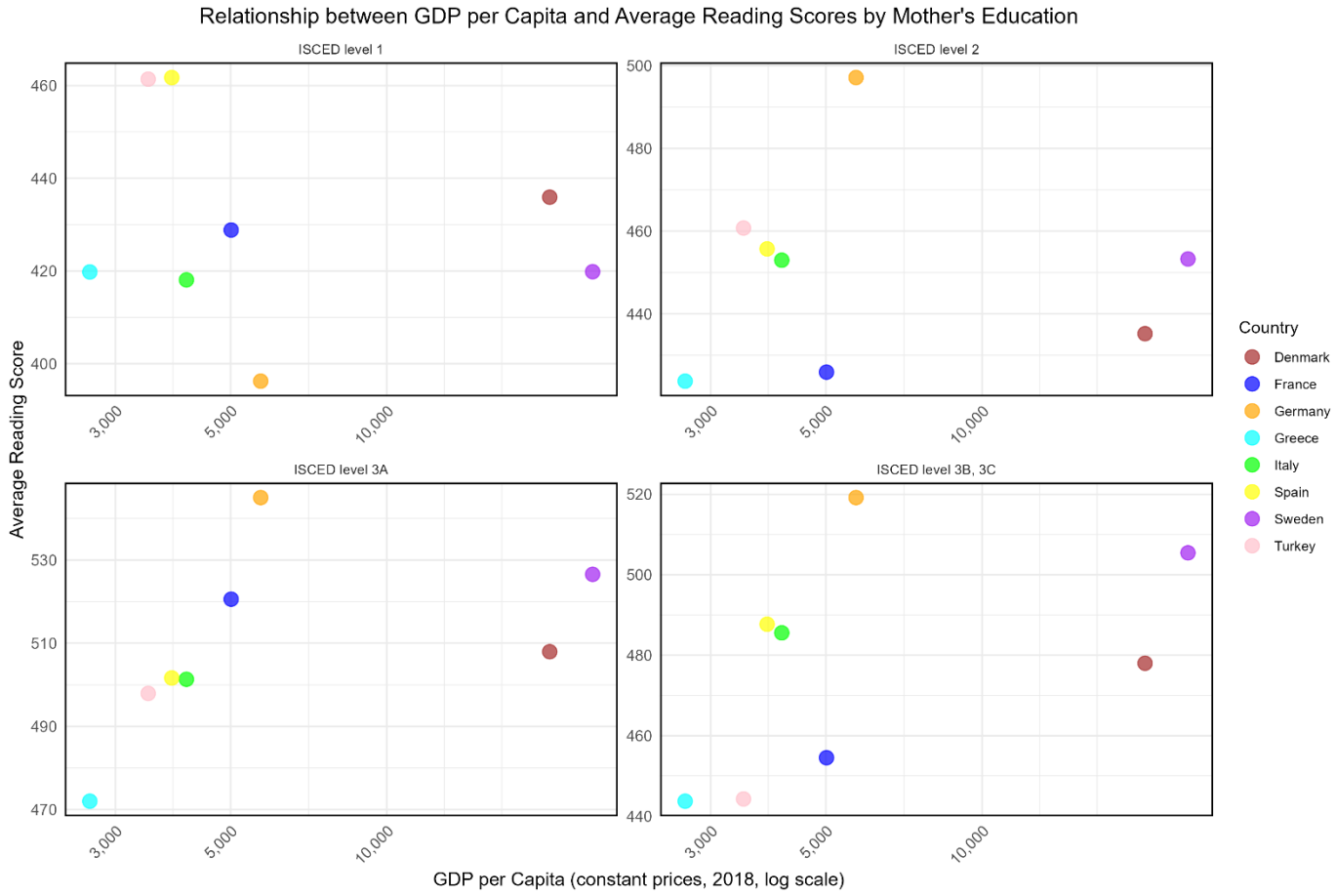
Overall, both diagrams reaffirm the significant role of parental education in influencing academic performance, with Greece showing comparative results within the European context but slightly behind the leading regions such as Asia and the USA. The data shows the importance of educational support at home and its correlation with higher student achievement.

Bubble plots of Impact of GDP per Capita and Parental Education on Student Performance across some Countries in Europe






Relationship between GDP per Capita and Average Math Scores by Mother's Education
ISCED level 1
ISCED level 2
ISCED level 3A
ISCED level 3B, 3C
She did not complete ISCED level 1
Average Math Score
GDP per Capita (constant prices, 2018, log scale)
Country
Denmark
France
Germany
Greece
Italy
Spain
Sweden
Turkey


Relationship between GDP per Capita and Average Reading Scores by Mother's Education
ISCED level 1
ISCED level 2
ISCED level 3A
ISCED level 3B, 3C
Average Reading Score
GDP per Capita (constant prices, 2018, log scale)
Country
Denmark
France
Germany
Greece
Italy
Spain
Sweden
Turkey

In the diagrams Greece shows varying performances across different educational levels in relation to GDP per capita and the education level of the father and mother.

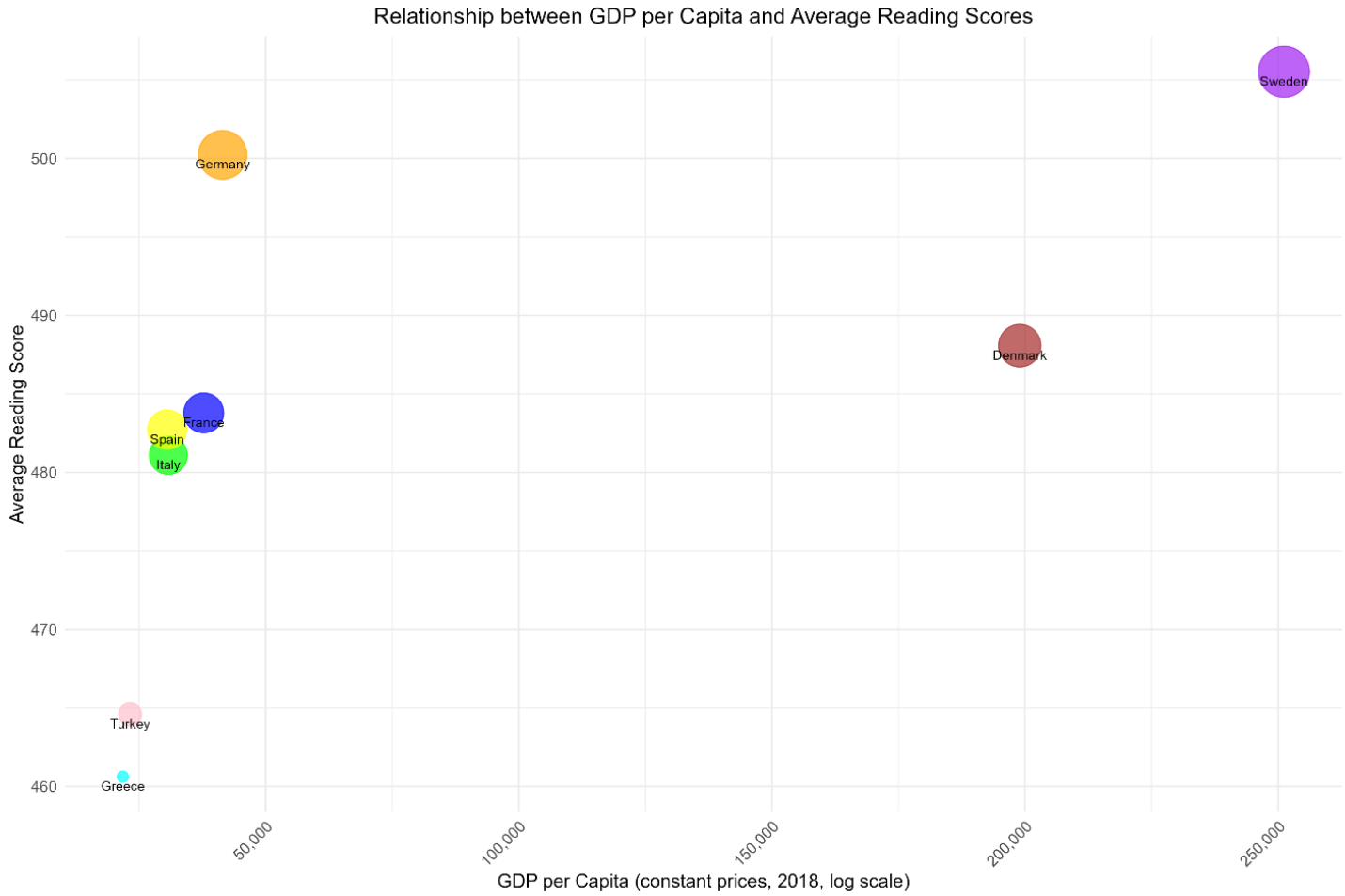
Father's Education Influence: Greece generally places in the mid to lower range of scores compared to other European countries. When looking at the correlation between father's education levels and math scores, Greece shows moderate scores, particularly noticeable at the highest level of father's education (ISCED level 3B, 3C) where its performance is lower than several other countries like Denmark, Germany, and Sweden.

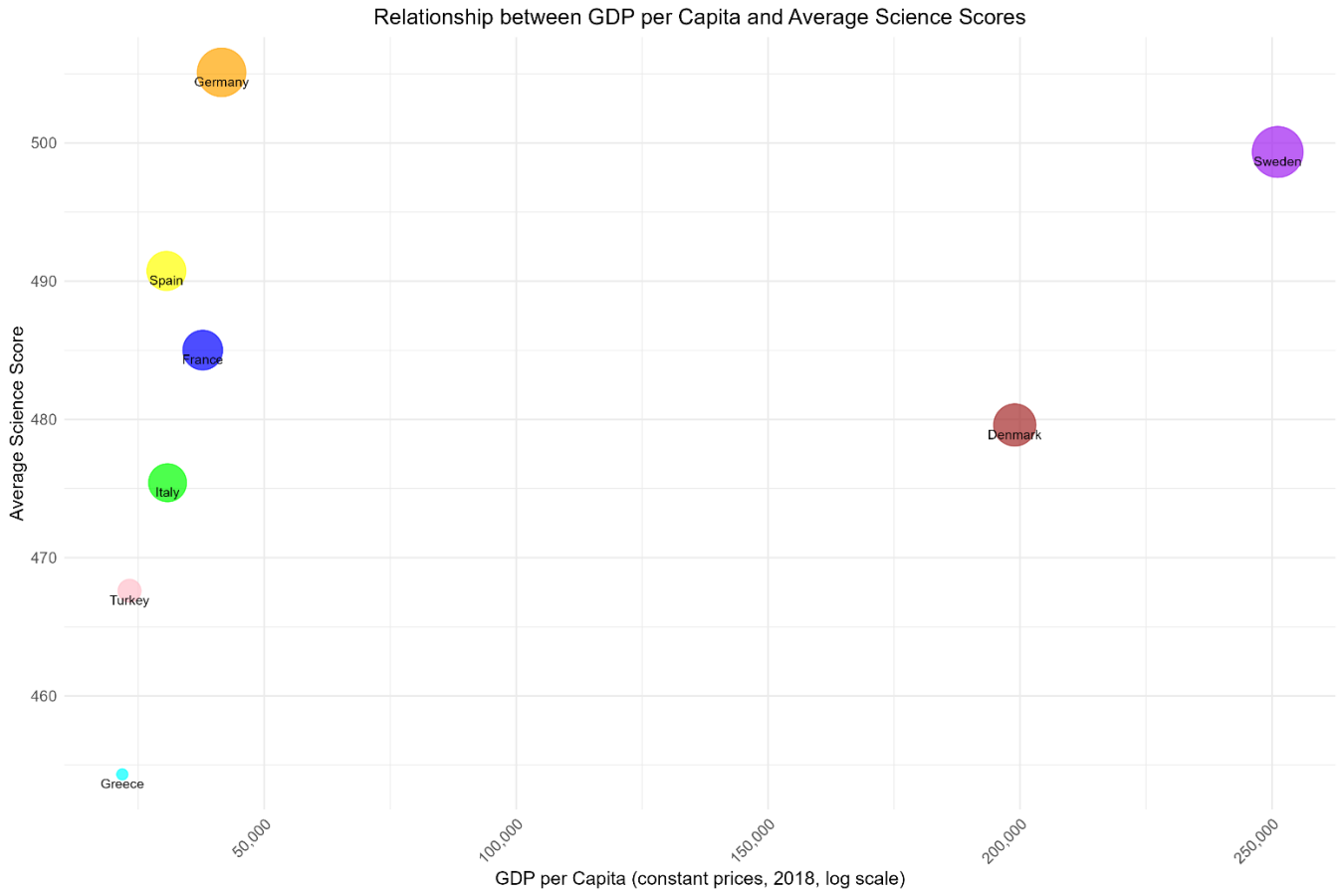
Mother's Education Influence: Similar trends are observed with mother's education levels, where Greece again scores in the mid to lower range. It's important to note that even at higher levels of mother's education, Greece's average scores tend to remain below those of top-performing countries, showing that parental education level might not be the sole factor influencing academic success in Greece.

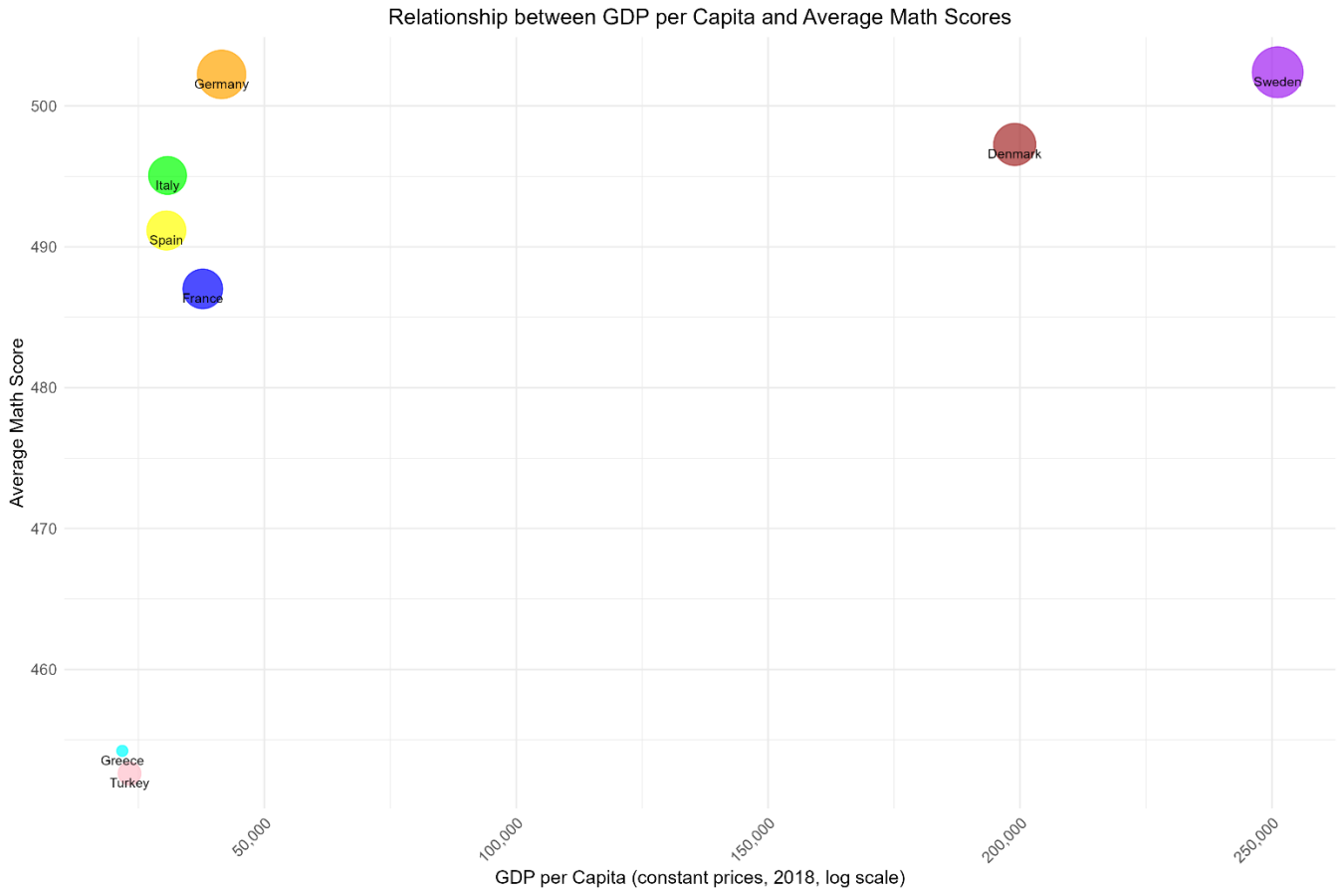
GDP per Capita Relationship: The relationship between GDP per capita and educational scores is also quite telling. Despite variations in GDP, Greece's scores do not show dramatic differences, suggesting that while economic factors are influential, they may not be the dominant determinants of educational outcomes in Greece.

Overall, these diagrams show that Greece's educational performance, when compared internationally, is influenced by a combination of economic and parental education factors. However, the impact of these factors is not exceptionally pronounced, suggesting that other variables, possibly including educational policy and school resources, may also play significant roles.

Bubble plots of Impact of GDP per Capita and Student Academic Performance In Reading , Science and Math across some Countries in Europe




Relationship between GDP per Capita and Average Science Scores
Germany
Sweden
Spain
France
Denmark
Italy
Turkey
Greece
500
490
480
470
460
Average Science Score
50,000
100,000
150,000
200,000
250,000
GDP per Capita (constant prices, 2018, log scale)


Relationship between GDP per Capita and Average Math Scores
Germany
Sweden
Denmark
Italy
Spain
France
Greece
Turkey
500
490
480
470
460
Average Math Score
50,000
100,000
150,000
200,000
250,000
GDP per Capita (constant prices, 2018, log scale)

The relationship between GDP per capita and average scores in reading, science, and math for several countries, Greece is consistently positioned towards the lower end of both economic and educational performance metrics among the showed nations.

Reading Scores: Greece is positioned near the bottom with a score around 470, just above Turkey. The other countries, notably Sweden and Denmark, exhibit significantly higher reading scores, correlating with higher GDP per capita.

Science Scores: Again, Greece is among the lower performers, with Turkey again trailing slightly. Countries like Sweden and Denmark maintain higher positions, suggesting a trend where higher GDP per capita is associated with better average science scores.

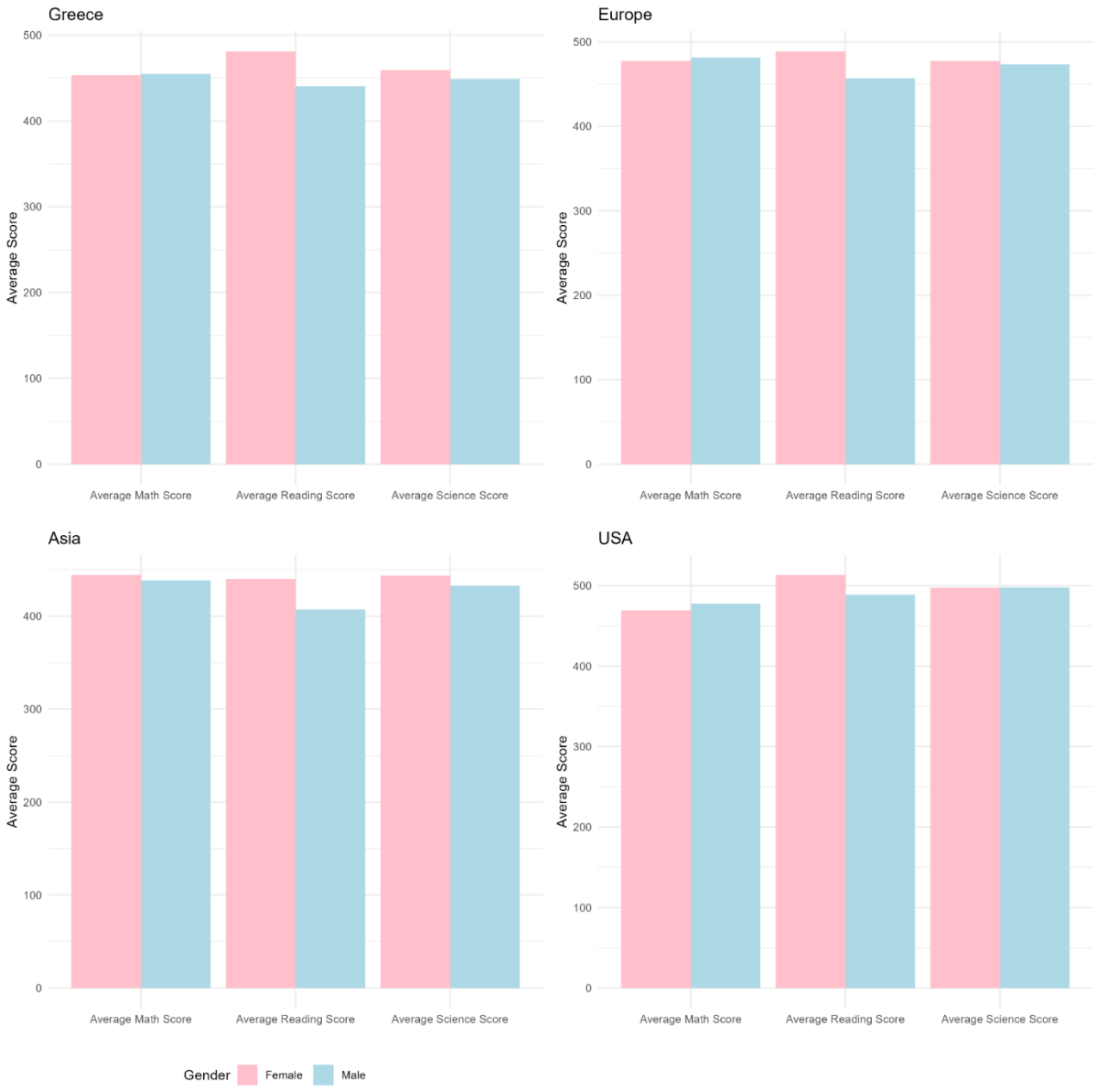
Math Scores: The pattern is similar here, with Greece and Turkey at the lower end of the spectrum. Higher GDP per capita countries like Denmark and Sweden show better math scores.

These diagrams collectively show a general trend where countries with higher GDP per capita tend to have higher average scores in reading, science, and math. Greece, with a relatively lower GDP per capita, scores lower in all three educational categories compared to countries like Denmark and Sweden, which feature both higher GDP per capita and educational outcomes. This suggests that economic prosperity may be linked to educational performance, showing potential areas for policy focus to improve educational outcomes in lower GDP countries like Greece.

4. Gender-Based Analysis

We will compare the gender GAP in different countries

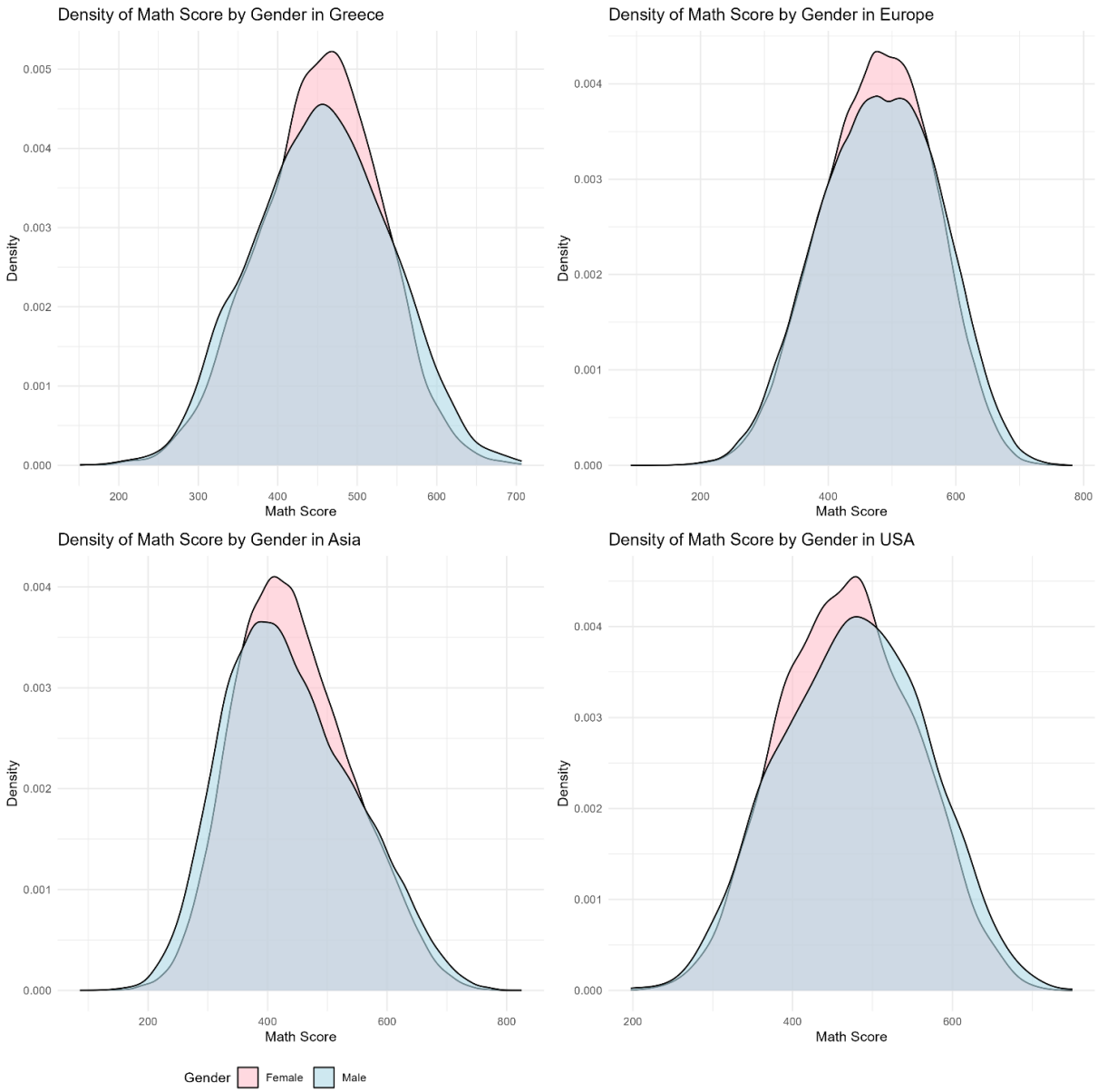
Bar Chart of Average Scores by Gender in Greece, Europe, Asia, United states

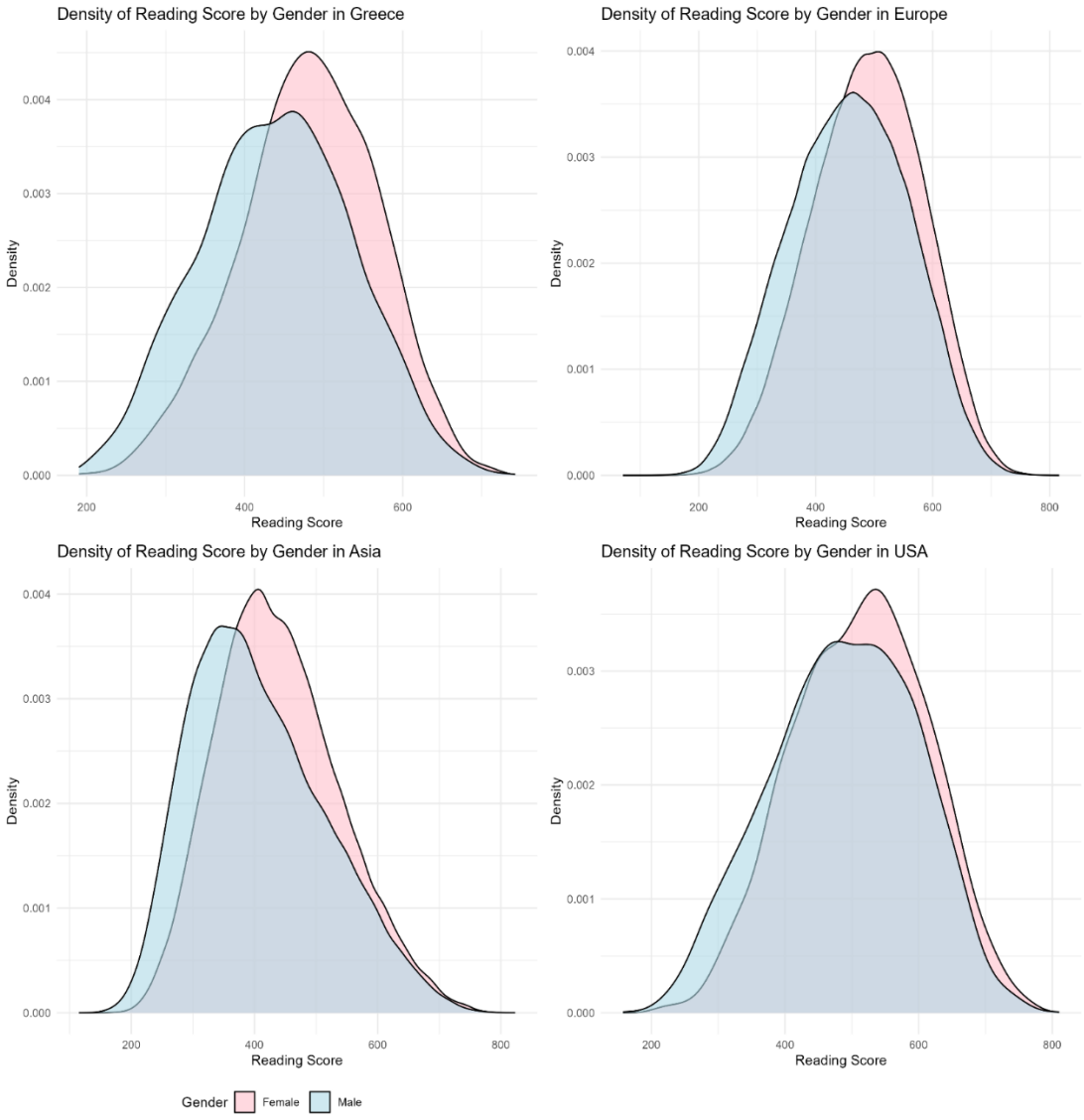


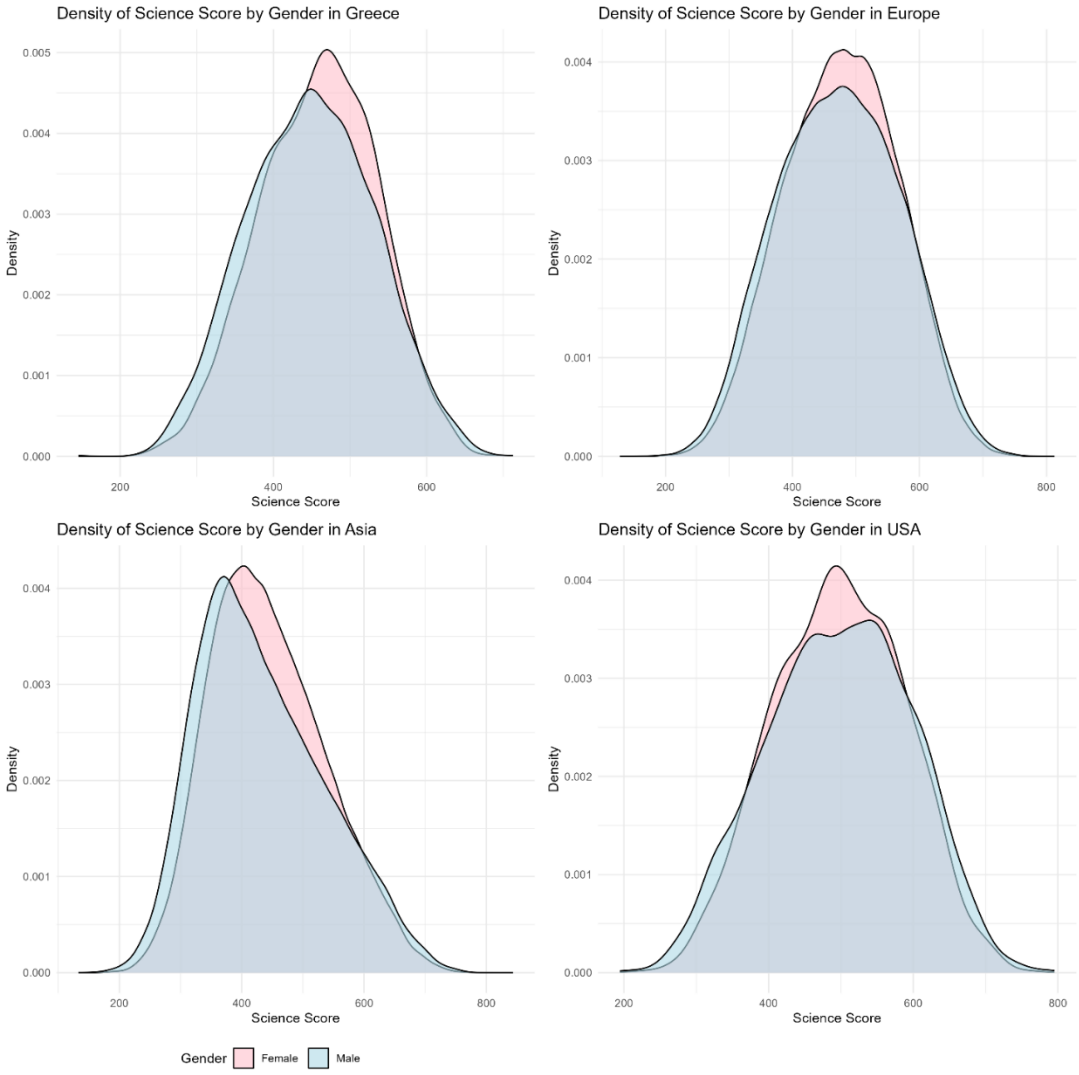
The diagram presents a comparison of average scores in Math, Reading, and Science across genders (male and female) in four different regions: Greece, Europe, Asia, and the USA.

In all regions, females tend to score higher on average in Reading, while males often score higher in Science. Math scores show a more mixed trend, with some regions showing higher scores for males and others for females.

Density Plot of Scores by Gender in Greece, Europe, Asia, United states.




Density of Reading Score by Gender in Greece
Density of Reading Score by Gender in Europe
Density of Reading Score by Gender in Asia
Density of Reading Score by Gender in USA
Density
Reading Score
0.000
0.001
0.002
0.003
0.004
200
400
600
800
Gender
Female
Male



The density plots for math, reading, and science scores by gender across Greece, Europe, Asia, and the USA show how student performance in these subjects is distributed between genders and across different regions:

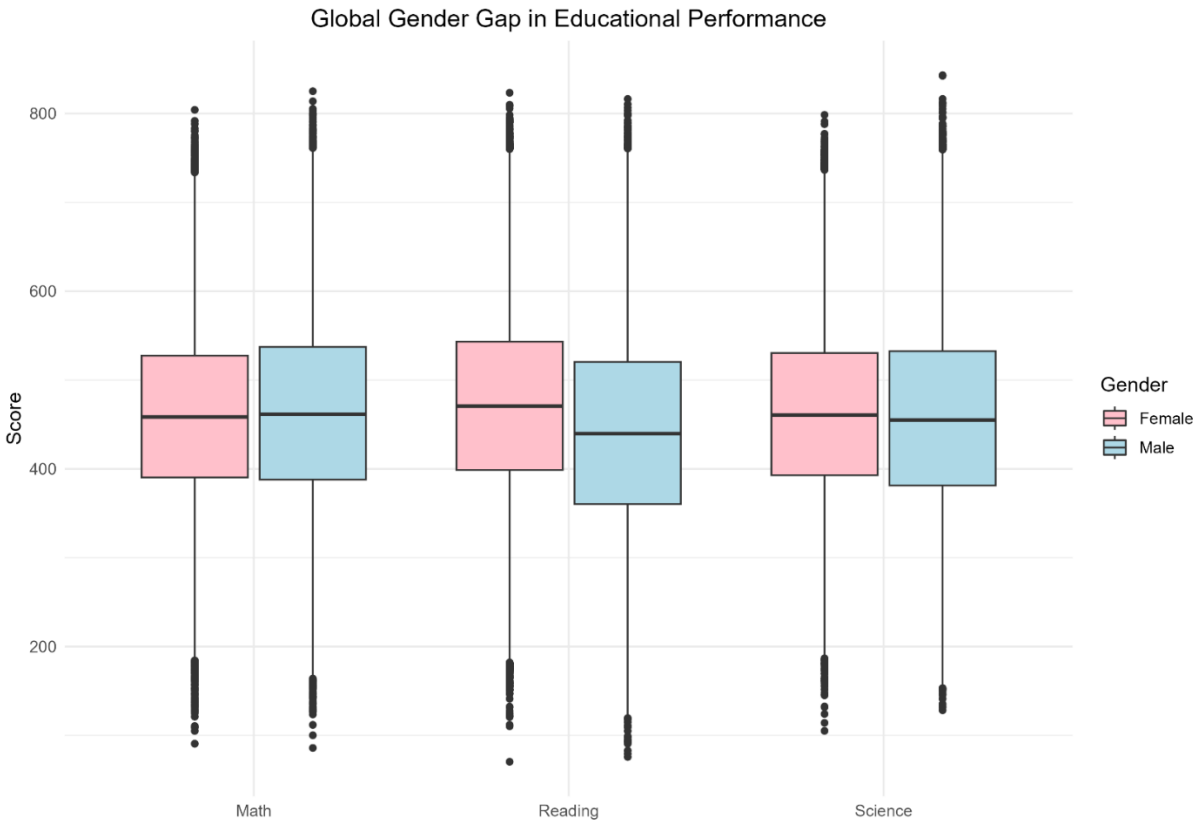
Greece: The plots show very similar performance between male and female students across all subjects, with a slightly higher peak for males in science scores, showing a marginal gender difference in performance favoring males in science.

Europe: In Europe, the performance density is similar between genders for math and reading, but females show a slightly higher peak in reading, suggesting a slight advantage. For science, the scores are almost identically distributed between genders.

Asia: The plots indicate a broader distribution for males in math scores, suggesting higher variability in their scores. For reading and science, the distributions are similar, but females tend to have a slightly higher peak in reading, pointing to better average performance.

USA: The density plots show a higher peak for female students in both reading and science, showing that females tend to score higher on average compared to males in these subjects. The math scores are very similar, with a slight male advantage.

Boxplots of of Math, Reading, and Science Scores by Gender Globally



The global gender gap in educational performance across three core subjects: Math, Reading, and Science.

Math: The box plot shows that males (blue box) have a slightly higher median score compared to females (pink box), with both genders showing a wide range of scores. The whiskers, which represent the range excluding outliers, and the outliers themselves, indicate a broad spread of scores among both genders. The median for males is marginally higher, suggesting a small male advantage in math performance globally.

Reading: In reading, females exhibit a higher median score than males, indicated by the higher median line in the pink box. This suggests that females generally perform better in reading than males. The distribution of scores for both genders is similar, but the female box plot shows a slightly higher upper quartile, reinforcing the notion of female superiority in reading skills.

Science: The science scores show a very similar median for both genders, with overlapping interquartile ranges, suggesting that there is minimal gender difference in science performance on a global scale. Both genders show a broad distribution of scores, as indicated by the long whiskers and presence of outliers.

The diagram shows that while there may be slight differences in performance in specific subjects (like a male advantage in math and a female advantage in reading), the differences are generally not drastic. Science shows the most gender parity.