Creative Environments and Academic Achievement: Exploring the Correlation Between Extra-Curricular Activities and Country-level PISA Scores

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Abstract

This study investigates the relationship between creativity resources in schools and academic performance at the country level using PISA scores from 2015, 2018 and 2022. Although previous research has established the positive relationship of creativity resources on individual student performance, particularly for disadvantaged students, little is known about whether these relationships translate to the country level (Sirin, 2005; Perry & McConney, 2010; Chiu & McBride-Chang, 2006). We used the COVID-19 pandemic as a natural experiment, using country lockdown as an indicator of the absence of creative resources, to confirm countries of which developing level benefit the most academically from creativity resources. Our analysis reveals that creativity resources used in schools at the country level have positive relationships with the country's academic performance in subjects such as mathematics, science, and literacy reading. Secondly, we show that the COVID-19 pandemic did have an influence on academic scoring globally. Thirdly, we reveal that there are varying correlations between creative resources and academic performance based on countries' GDP per capita, where creative resources have a higher correlation with low GDP per capita countries. The findings suggest that countries with lower GDP per capita benefit more substantially from creativity resources, mirroring individual-level findings from previous literature. These results have significant implications for educational policy and resource allocation, particularly for developing nations and those seeking to improve their educational outcomes.

1. Introduction

The role of creativity resources in education has gained increasing attention in recent years, with numerous studies demonstrating their positive impact on individual student performance. However, a significant gap exists in our understanding of how these effects translate to the country level. This research addresses this gap by examining the relationship between creativity resources and academic performance across nations, using PISA scores as a measure of educational achievement. The Programme for International Student Assessment (PISA), conducted by the OECD every three years, measures 15-year-old students' performance in mathematics, reading, and science, with over 80 countries participating in recent cycles. PISA's extensive contextual data collection through school and student questionnaires provides rich insights into educational resources and practices across different countries, making it an ideal dataset for examining the relationship between creativity resources and academic performance at the national level.

1.1 Research Significance

This study makes several important contributions to the existing literature. First, it extends individual-level findings about creativity resources to the country level, providing insights into whether national investments in creativity resources yield similar benefits to those observed in individual students. Second, it leverages the unprecedented natural experiment created by the COVID-19 pandemic to examine how the sudden absence of creativity resources affects academic performance. Third, it provides evidence-based insights that can inform educational policy decisions, particularly regarding resource allocation in different economic contexts.

1.2 Hypothesis

Our analysis builds on previous research showing that creativity resources are particularly beneficial for students from disadvantaged backgrounds, which we translate to countries with lower GDP per capita.

We hypothesize that the positive association between creative environments and academic performance observed at the individual level also holds true at the country level, suggesting potential implications for national education policies.

1.3 Research Questions

This study addresses five primary questions:

1. What is the relationship between creative resources and global academic performances?
2. Which creative resource has the strongest impact on global academic performance?

3. How does the impact of creativity resources correlate with academic performance for countries with varying GDP per capita?
4. What is the impact of the COVID-19 pandemic on the PISA scores, and how has that influenced countries academic performance based on their level of creative output?
5. What is the impact of creativity resources for countries that experienced full COVID-19 lockdowns on national PISA scores performance?

2. Literature Review

2.1 Extracurricular Activities and Academic Performance

The relationship between extracurricular activities and academic performance has been widely studied, with findings suggesting a positive influence on educational outcomes. Marsh and Kleitman (2002) found that participation in extracurricular activities can enhance students' academic achievement, including their performance on standardized tests. Similarly, Fujita (2006) observed a positive correlation between extracurricular involvement and academic performance among junior high students, emphasizing its potential to boost international assessment scores.

The OECD's report on PISA 2012 (OECD, 2013) further supports these findings by highlighting how student engagement through extracurricular participation correlates positively with PISA scores. This suggests that extracurricular activities not only enhance individual student performance but could potentially correlate with academic performance at the national level.

2.2 Educational Outcomes in the Context of COVID-19

The COVID-19 pandemic has had a profound impact on education systems worldwide, affecting traditional learning environments and the execution of standardized tests like PISA. The OECD (2021) documents these changes, while Azevedo et al. (2020) simulate the potential impacts of school closures on learning outcomes, providing crucial forecasts of future PISA results. Engzell et al. (2021) provide empirical evidence of significant learning loss due to school closures, underscoring the pandemic's disruptive impact on education.

2.3 Country-Level Educational Performance

Research using PISA data has demonstrated the importance of considering multiple levels of analysis in educational outcomes. A comprehensive study of reading achievement across 43 countries found that country-level factors, particularly GDP per capita, accounted for significant

variations in performance (Chiu & McBride-Chang, 2006). Family socioeconomic status, school characteristics, and individual factors all contributed to academic achievement, suggesting the need for a multi-level approach to understanding educational outcomes.

2.4 Research Gap and Current Study

While extensive research exists on the impact of creativity resources at the individual level, there is limited understanding of how these effects translate to the country level. Our study addresses this gap by examining whether the patterns observed at the national level, particularly the enhanced benefits for disadvantaged students (OECD, 2013). By using the COVID-19 pandemic as a natural experiment, we provide insights into how the sudden removal of creativity resources affects national academic performance (Azevedo et al., 2020; OECD, 2021).

This research is particularly timely given the global interruption of traditional educational activities during the pandemic and the ongoing debate about resource allocation in education. Understanding how creativity resources affect country-level academic performance can inform policy decisions about educational investment, particularly in countries with limited creativity resources.

3. Methodology:

3.1 Datasets

This study employs several datasets to examine the relationship between creative resources and academic performance around the world. The datasets utilized are:

- **OECD PISA dataset**: This dataset provides standardized scores in reading, science, and mathematics for 15-year-old students across 67 countries. For this study, we use data from the 2015, 2018, and 2022 cycles, selected for their overlapping countries and sufficient time span to enable longitudinal analysis of educational outcomes (OECD, 2015; OECD, 2018; OECD, 2022).
- **OECD PISA Survey Data:** Global school-level survey data from the PISA database (OECD, 2015; OECD, 2018; OECD, 2022), consisting of more than 650 features to explore from.
- **World Bank Dataset on Country-level GDP**: GDP per capita data spanning 2012-2022 for 218 countries are obtained from the World Bank's World Development Indicators database (World Bank, 2024).

- **COVID-19 Lockdown Dates Globally**: Data on country-specific lockdown implementation dates during the COVID-19 pandemic were obtained from Kaggle's 'COVID-19 Lockdown dates by country' dataset (Jcyzag, 2020).

3.2 Dataset Processing

The PISA survey dataset initially consisted of more than 650 features capturing diverse aspects of school-level environments across participating countries. To ensure consistency across the 2015, 2018, and 2022 cycles, we processed the data to identify 91 features that were consistently available for all years and countries.

To identify the gap in the relationship between creative activities and academic performance on a global scale, we selected seven features that focus on the level of creative environments employed within schools. These features are: participation in band/orchestra/choir, creative extracurricular activities, school plays/musicals, contributions to school yearbook/newspaper/magazine activities, volunteering/service activities, sports team activities, and art club activities.

In the PISA school survey data, these creative features were represented as binary variables, indicating whether a specific feature was present in schools within a country. However, the survey data did not contain information about individual schools' performance on PISA tests. To address this limitation, we employed the following aggregation steps:

- **Country-Level Aggregation**: We aggregated the school-level survey data by country, calculating the percentage of schools in a country that promotes each creative feature. This transformed the binary variables into average percentages, providing a national-level representation of how prevalent these creative environments were.

- **Integration with PISA Scores**: We combined the aggregated survey data with the OECD PISA dataset, which provided standardized reading, science, and mathematics scores for each country. This integration resulted in a comprehensive dataset linking the prevalence of creative features with national academic performance.

In addition to the PISA data, we integrated further relevant country-level datasets to contextualize these findings.

- **COVID-19 Lockdown Measures:** To utilize the natural experiment created by the pandemic and analyze the effect of the exposure to creative environments on the PISA scores of countries that imposed full lockdowns during the pandemic.

- **GDP per Capita (2012–2022):** Country-level GDP per capita data is introduced to explore the relationship between creative environments and academic performance under the context of different national economic levels .

3.3 Techniques:

This paper utilizes various statistical methods for analyzing the data, such as Pearson Coefficient Correlation analysis, Regressions, and Coarse-Exact Matching (CEM) (Iacus, King, & Porro, 2012).

We created a heatmap matrix based on **Pearson correlation coefficients** to examine the strength of the relationship between creative resources and academic performance across all countries from 2015 to 2022. Using the aggregated PISA dataset, we calculated correlations between each of the seven creative features and subject scores (math, reading, and science) globally. This correlation matrix highlights which creative activities are more strongly and consistently associated with academic outcomes worldwide than the others. To explore these relationships in greater depth, we further analyzed:

- Correlations between creative features and a specific subject overtime (2015-2022)
- Correlations between creative features and all three subject scores within a specific year.

These additional matrices provide insights into how the inclusion of creative activities in schools relates to academic achievement, both over time and within specific educational contexts.

For **regression analysis**, we used the statsmodel Python module that provides classes and functions for estimating many different statistical models, including linear regression (Seabold, 2010). Our regression analysis aims to develop a linear model that determines the effect of particular creative features on the PISA math, science, and reading scores. Through p-value tests, we evaluate the significance of the results we obtained from the regression analysis and interpret the effect of each variable by analyzing their corresponding coefficients. It is worth noting that the original PISA scores dataset contains no information related to the COVID-19 pandemic. To address this, we assign a value of 0 to each data point corresponding to years before 2019 and a value of 1 to those from 2019 onward. This study contains two regression studies. The first one involves data from all years, where the independent variables are all creative features of interest and pre/post Covid classification. The dependent variables are math, science, and reading PISA scores. The second model uses the data from the PISA scores and the Covid lockdown datasets. There, we focus only on the data points corresponding to 2022, and we consider only the countries that implemented full lockdown during the pandemic to evaluate the effect of the creative engagement of students on their performance on the PISA test after experiencing Covid lockdown.

The **CEM technique** aims to quantify the effect of the COVID-19 pandemic on the PISA math, science, and reading scores. Given that all the attributes contain continuous values, we performed binning on each attribute to allow for matching among the records. In this paper, we classify the features into quartiles such that each bin contains an equal number of records. Now, because we want to estimate the effect of the COVID-19 pandemic on the PISA scores, our treatment group will be the records post-COVID, and the others will belong to control. The goal of CEM is to group the data points into the same categories according to all creative features of interest in both the treatment and control and then compare the weighted average difference between the treatment and control to estimate the effect of the control. Considering that the number of tuples for a particular group will be different for both the treatment and the control, we needed to perform some weighting for each group. Namely, we set the weight for each treatment group to be 1, while the weight of the control tuples is

$$\frac{number\ records\ in\ treatment\ group}{number\ of\ records\ in\ treatment\ group} * \frac{total\ records\ in\ control}{total\ records\ in\ treatment}$$

A **comparative statistical analysis** was also done to examine how the relationship between creative activities and academic performance varies across countries with different GDP levels. This analysis seeks to determine whether creative resources have a higher correlation with PISA scores for countries with lower GDP per capita levels. The 67 countries that participated in the PISA test are divided equally into three groups based on GDP per capita (Low GDP, Medium GDP and High GDP countries). This analysis illustrates the correlation strengths for countries for each development level. Furthermore, a comparison of the PISA scores before and after lockdown are also conducted to verify the findings. Countries with lower GDP per capita that went into lockdown should show larger drops in PISA scores since we hypothesize that creativity resources, which are not available during lockdown, are particularly beneficial for them. These analyses provide insights into whether the positive relationship of creativity resources on individual student performance, particularly the relationship between disadvantaged students and GDP per capita levels, can translate to the country level.

4. Results:

To view the data through a more comprehensive lens, a heat map of the world based on the countries that participated in the PISA assessment in all 3 cycles was made to illustrate the distribution of the Creative Score Index as shown in Figure 1a. This score is an average of all the creative features employed within schools for a particular country, such as arts, music, and extracurricular activities. It's interesting to note that the highlighted disparities, with higher indices concentrated in economically advanced countries, potentially reflecting stronger

institutional support for creativity-related activities. In contrast, lower indices are observed in underdeveloped and developing countries, signaling limited access to these resources.

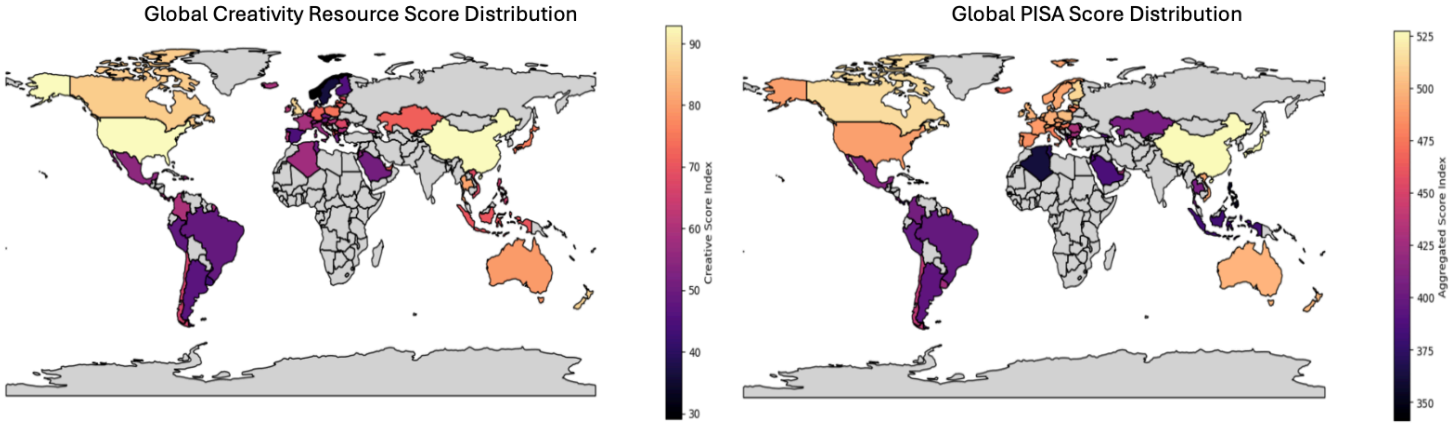

Figure 1a (left) and 1b (right).
World heat maps showing the average creative score averaged PISA score per country.

Figure 1b shows the average academic PISA scores across science, reading, and mathematics across different countries. Not only can we see from this map the overall average scoring between countries, but we can also use this mapping to compare with higher the Creative Score Index as well. We can see that countries with higher creative score indices often exhibit much more academic performance, reinforcing the hypothesis that creativity-enriched environments contribute positively to educational outcomes. These visualizations underscore the need to further explore the interplay between a country's economic development, creative investments, and academic achievements, offering critical insights for policymakers aiming to bridge educational and developmental gaps globally.

4.1 Pearson Correlation:

The Pearson correlation matrix presented in Figure 2 illustrates the strength of the relationships between the seven creative features (on the y-axis) and academic performance across math, reading, and science scores (on the x-axis) worldwide from 2015 to 2022. We observe that band/orchestra/choir consistently demonstrates the highest correlations across all three subjects, with values of $r = 0.38$ for mathematics, $r = 0.40$ for reading, and $r = 0.41$ for science. This suggests that countries that employ more musical activities seem to have much higher academic performance associated. Marsh and Kleitman's research on extracurricular activities found that such engagements have a positive impact on students' academic achievements (2002). Similarly, Fujita's analysis indicates that extracurricular involvement, including musical activities, correlates positively with academic performance among junior high students (2006).

Furthermore, creative extracurricular activities also exhibit relatively strong correlations, hinting at their potential contribution to holistic skill development.

The main takeaway from here is that creativity resources have positive correlations with the subject scores attained globally. Features such as art club/activities and sports team/activities show the weakest correlations, with values close to zero or even slightly negative for reading (-0.036). This suggests that these activities may have limited or inconsistent associations on academic performance when aggregated at a global level.

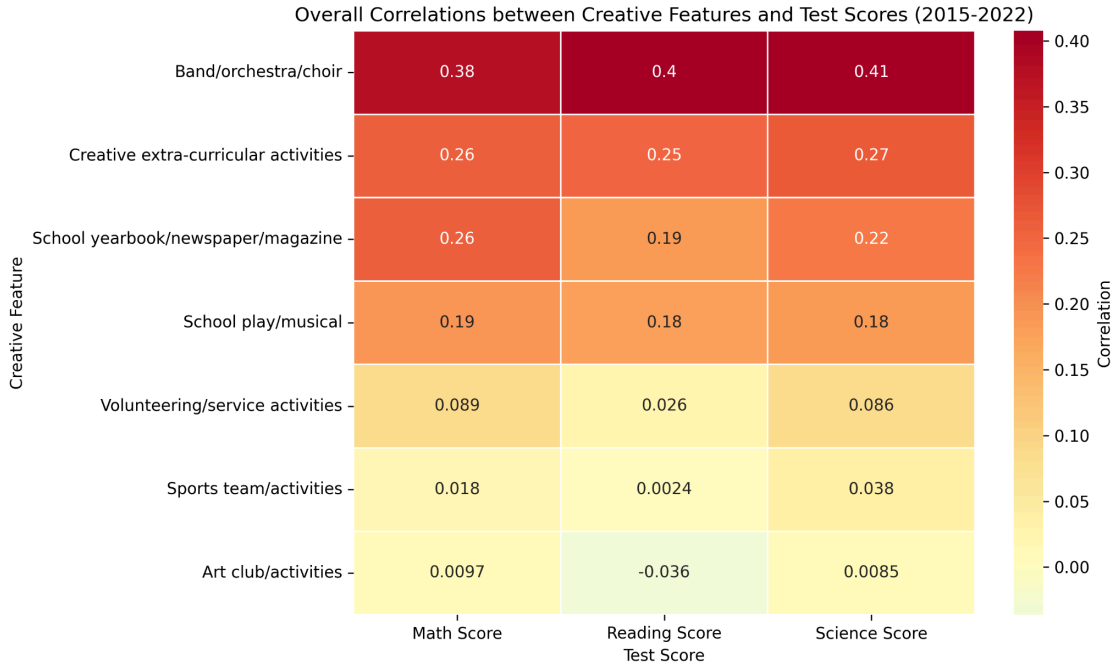

Figure 2. Pearson correlation matrix between the seven creative features and each subject score across all countries from the 2015-2022 PISA dataset.

To further support this matrix, correlation matrices were done for these creative features for a particular subject as well as a particular year to capture insights into specific temporal and subject-based relationships [Available in Appendices A and B]. Looking at these matrices, we can see finer details in the relationships between the correlations. The feature of band/orchestra/choir consistently shows the strongest positive correlations across all subjects as well as for each year, which further supports the idea that participation in musical activities has a more pronounced association with academic performance. It's also interesting to note that the correlations seem like they are at their weakest in the year 2018, with lots of negative or decreased r values since 2015, likely due to the beginning of the COVID pandemic which halted many countries and schools from access to these creative outputs.

4.2 Regression Analysis I: Impact of Creative Activities on PISA Scores

Before delving into a detailed interpretation of our initial regression analysis, it is essential to highlight that Figure 3 displays the independent variables on the x-axis and their corresponding coefficients from the linear regression models on the y-axis, accompanied by 95% confidence intervals. This analysis uses a linear model to estimate the effect of the percentage of schools stimulating extracurricular activities on the PISA test scores in Math, Reading, and Science. Looking at Figure 3, one could notice that only a few creative extracurricular activities had positive coefficients, meaning that a unit increase in the percentage of those creative extracurriculars in a country leads to an elevation in the country's PISA scores. Note that we used a P-value statistical test with a threshold of 0.05 to determine the significance of the results, and the statistically significant results are in red in Figure 3. Our analysis demonstrates that among all three subjects, the coefficient we got for the School yearbook/newspaper/magazine variable is statistically significant and has a positive coefficient. In other words, the results from the linear regression suggest that a unit increase in the percentage of yearbooks/newspapers/magazines per country results in 0.7, 0.9, and 0.7 units of increase in the science, math, and reading PISA scores, respectively. On the contrary, a unit increase in the percentage of art clubs/activities results in a decrease of 4.7, 4.9, and 5.5 units in the science, math, and reading PISA scores per country, respectively. This observation is also statistically significant according to a 0.05 P-value test. The observed r-squared values for science, math, and reading are 0.33, 0.33, and 0.36, respectively, meaning that the variables on the x-axis explain about 33%, 33%, and 36% of the variance in y (the science, math, and reading scores).

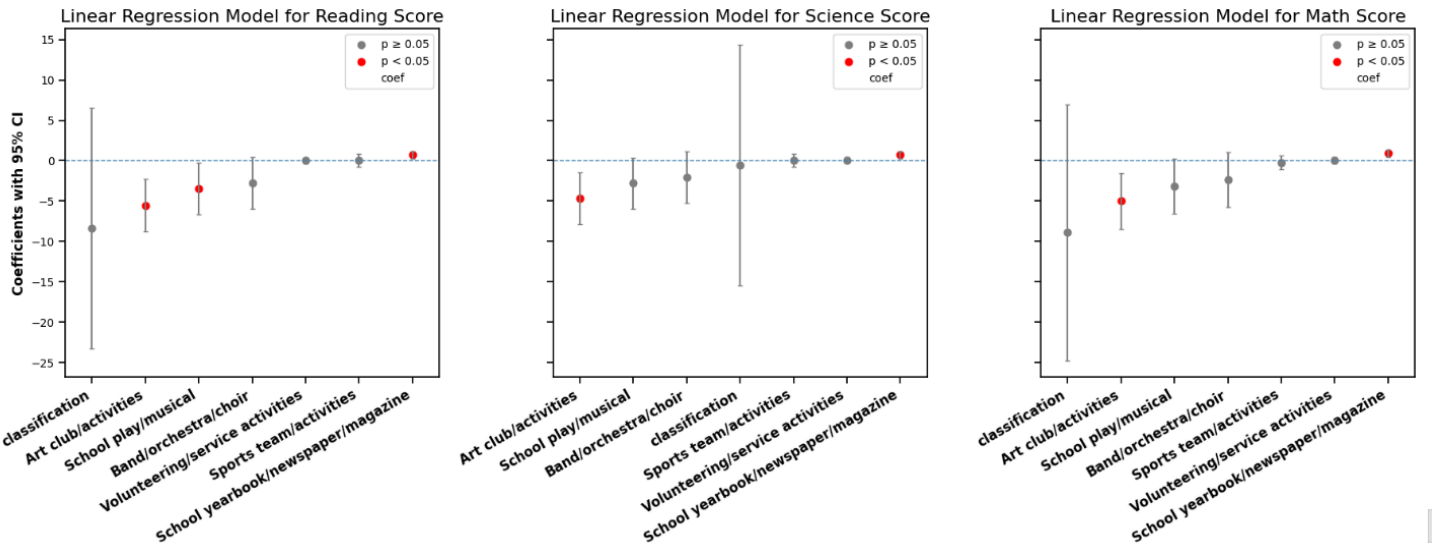

Figure 3. The visualization displays the results from three linear regression models, estimating the impact of each creative feature on PISA test scores across multiple years.

4.3 Coarsened Exact Matching

The power of CEM is that this technique quantifies the effect of a treatment on some variable for records belonging to the same groups according to some criteria. In this paper, we want to compare the weighted average PISA scores for science, math, and reading by considering the records corresponding to 2022 to be in the COVID treatment group while the ones before are in control.

Figure 4 represents a bar plot that shows the weighted average of PISA scores for all subjects. It is important to note that the blue bars represent the pre-COVID years, and the pink bars correspond to the post-COVID/treatment. The main takeaway from this visualization is that it reveals a decline in the weighted average scores across all subjects following COVID-19, suggesting that the pandemic may have affected countries' performance on the PISA test. Although not visually drastic, this decline was greater when it came to math, where the drop was about 15 points, while the drop for reading and science was about 7 and 4 points, respectively.

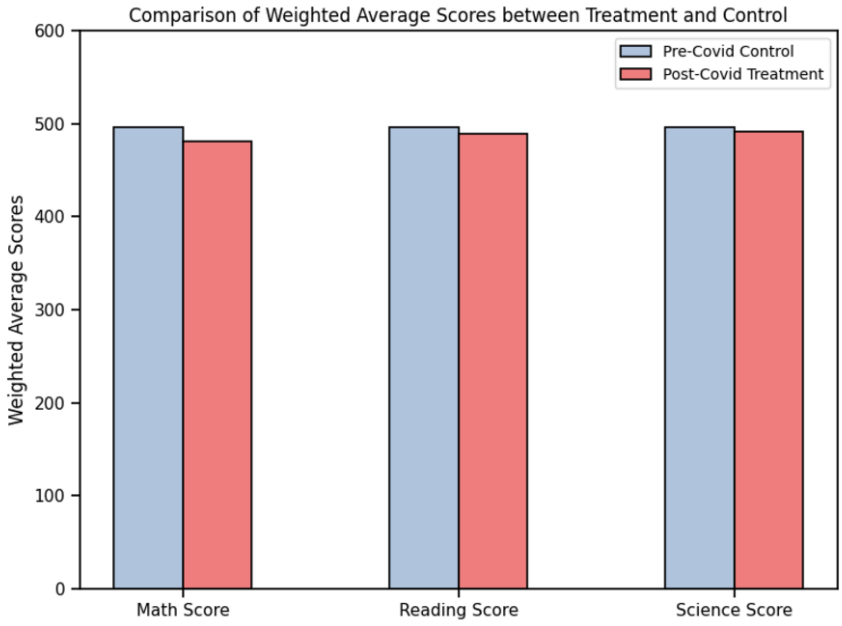

Figure 4. The plot shows the weighted average scores produced as a result of the CEM technique elaborated in the Methodology section

4.4 PISA Scores and Creativity Activities in Different GDP Groups

Figure 5 presents the relationship between PISA scores and creativity activities across GDP groups. The most striking pattern in this visualization is the systematic decrease in both correlation strength and R^2 values as country GDP increases. In low-GDP countries, creativity activities strongly predict academic performance, while this relationship progressively weakens in medium-GDP countries and becomes almost negligible in high-GDP countries. This clear declining pattern provides compelling evidence that creativity resources have the strongest correlation in economically disadvantaged nations, aligning with previous findings that creativity resources are most beneficial for disadvantaged populations.

This finding suggests that creative activities have a more pronounced impact on academic outcomes in low-income countries, potentially due to limited alternative resources or support systems. Conversely, the weak correlation for high GDP countries may reflect the presence of well-established educational systems, making creativity less critical for academic success. In these countries, educational outcomes are less dependent on creative environments, likely because they already provide strong baseline educational support and infrastructure. These results suggest that fostering creative activities may have the most significant impact in low and medium GDP countries, where educational systems might lack robust alternative supports.

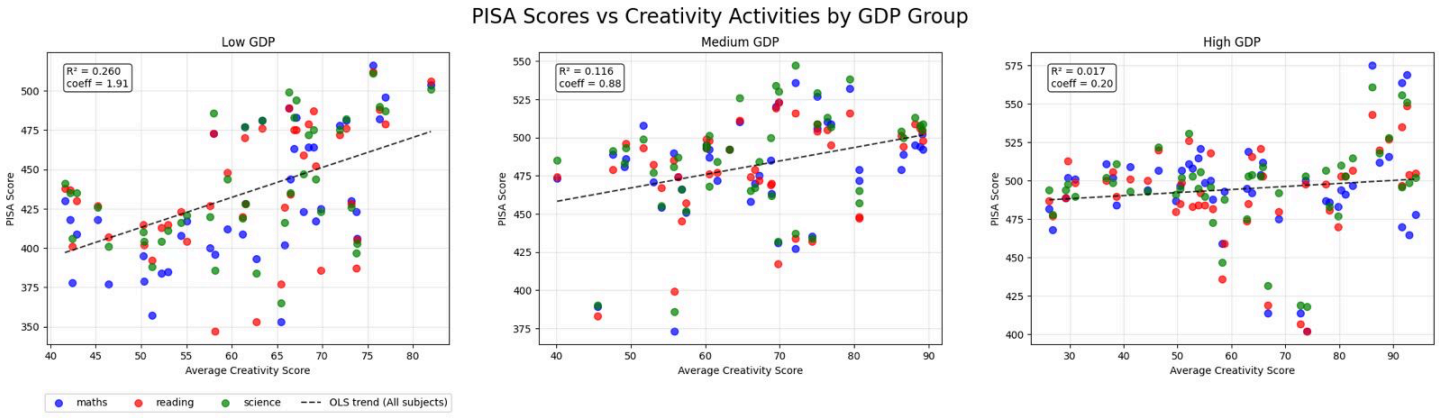

Figure 5. Relationship between PISA scores and creativity activities across GDP groups. It reveals a clear pattern where the strength of the relationship between creativity activities and PISA scores decreases as country GDP increases.

4.5 Regression Analysis II: Creative Activities Exposure on PISA scores for Countries after Lockdown

In our second Linear Regression Analysis, we aim to estimate the effect of exposure to the creative environment and extracurricular activities on the PISA scores for countries that implemented full lockdowns during the COVID pandemic. Figure 6 displays the independent variables on the x-axis and their corresponding coefficients from the linear regression models on the y-axis, accompanied by 95% confidence intervals. Unlike Figure 3, in Figure 6, we observe more creative features having positive coefficients, some of which were statistically significant with p-values less than 0.05. A unit increase in the percentage of students participating in Band, Orchestra, or Choir within a country corresponds to increases of 10.3, 8.6, and 8.9 units in PISA reading, math, and science scores, respectively. On the other hand, a unit increase in the percentage of students participating in School play/Musical results in 9.5773, 6.8676, and 7.4857 unit increases in the PISA reading, math, and science scores. However, one should note that the results for the school play/musical creative features are statistically significant for the reading and science test scores. The observed r-squared values for science, math, and reading are 0.76, 0.69, and 0.74, respectively, meaning that the variables on the x-axis explain about 76%, 69%, and 74% of the variance in the y-axis (the science, math, and reading scores).

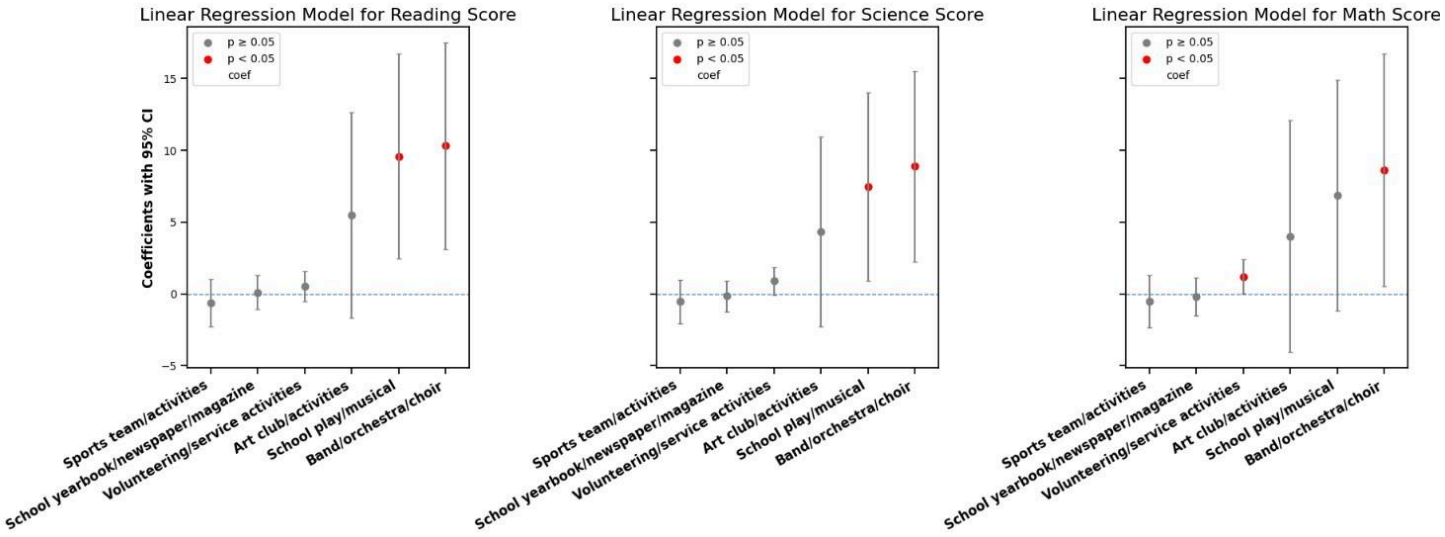

Figure 6. The visualization displays the results from three linear regression models, estimating the impact of each creative feature on PISA test scores in 2022 for countries that implemented full lockdown

Average Changes in PISA scores following COVID-19

Building on top of Regression Analysis II, Figure 7 demonstrates the average changes in PISA scores across GDP levels following COVID-19 lockdowns. The graph demonstrates the differential impact of lockdowns on academic performance across countries with varying GDP levels. Countries with low GDP experienced the largest decline in scores (approximately -15 points in mathematics, -14 points in reading, and -5 points in science), while high-GDP countries showed smaller decreases or even slight improvements (in science). This pattern supports our hypothesis that creativity resources have a stronger correlation on academic performance in lower-GDP countries, as the forced removal of these resources during lockdowns had a more severe negative effect on their PISA scores. The consistent trend across all three subjects, with the most pronounced effects in mathematics and reading, suggests that the impact of losing access to creativity resources during lockdowns was particularly detrimental for countries with lower economic resources. This natural experiment provides additional evidence for the differential importance of creativity resources across economic contexts.

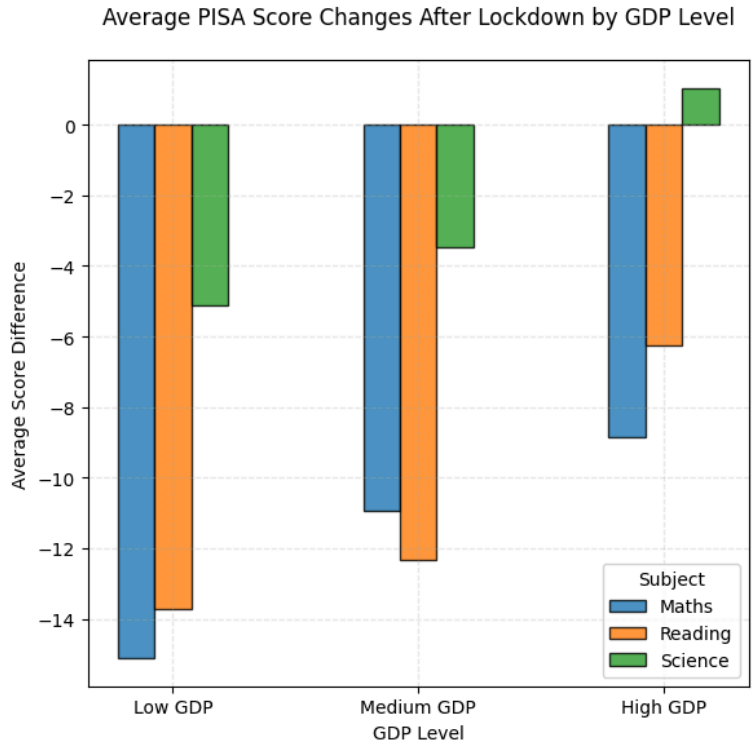

Figure 7. Average changes in PISA scores after COVID-19 lockdowns by country GDP level. Low-GDP countries experienced the largest declines (-15 to -5 points across subjects), while high-GDP countries showed minimal decreases or slight improvements.

5. Discussions:

The analyses in this study collectively highlight the nuanced relationship between creative educational resources and academic performance while also contextualizing this relationship within broader economic and social dynamics. Each analytical step builds upon the previous, providing a cohesive narrative of how creativity resources influence PISA scores across diverse contexts.

Our regression analysis identified which creative resources most significantly contribute to academic performance, with the results aligning with existing literature that underscores the benefits of specific extracurricular activities. This step helped establish a hierarchy of impactful resources, setting the foundation for subsequent analyses.

Second, we demonstrated the absence of correlation between GDP and creative scores, suggesting that the prevalence of creative resources is not directly tied to a country's economic standing. This finding allowed us to isolate the effects of creative resources on academic outcomes, independent of economic factors.

Building on these insights, we explored the relationship between creativity resources and academic performance across GDP groups. This analysis revealed that the impact of creativity resources is significantly stronger in countries with lower GDPs, resonating with prior literature that suggests disadvantaged students benefit disproportionately from creative environments. This finding emphasizes the unique role of creative resources in addressing educational inequities.

Finally, the lockdown analysis reinforced these conclusions. Countries that experienced full lockdowns and therefore likely faced restricted access to creativity resources showed a pronounced decline in academic performance, particularly in nations with lower GDPs. This natural experiment highlighted the critical role of creative resources in sustaining educational outcomes during periods of disruption.

Taken together, these analyses underscore the importance of tailoring educational policies to maximize the potential of creative resources, particularly in low- and middle-income countries. Investing in such resources could play a transformative role in addressing global educational disparities, as evidenced by their disproportionate benefits for disadvantaged populations.

5.1 Limitations

This study faces a number of limitations that call for careful interpretation of the findings, even though it offers important insights into the relationships between creativity resources and educational outcomes at the national level. To begin, even with the use of sophisticated statistical techniques like Coarsened Exact Matching, our ability to prove causation is limited by the

observational nature of our data. Although confounding variables were attempted to be controlled for, unmeasured elements pertaining to educational systems and cultural perspectives on education might still have an impact on the results.

Second, using PISA scores as the only indicator of academic achievement might not account for all aspects of education, especially more general objectives like critical thinking and original problem-solving. Furthermore, our study might not fully account for the additional variability introduced by the COVID-19 pandemic's unique impact on educational systems.

Additionally, our analysis presupposes uniform benefits from the presence of creativity resources, overlooking potential variations in quality and implementation across different regions or countries. These qualitative variations should be examined in future studies in order to more precisely evaluate the influence of creativity resources.

5.2 Policy Implications

Despite these limitations, the findings suggest several implications for educational policy. The observed positive correlations between creativity resources and academic performance, especially in nations with lower GDP per capita, suggest that targeted investments in creativity resources could be beneficial. Policymakers, particularly in developing countries, might consider prioritizing such investments as a strategic approach to enhancing educational outcomes.

The data indicating that nations with robust creativity resources are more closely associated with resilience during educational disruptions, such as those experienced during the COVID-19 pandemic, suggest that these resources may contribute to greater systemic resilience. This underscores the potential of creativity resources to provide benefits beyond immediate academic performance, helping educational systems adapt to and recover from various types of disruptions. Moreover, inspired by Regression Analysis II, policymakers might consider stimulating exposure to creative environments and activities in countries that implemented a full lockdown during the pandemic.

Furthermore, the varying correlations between creativity resources and PISA scores imply that national education policies could be more effective if they are tailored to the specific needs and contexts of different countries. For higher-income countries, integrating technology and interdisciplinary approaches with creativity resources might be more appropriate, while simpler, scalable creative interventions could be more beneficial for lower-income nations.

5.3 Future Research

In order to better examine the effects of creativity resources over time, future research should aim to overcome the limitations found by incorporating longitudinal data. Experimental designs, such as policy interventions or pilot programs, could provide more definitive evidence of these resources' effects.

Additionally, examining the qualitative facets of the application of creativity resources may provide a better understanding of their efficacy in various cultural and social-economic contexts. Such research could contribute to the clarification of the ways in which resources for creativity impact learning outcomes and guide more complex policy choices.

In summary, although this study shows a positive relationship between resources for creativity and better educational outcomes nationally, a more thorough approach is required to completely comprehend and capitalize on these relationships. Future studies should examine the intricate interactions between institutional, cultural, and social-economic elements that affect the effectiveness of creativity resources in addition to more general educational metrics.

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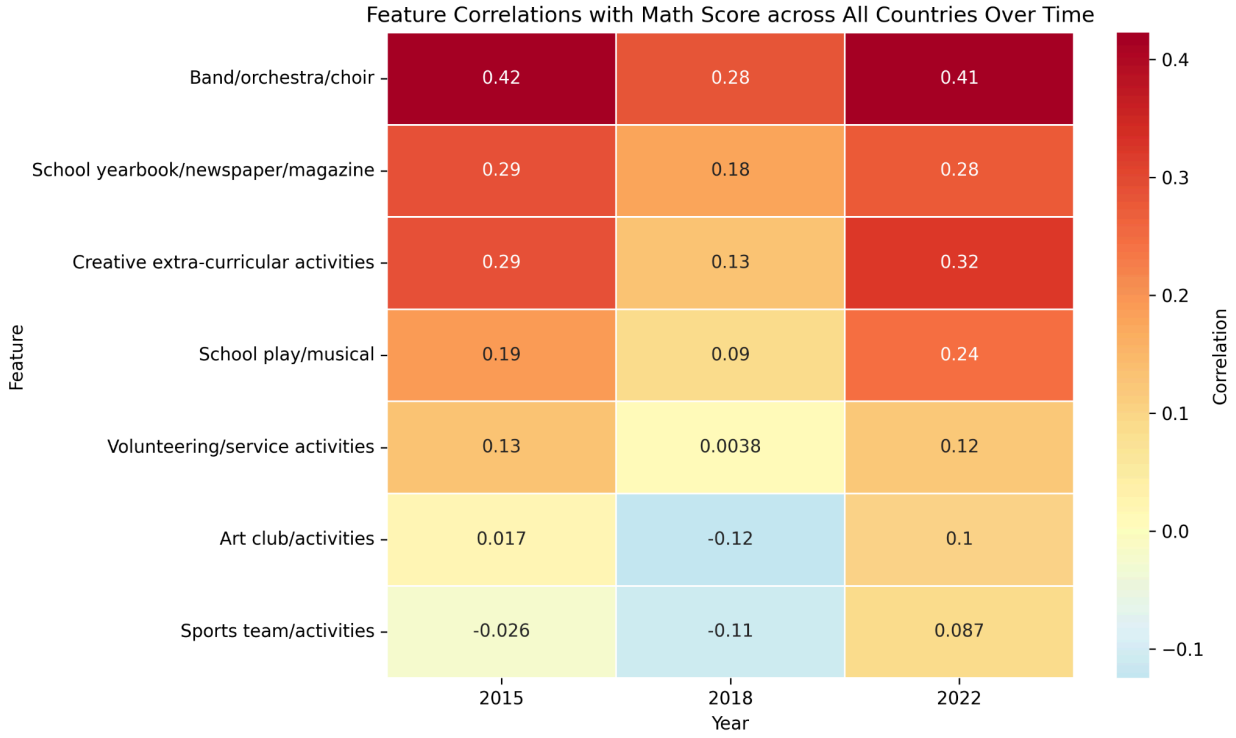
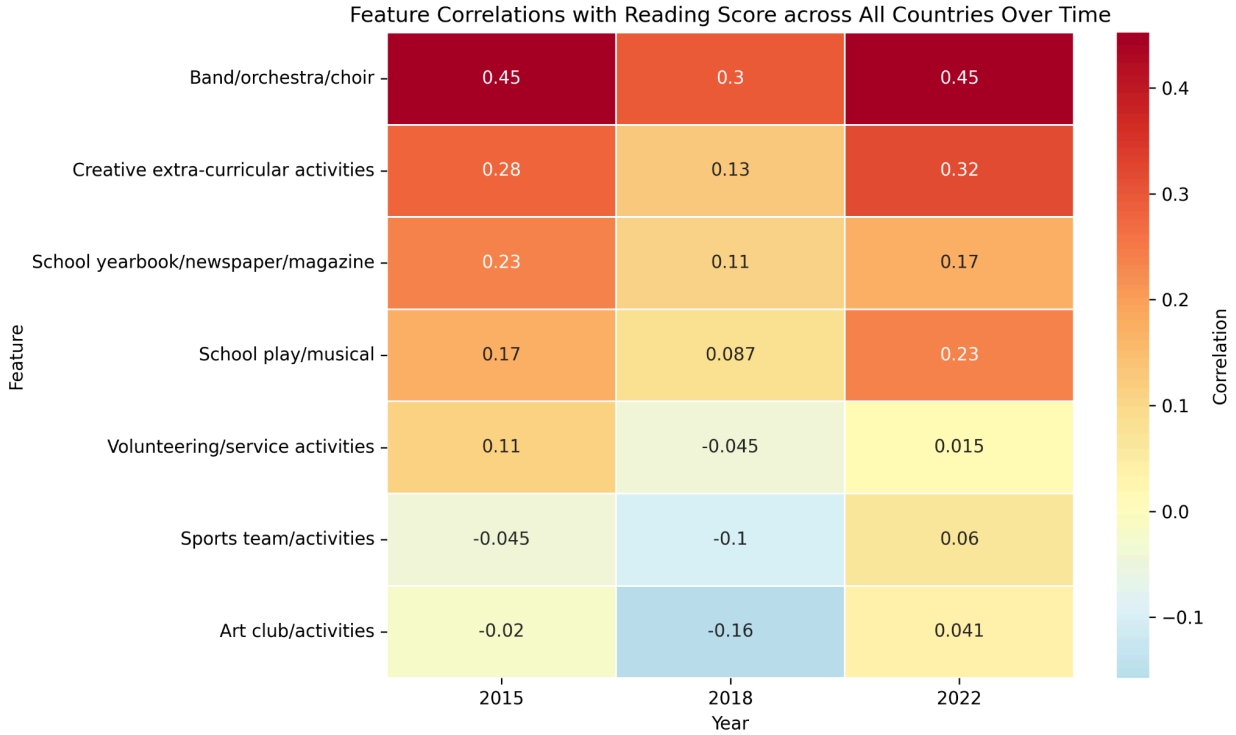
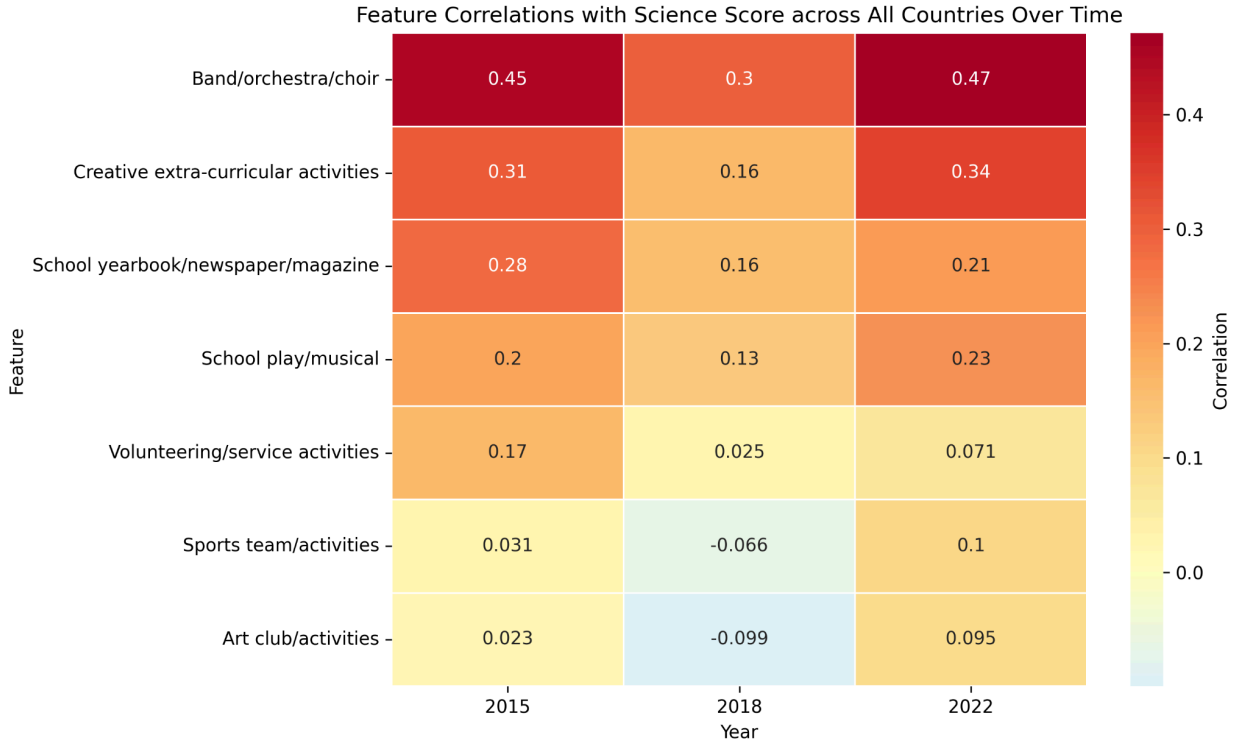
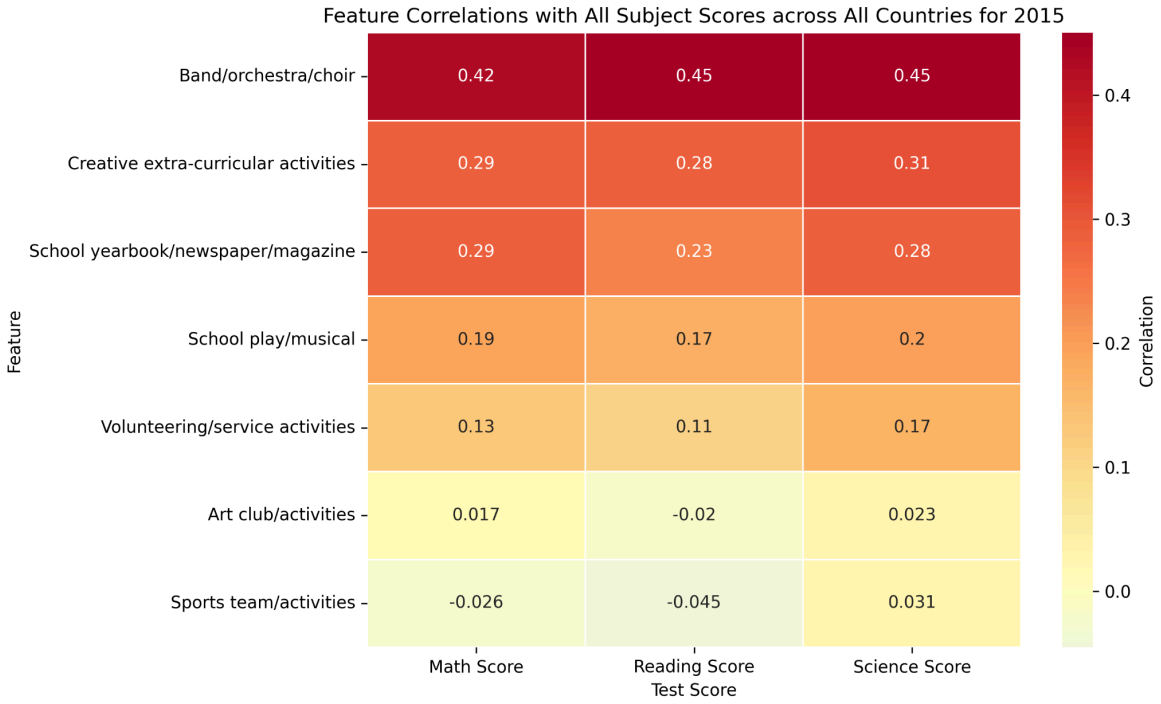
Appendix A: Further detailed Pearson correlation matrices between creative features a particular subject overtime

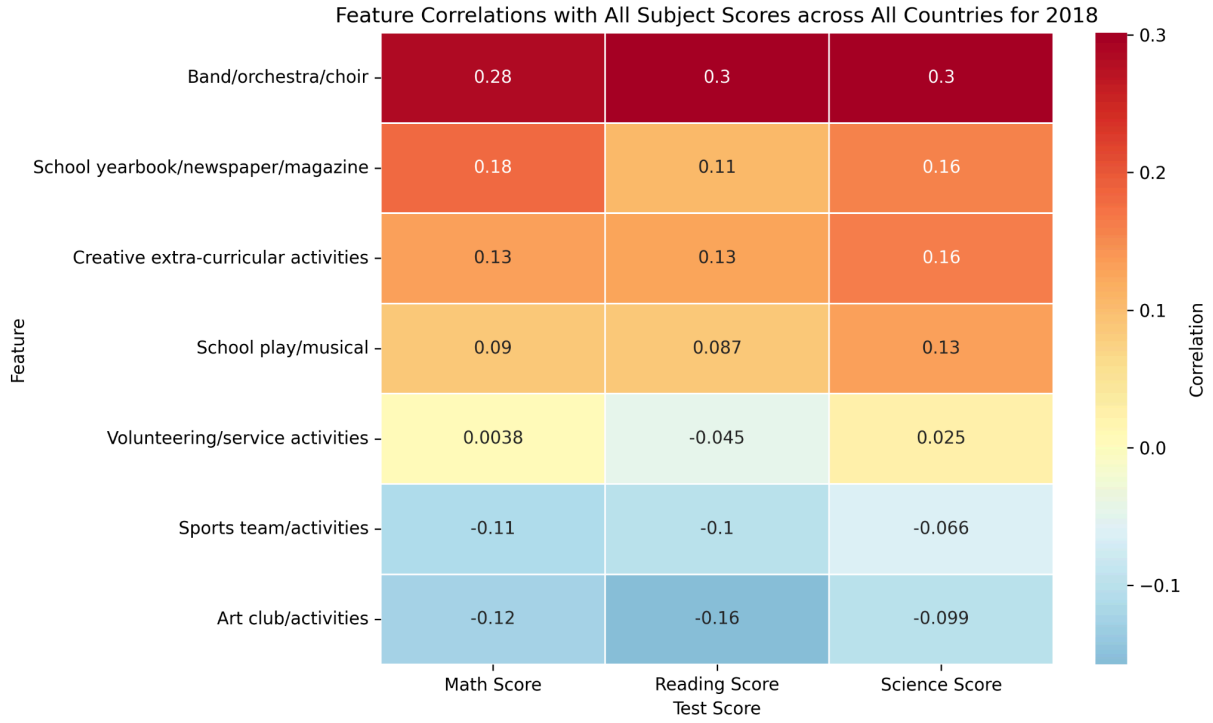


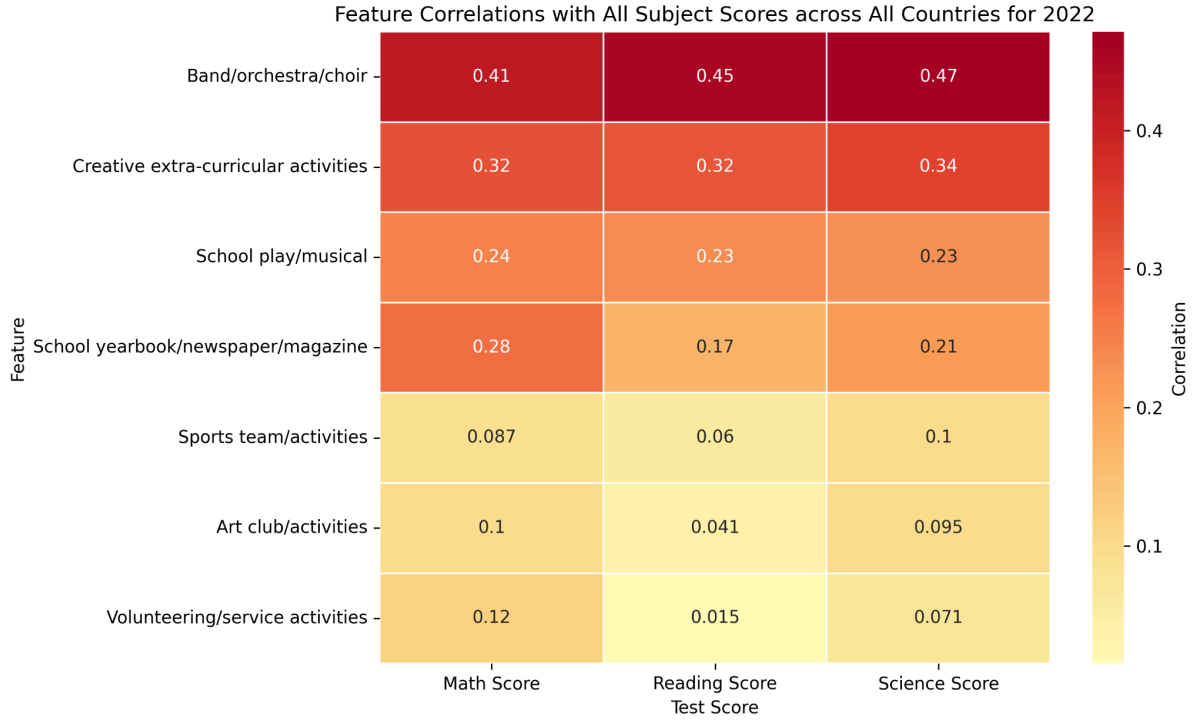




Appendix B: Further detailed Pearson correlation matrices between creative features and all three subject scores for a particular year.




Feature Correlations with All Subject Scores across All Countries for 2018
Band/orchestra/choir
School yearbook/newspaper/magazine
Creative extra-curricular activities
School play/musical
Volunteering/service activities
Sports team/activities
Art club/activities
0.28
0.3
0.3
0.18
0.11
0.16
0.13
0.13
0.16
0.09
0.087
0.13
0.0038
-0.045
0.025
-0.11
-0.1
-0.066
-0.12
-0.16
-0.099
Math Score
Reading Score
Science Score
Test Score
Feature
Correlation
0.3
0.2
0.1
0.0
−0.1


Feature Correlations with All Subject Scores across All Countries for 2022
Band/orchestra/choir
Creative extra-curricular activities
School play/musical
School yearbook/newspaper/magazine
Sports team/activities
Art club/activities
Volunteering/service activities
0.41
0.45
0.47
0.32
0.32
0.34
0.24
0.23
0.23
0.28
0.17
0.21
0.087
0.06
0.1
0.1
0.041
0.095
0.12
0.015
0.071
Math Score
Reading Score
Science Score
Test Score
Feature
Correlation
0.4
0.3
0.2
0.1