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Research Article

Socioeconomic and Parental Effects on ENEM Achievement: Evidence from Brazilian Microdata (2015–2023)

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Abstract

This study investigates the influence of family income and parental education on the performance of candidates in the Brazilian National High School Exam (ENEM) from 2015 to 2023, considering the five macro-regions of Brazil. Using INEP microdata, the analysis focuses on candidates who attended both exam days and obtained valid scores (≥100 points) in all knowledge areas and the essay component. Descriptive statistics and comparative analyses were employed to examine performance differentials across income brackets, parental education levels, school origin, and regional contexts. The results reveal a robust and persistent socioeconomic gradient: candidates from higher-income households and those whose parents hold higher education or postgraduate degrees scored, on average, up to 150 points higher than their peers from the lowest strata. Maternal education exhibited a slightly stronger association with performance than paternal education, while the joint effect of highly educated parents showed a complementary impact beyond individual contributions. Although the COVID-19 pandemic temporarily compressed performance disparities, inequalities reemerged by 2023, indicating strong structural persistence. The findings highlight the central role of family socioeconomic and cultural capital in shaping educational outcomes and underscore the need for educational policies that integrate school-based interventions with broader family- and community-oriented strategies to mitigate long-standing inequalities in access to higher education.

Introduction

The Brazilian National High School Exam (ENEM) has become the main gateway to higher education in Brazil, serving as a unified selection mechanism for public and private universities and as a key instrument for educational policy and social inclusion programs. Beyond its role in admission processes, ENEM functions as a large-scale assessment capable of revealing structural inequalities embedded in the Brazilian education system. Understanding the determinants of student performance in this exam is therefore crucial for both academic research and public policy design [1-6].

Among the factors most consistently associated with educational outcomes, family income and parental education stand out as central dimensions of socioeconomic and cultural capital. Classical and contemporary sociological theories emphasize that academic achievement is not solely a product of individual effort or cognitive ability, but rather the outcome of cumulative advantages linked to family resources, educational practices, and social expectations. In this context, parental education reflects long-term cultural capital, while family income captures material conditions that shape learning environments, access to educational resources, and opportunities for academic support [6-11].

Empirical studies in Brazil and other countries have documented strong associations between socioeconomic background and performance in standardized assessments. However, much of the existing literature on ENEM relies on cross-sectional analyses, single-year data, or restricted population segments. Fewer studies adopt a longitudinal perspective that simultaneously accounts for income, parental education, and regional heterogeneity over extended

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periods. This limitation is particularly relevant in Brazil, a country marked by pronounced regional disparities in income distribution, educational infrastructure, and access to public policies [9-26].

This article addresses this gap by examining the influence of family income and parental education on ENEM performance over nine years (2015–2023), with explicit attention to Brazil's five macro-regions. By leveraging official microdata from the National Institute for Educational Studies and Research (INEP), the study provides a comprehensive and data-driven assessment of how socioeconomic gradients evolve, how they respond to systemic shocks such as the COVID-19 pandemic, and how maternal and paternal education contribute differently to student outcomes [9-25].

The remainder of the paper is organized as follows. Section 2 reviews related literature on socioeconomic determinants of educational performance. Section 3 describes the dataset and methodological approach. Section 4 presents and discusses the main empirical results, emphasizing income gradients, parental education effects, and regional patterns. Section 5 concludes with policy implications and directions for future research.

Methodology

This study adopts a quantitative and longitudinal research design based on official microdata from the Brazilian National High School Exam (ENEM), provided by the National Institute for Educational Studies and Research (INEP). The analysis covers the period from 2015 to 2023 and includes all five Brazilian macro-regions (North, Northeast, Midwest, Southeast, and South) [1-6,13-20].

Data source and sample selection

The dataset consists of annual ENEM microdata files, publicly released by INEP. To ensure comparability across years and avoid distortions associated with absenteeism and invalid scores, the sample was restricted to candidates who: (i) attended both days of the exam; and (ii) obtained valid scores (≥100 points) in all four knowledge areas (Languages, Mathematics, Natural Sciences, and Human Sciences) as well as in the essay component.

This filtering strategy yields a consistent population of active participants whose results reliably reflect academic performance. After applying these criteria, the final sample size varies by year, reflecting structural changes in ENEM participation and the impact of the COVID-19 pandemic.

Variables

The dependent variable is the average ENEM score, computed as the arithmetic mean of the five components evaluated in the exam. This aggregate measure is widely used in the literature and provides a synthetic indicator of overall performance.

The main independent variables are:

- **Family income**, categorized according to the official ENEM income brackets (A to Q), ranges from no income to households earning more than R$ 24,240 per month.
- **Parental education**, reported separately for fathers and mothers, was classified into eight categories: from "never studied" to "postgraduate degree", including a residual "do not know" category.
- **School origin**, distinguishing between public (federal, state, municipal) and private institutions.
- **Region**, defined according to Brazil's five macro-regions.

Analytical strategy

The analysis combines descriptive statistics, comparative mean analysis, and regression-based models. First, income and parental education gradients were examined through longitudinal comparisons of average scores across categories and years. Second, heatmap-style comparisons were used to assess the joint effects of parental education and income.

To quantify marginal effects, linear regression models were estimated for selected years, particularly 2023, using the average ENEM score as the dependent variable. Four model specifications were considered: (i) parental education only; (ii) family income and paternal education; (iii) family income and maternal education; and (iv) family income combined with both paternal and maternal education.

Model fit was evaluated using the coefficient of determination (R^2), allowing assessment of the explanatory power of socioeconomic variables over time. All analyses were conducted using reproducible scripts, ensuring consistency across years.

Results and discussion

The following results and discussion are based on the four figures that follow. In particular, for Figures 1,2, we highlight what follows. The income categories used in the heatmaps follow the official coding of the ENEM socioeconomic questionnaire provided by INEP. The letters A–Q correspond to progressively increasing monthly household income brackets, where A represents candidates who declared no family income, and Q represents the highest income bracket (above R$ 24,240 per month, according to the reference year of the microdata). To improve clarity and interpretability, the figures and their captions were revised to explicitly describe the correspondence between each letter and its respective income range, ensuring full transparency of the coding scheme adopted in the analysis.

The apparent omission of category A on some axes in the original graphical layout resulted from formatting and visualization choices, particularly in cases where the reference category ("no income") was used as the baseline for comparison (e.g., in difference calculations) or had low relative frequency after sample restrictions. In the revised

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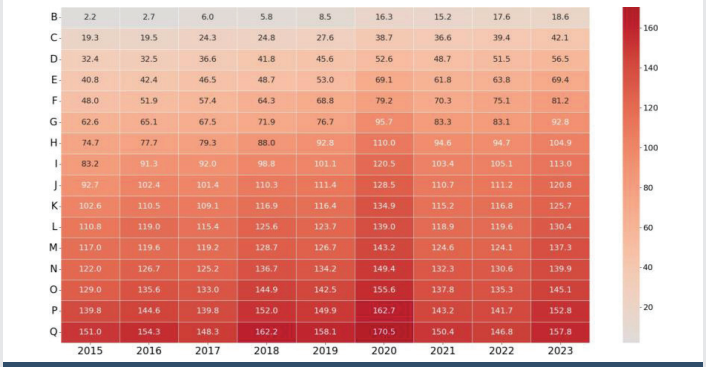

Figure 1: Longitudinal heatmap of average ENEM scores by family income bracket (2015–2023).

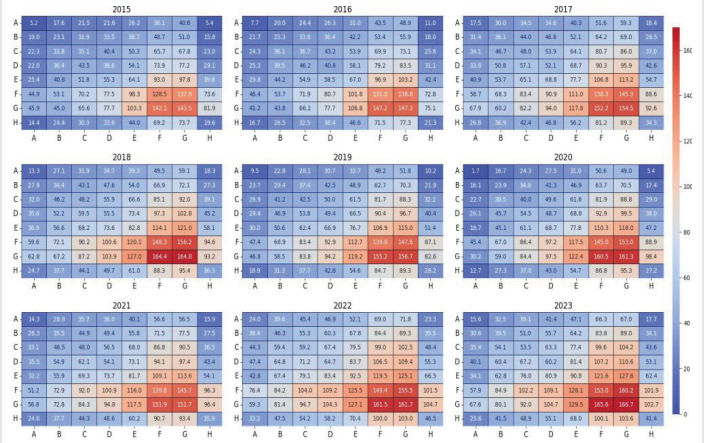

Figure 2: Average ENEM scores by parental education pairing (father × mother), selected years.

version, the axis presentation was standardized to ensure full consistency between the alphabetical coding (A–Q) and the graphical representation, and the complete mapping of categories is now clearly stated in both the figure captions and the methodological description (Figures 3,4).

Similarly, the parental education categories A–H correspond to the INEP classification of educational attainment: A – never studied; B – did not complete the 5th year of elementary school; C – completed the 5th year but not the 9th year; D – completed elementary school but not high school; E – completed high school but not higher education; F – completed higher education; G – completed postgraduate education; and H – does not know. The revised manuscript explicitly specifies which axis refers to the father's education and which refers to the mother's education in each figure and model, thereby eliminating any ambiguity and strengthening the clarity and interpretability of the results.

Socioeconomic Gradients in ENEM Performance

Across the entire 2015–2023 period, the results reveal a strong and persistent socioeconomic gradient in ENEM performance. Average scores increase almost monotonically with family income, with differences between the lowest and highest income brackets reaching approximately 150 points in most years. This gap corresponds to more than one standard deviation of the ENEM score distribution, indicating substantial inequality in academic achievement [7-20].

The gradient remains remarkably stable over time. While short-term fluctuations are observed—particularly during the COVID-19 pandemic—the relative ordering of income groups is preserved. This stability suggests that family income captures durable material advantages, such as access to private tutoring, digital resources, and favorable study environments, which consistently translate into higher exam performance.

Parental education effects

Parental education also exhibits a clear and robust association with ENEM outcomes. Candidates whose parents completed higher education or postgraduate studies systematically outperform those whose parents have low or incomplete schooling. Importantly, the effect is not merely additive: candidates whose father and mother both have high levels of education achieve average scores substantially higher than those with only one highly educated parent [16-22].

Maternal education shows a slightly stronger association with performance than paternal education, particularly at intermediate and higher schooling levels. This pattern aligns with prior evidence emphasizing the role of mothers in mediating educational practices, academic expectations, and daily study routines within households.

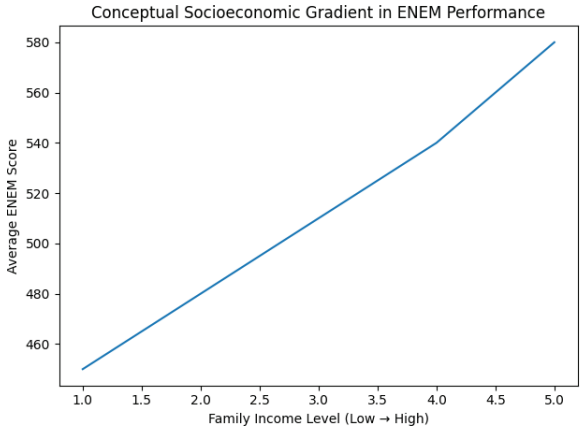

Figure 3: Socioeconomic Gradient.

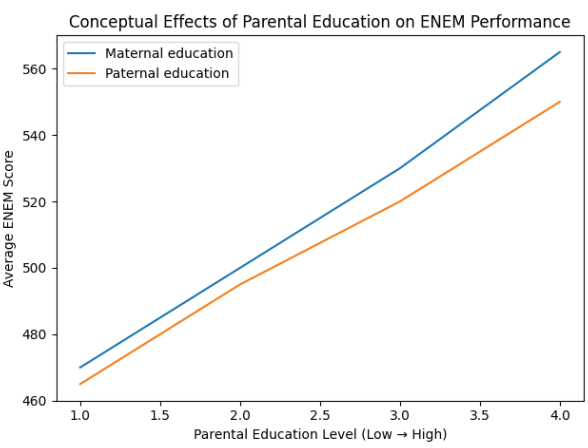

Figure 4: Parental education effects.

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Pandemic shock and partial compression of inequalities

The year 2020 represents a structural break in the series. Average scores decline across all socioeconomic groups, reflecting widespread learning losses associated with school closures and disruptions. However, the decline is relatively uniform, resulting in a temporary compression of performance gaps. By 2022–2023, income- and education-based disparities largely reemerge, indicating that the pandemic shock did not alter the underlying structure of educational inequality. This rapid reconstitution of gaps underscores the resilience of socioeconomic advantages and the limited capacity of short-term policy responses to offset long-standing disparities [10-15].

Income and parental education: Joint effects

In the regression models, family income emerges as the single strongest predictor of ENEM performance. In the 2023 specification, the difference between the lowest and highest income brackets corresponds to an average increase of approximately 130–150 points in predicted scores, holding parental education constant. When parental education is included without income controls, candidates whose parents completed higher education or postgraduate studies score, on average, between 60 and 90 points higher than those whose parents did not complete elementary school. After the inclusion of family income, these coefficients decrease but remain statistically significant ($p < 0.01$), with adjusted marginal effects typically ranging from 25 to 55 points depending on the level of schooling.

In models including income and only one parental education variable, maternal education exhibits slightly larger marginal effects than paternal education at most schooling levels. For example, completion of higher education by the mother is associated with an increase of roughly 40–50 points relative to the lowest schooling category, whereas the corresponding paternal effect ranges from approximately 30–45 points. When both parents' education levels are included simultaneously alongside income, the individual coefficients shrink further, generally falling within the 20–40 point range for higher education categories, indicating partial overlap between paternal and maternal educational capital.

These estimates confirm that, although a substantial portion of the parental education effect is mediated by family income, an independent and meaningful association remains even after controlling for material resources. The persistence of coefficients of this magnitude suggests that cultural and educational practices transmitted within households exert additional influence beyond purely economic constraints.

In a nutshell, these findings point to a partially redundant structure of family resources: income encapsulates a broad set of material advantages, while parental education captures long-term cultural and cognitive capital. Together, they explain a substantial share of performance variation, but neither is sufficient on its own.

Model performance and explanatory limits

Across the 2015–2023 period, models using only parental education explain approximately 18% – 20% of the variance in average ENEM scores. The inclusion of family income increases explanatory power by roughly seven percentage points, raising R^2 values to around 26% – 28% in pre-pandemic years. During 2020–2021, model fit declines modestly, reflecting the disruptive effects of the pandemic on learning processes and exam participation [11-16].

Importantly, even the most comprehensive specification leaves more than two-thirds of score variance unexplained. This ceiling highlights the limits of family background variables and suggests that school-level factors, individual motivation, instructional quality, and psychosocial dimensions play a major role in shaping exam outcomes. Nonetheless, the stability of income and parental education effects over time confirms their centrality in structuring educational opportunities.

Regional patterns

Although the core socioeconomic gradients are observed in all five macro-regions, their intensity varies. North and Northeast regions exhibit a stronger concentration of candidates in lower income and schooling categories, while South and Southeast regions display more heterogeneous distributions. Despite these differences, the direction and magnitude of income and parental education effects remain remarkably similar across regions [5-15].

This homogeneity suggests that regional disparities in ENEM performance are driven primarily by differences in population composition, rather than by region-specific mechanisms. Once income and parental education are accounted for, regional contrasts narrow substantially, reinforcing the interpretation that socioeconomic structure, rather than geography per se, underlies observed performance gaps.

Conclusion and future work

This study examined the influence of family income and parental education on ENEM performance between 2015 and 2023 using nationally representative microdata. The results provide strong and consistent evidence of a persistent socioeconomic gradient in large-scale educational assessment outcomes in Brazil. Candidates from higher-income households and those with highly educated parents achieve substantially higher scores, with differences exceeding 150 points between extremes of the distribution.

Parental education exerts an independent and meaningful effect, particularly when both parents attain high schooling levels, suggesting a complementary accumulation of cultural capital. Maternal education shows a slightly stronger association with performance than paternal education, even after controlling for income. Although the COVID-19 pandemic temporarily compressed score differentials, inequalities quickly reemerged, underscoring the resilience of structural advantages.

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From a policy perspective, the findings indicate that school-centred interventions alone are unlikely to eliminate performance gaps rooted in family background. Effective strategies require integrated approaches that combine improvements in educational quality with family-oriented and community-based support, particularly for students from low-income and low-education households. In the Brazilian context, this implies strengthening redistributive financing mechanisms such as FUNDEB to ensure more equitable allocation of qualified teachers, pedagogical resources, and infrastructure in socioeconomically vulnerable regions, especially in the North and Northeast. It also suggests aligning performance-equity goals with the objectives of the National Education Plan (PNE), reinforcing targets related to educational quality (e.g., learning outcomes in basic education) while explicitly addressing socioeconomic disparities. Conditional income-transfer programs, such as Bolsa Família, can further mitigate material constraints that affect school engagement, particularly when combined with structured academic support initiatives.

Furthermore, expanding full-time schooling programs (Escola em Tempo Integral) and structured tutoring policies targeted at first-generation students may help compensate for differences in cultural capital within households. Additionally, parental engagement initiatives embedded in public school networks — including literacy promotion programs and guidance on supporting academic routines at home — could strengthen the home–school interface. Sustainable reductions in inequality will likely depend on coordinated policies that address both school effectiveness and the broader socioeconomic environment in which students are embedded.

Future research may extend this analysis by incorporating school-level characteristics, individual trajectories, and advanced modelling techniques, such as machine learning, to explore non-linear interactions among socioeconomic variables. Comparative studies across countries with similar national examinations could further clarify the generality of the mechanisms identified here.

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