

Considerations on the impacts of family income and maternal education on Mathematics performance in the ENEM 2022

Considerações acerca dos impactos da renda familiar e da escolaridade materna no desempenho em Matemática no ENEM 2022

Consideraciones sobre el impacto del ingreso familiar y la educación materna en el desempeño en Matemáticas en el ENEM 2022

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Abstract: This study is based on the assessment of students' performance in Mathematics on the ENEM exam of 2022. Methodologically, the study will consist of the ENEM 2022 database; the selection of the variables used—administrative dependence, family income, and maternal education; and descriptive analyses, discussions, and interpretations of the results in relation to Brazilian society. It is observed that as family income and maternal education level increase, there is a tendency for scores to improve. In other words, the study highlighted that average scores are significantly higher among students whose mothers have a higher education degree, especially when combined with a high family income. For example, students whose mothers have only primary education tend to achieve average scores below 600 points, while those whose mothers have a higher education or postgraduate degree often surpass this threshold. These results confirm the hypothesis that these variables are significant for student performance, highlighting the influence of the family context on the educational process.

Keywords: Education; Socioeconomic factors; Mathematics Performance; ENEM.

Resumo: Este estudo baseia-se na avaliação da proficiência em Matemática dos alunos que realizaram a prova do ENEM no ano de 2022. Metodologicamente, o estudo será constituído pela base de dados do ENEM 2022; pela seleção das variáveis utilizadas: dependência administrativa, renda familiar e escolaridade materna; por análises descritivas, discussões e interpretações dos resultados, frente à sociedade brasileira. Observa-se que, à medida que se aumentam a renda familiar e o grau de escolaridade materna, há uma tendência de melhora nas notas. Ou seja, estudo destacou que as médias das notas são significativamente maiores entre os alunos cujas mães possuem maior nível de escolaridade, especialmente quando apresentam uma renda familiar elevada. Por exemplo, alunos com mães que possuem apenas o

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ensino fundamental tendem a apresentar notas médias inferiores a 600 pontos, enquanto aqueles cujas mães têm nível superior ou pós-graduação, frequentemente, superam essa marca. Os resultados confirmam a hipótese de que essas variáveis são significativas para o desempenho dos estudantes, evidenciando a influência do contexto familiar no processo de formação educacional.

Palavras-chave: Educação; Fatores socioeconômicos; Desempenho em Matemática; ENEM.

Resumen: Este estudio se basa en la evaluación del dominio en Matemáticas de los estudiantes que rindieron la prueba ENEM, en el año 2022. Metodológicamente el estudio constará de una base de datos; por la selección de variables utilizadas: dependencia administrativa, ingreso familiar y educación materna; a través de análisis descriptivos y discusiones e interpretaciones de resultados, en relación a la sociedad brasileña. Se observa que, a medida que aumentan los ingresos familiares y el grado de escolaridad materna, existe una tendencia a la mejora en las calificaciones. El estudio también destacó que los promedios de calificaciones son significativamente más altos entre los estudiantes cuyas madres tienen un mayor nivel de escolaridad, especialmente cuando se combina con un ingreso familiar más elevado. Por ejemplo, los estudiantes cuyas madres solo tienen educación primaria tienden a tener calificaciones promedio inferiores a 600 puntos, mientras que aquellos cuyas madres tienen educación superior o posgrado suelen superar esta marca. Los resultados confirman la hipótesis de que estas variables juegan un papel significativo en el desempeño de los estudiantes, destacando la influencia del contexto familiar en el proceso de formación educativa.

Palabras clave: Educación; Factores socioeconómicos; Rendimiento en matemáticas; ENEM.

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Introduction

Historically, it is observed that education is an essential element in the formation of human beings. The role of public and private educational institutions, as well as social factors, has been constantly discussed to analyze students' performance within the Brazilian educational system.

According to Brooke and Soares (2008), three main structures influence a student's academic performance: family, socioeconomic condition, and the type of school attended. Also, according to Brooke and Soares (2008, p. 194), "...in addition to intellectual goals, teachers considered that personal and social areas to be equally important". In other words, the need for a central analysis on a national scale was identified, aiming to demonstrate the factors that influence a student's cognitive performance.

In this context, in 1990, the Basic Education Assessment System (SAEB) was created, a mechanism responsible for developing tests and questionnaires targeted at public and private institutions as a means of assessing the quality of education provided

to students in learning environments. From this milestone, it became possible to quantify the school effect in Brazil—understood as the school's responsibility for a student's learning—using multilevel regression models and, later, to compare the relationships between different social groups and classes through other systems. One way to objectively calculate the school effect using multilevel regression models is by considering the proportion of the model error variation at the school level.

Currently, the National High School Exam (ENEM) is the main means of admission to higher education institutions in Brazil. According to Lourenço (2016, p. 120), ENEM can be considered "a recent and dynamic public policy, in the process of consolidation, and therefore, it deserves to be systematically monitored". It is composed of four areas of knowledge: Languages, Codes, and their Technologies; Human Sciences and their Technologies; Natural Sciences and their Technologies; and Mathematics and its Technologies, totaling 180 multiple-choice questions (INEP, 2020). The exam allows students from distinct parts of the country the opportunity to access higher education. In a way, it is related to social mobility, as it enables individuals to move beyond their current context in search of better opportunities. However, significant obstacles to accessing these institutions can still be observed, making it necessary to analyze how socioeconomic factors affect students' academic performance.

Given the presented context, the objective of this article is to discuss how the relationship between family income and maternal education influences students' performance in the ENEM, as these two variables are of utmost importance. The Mathematics score was chosen because, when a comparative analysis of all areas of knowledge areas was conducted, it showed the greatest discrepancies among the selected groups in the research. It is possible that the greatest discrepancies occur due to a stronger impact of socioeconomic variables on Mathematics performance. However, a deeper discussion in this regard, aiming to identify the reasons behind the differences in proficiency levels, is beyond the scope of this article. In the following section, the methodology and database used in this study, which served as the basis for selecting the variables, will be presented.

Methodology and Database

The present study is based on the assessment of Mathematics proficiency scores of students from the five main regions of Brazil—South, Southeast, North, Northeast, and Central-West—who took the ENEM exam in 2022. Methodologically, the database will consist of the students who took this exam. The variables used will be administrative

dependence, aiming to compare the performance of students from public and private schools, family income, and maternal education. Subsequently, descriptive analyses will be conducted, and discussions on the relationships between these variables and Mathematics performance will be presented.

To determine the influence of family income and maternal education on students' performance in the exam, an analysis was conducted using microdata provided by the National Institute for Educational Studies and Research Anísio Teixeira (INEP), which allow researchers, educational institutions, and professionals in the education field to 'support diagnoses, studies, research, and the monitoring of educational statistics and information' (INEP, 2023). These microdata encompass various information on socioeconomic and family variables, which underwent processing to extract the most relevant values, as well as the adjustment and manipulation of the elements in question, using R and RStudio software.

Initially, the database included 951,944 students who took the ENEM in 2022. After data processing and the removal of missing Mathematics scores, the database was reduced to a total of 695,008 students, with the majority from the Southeast region and the minority from the North region, as shown in Table 1.

Table 1: Distribution and percentage of students by region in Brazil.

	Students	Percentage (%)
South	91,389	13.1
Southeast	258,698	37
North	59,053	8.5
Northeast	220,564	32
Central-West	65,304	9.4
Total	695,008	100

Source: Elaborated by the authors (2024).

From Table 1, it can be observed that there is a significant disparity between the number of participants from the Southeast and North regions, emphasizing the regional inequality present in Brazil. In general, regions with large metropolitan centers, such as the Southeast, tend to have a portion of their population with better socioeconomic conditions, infrastructure, and investments in quality education, leading to higher participation in the ENEM. According to IBGE (2022), the 2022 Census showed that the Southeast region had the highest percentage of households with sewage collection (86.2%), while the North region

had the lowest rate (22.8%). Additionally, the average monthly per capita income in the Southeast and North regions in 2022 was R\$1,891.00 and R\$1,096.00, respectively, representing a difference of R\$795.00 between the two regions. Ferrão et al. (2018) demonstrate, through statistical models, that Mathematics proficiency scores in the North region decrease in comparison to other regions (mainly the Southeast region), suggesting that these inequalities stem from differences observed in the early years of elementary education, driven by both economic and social factors.

In this context, the debate on educational equity and performance in the ENEM is directly linked to socioeconomic and family factors. Therefore, family income was divided into 17 categories in the database (Table 2), each represented by a numerical range. It is important to highlight that, in 2022, the minimum wage was R\$1,212.00.

Table 2: Income distribution by group in the ENEM 2022.

A	No Income
B	Up to R\$ 1,212.00
C	From R\$ 1,212.01 to R\$ 1,818.00
D	From R\$ 1,818.01 to R\$ 2,424.00
E	From R\$ 2,424.01 to R\$ 3,030.00
F	From R\$ 3,030.01 to R\$ 3,636.00
G	From R\$ 3,636.01 to R\$ 4,848.00
H	From R\$ 4,848.01 to R\$ 6,060.00
I	From R\$ 6,060.01 to R\$ 7,272.00
J	From R\$ 7,272.01 to R\$ 8,484.00
K	From R\$ 8,484.01 to R\$ 9,696.00
L	From R\$ 9,696.01 to R\$ 10,908.00
M	From R\$ 10,908.01 to R\$ 12,120.00
N	From R\$ 12,120.01 to R\$ 14,544.00
O	From R\$ 14,544.01 to R\$ 18,180.00
P	From R\$ 18,180.01 to R\$ 24,240.00
Q	Above R\$ 24,240.00

Source: INEP (2022).

According to Table 3, a subset of the microdata provided by INEP was selected for the income variable, dividing it into four different groups: Group 1 (from 'A' to 'B'), Group 2 (from 'C' to 'G'), Group 3 (from 'H' to 'L'), and Group 4 (values greater than or equal to 'M'). These values correspond, respectively, to a family income of less than or equal to one minimum wage, between one and four minimum wages, between four and nine minimum wages, and greater than nine minimum wages.

Table 3: Subset selected for the analysis of the family income variable.

Group 1	less than or equal to R\$ 1,212.00
Group 2	R\$ 1,212.01 - R\$ 4,848.00
Group 3	R\$ 4,848.01 - R\$ 10,908.00
Group 4	greater than or equal to R\$ 10,908.01

Source: Elaborated by the authors (2024).

For the maternal education variable, the selected groups were "No Education," "5th Grade Incomplete," "9th Grade Incomplete," "Elementary School," "High School," "Undergraduate Degree," "Postgraduate Degree," and "Unknown". For the type of administrative dependence, a binary variable was used, where "0" represents a public school (federal, municipal, and state) and "1" represents a private school.

Descriptive Analyses

In this section, the variables will be discussed with the aim of relating them to Mathematics scores in the 2022 ENEM. Family income and maternal education, along with school dependence (public or private), are the selected socioeconomic and educational variables, categorized according to the divisions presented in Methodology. Moreover, this analysis considered the values of the 1st quartile, 2nd quartile (Median), 3rd quartile, and the Mean to differentiate the results obtained among the candidates. It is important to emphasize that values below the 1st quartile represent students with low performance, while values above the 3rd quartile represent students with high performance. Comparatively, between public and private schools, a discrepancy of approximately 95 points in the 1st quartile, 114 points in the Median, 104 points in the 3rd quartile, and 97 points in the Mean Mathematics scores can be observed (Table 4). As presented in Table 4, the Mathematics performance of students from private schools is higher than that of public school students, both in the mean and in the calculated quartiles. This suggests that the likelihood of a private school student entering higher education tends to be greater than that of a public school student. It is also observed that in the third quartile (where, up to this value, 75% of the scores are represented), only 25% of public school students achieve scores above 591.7, while private school students achieve scores above 696.1.

The difference in scores between public and private schools is a consequence of the social inequality existing in Brazil, which affects students from their initial schooling

until the moment they access higher education. This issue is directly linked to maternal education and monthly family income, since, in many cases, individuals with little or no formal education tend to have worse financial conditions and consequently cannot provide their children with access to higher-quality schools (usually private). Although the ENEM is the primary means of admission to higher education institutions, it is evident that the social and economic conditions of the population significantly influence the educational development process.

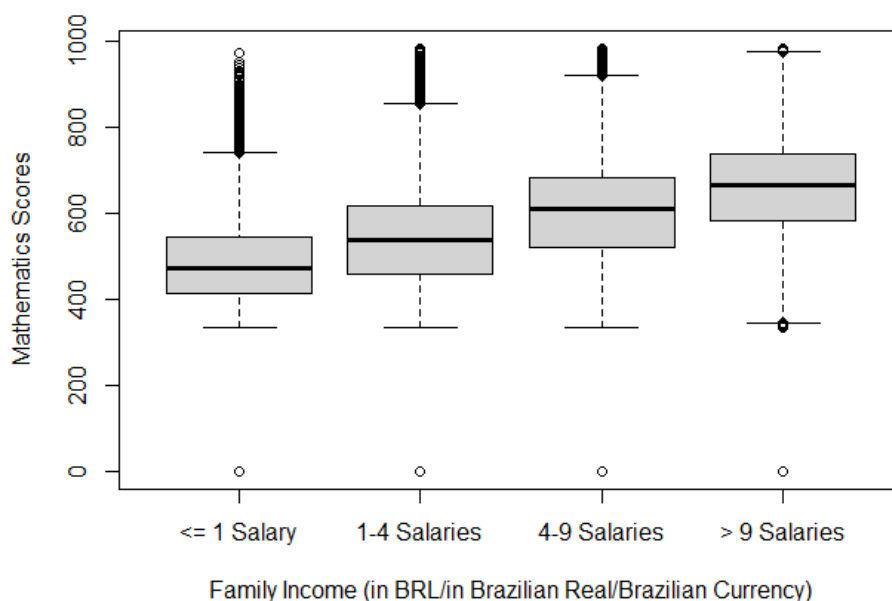
Table 4 – Mathematics Scores in Public and Private Schools in the ENEM 2022.

Type of School		
	Public (Federal, Municipal, and State)	Private
1st Quartile	437.2	531.9
Median	507.5	621.6
Mean	519	615.9
3rd Quartile	591.7	696.1

Source: Elaborated by the authors (2024).

Besides that, an important variable to be discussed is family income, which in this data analysis was divided into groups, where the first has an income less than or equal to one minimum wage, and the last has an income greater than nine minimum wages. As shown in Figure 1 and Table 5, the average Mathematics scores of students with family incomes less than or equal to one minimum wage are considerably lower than those of students with family incomes greater than nine minimum wages. While the mean score for the first group is 487.7, the last group has a mean score of 658.5, representing a difference of approximately 26% between the scores. Furthermore, it can be observed that the first quartile (25%) for students from families earning more than nine minimum wages is higher than the third quartile (75%) for those earning one minimum wage or less, clearly illustrating how this variable directly influences student proficiency.

Figure 1: Relationship between Family Income and Mathematics Scores in the ENEM 2022.



Source: Elaborated by the authors (2024).

Table 5: Mathematics Scores by Family Income Categories in the ENEM 2022.

Family Income				
	<= 1 salary	1-4 salaries	4-9 salaries	> 9 salaries
1st Quartile	416.5	460.4	523.1	582.7
Median	472	539.5	610.9	665.5
Mean	487.7	543.6	604.9	658.5
3rd Quartile	547.3	618.8	682.5	740.8

Source: Elaborated by the authors (2024).

Through Figure 2 and Table 6, it is also possible to observe the positive impact of maternal education on students' average scores in the ENEM. While the average score of a student whose mother has 'No Education' is 465.2, students whose mothers have an 'Undergraduate Degree' achieve an average Mathematics score of 596.1, representing a difference of approximately 131 points. It is important to highlight that students whose mothers have 'High School' education were numerically predominant (37% of cases), whereas students whose mothers had 'No Education' represented the lowest proportion (1.1% of cases). However, it is likely that the actual maternal education level of students who selected 'Unknown' falls within the range of the lowest education categories, potentially increasing the previously described percentage, as their score distribution—observable in Table 6—is consistently lower than that of students whose mothers have

'9th Grade Incomplete,' across all quartiles and the mean. Additionally, the groups '9th Grade Incomplete' and 'Elementary School,' as well as 'Undergraduate Degree' and 'Postgraduate Degree,' presented similar average scores, with differences of approximately 11 points and 13 points, respectively.

It can be concluded that the higher the maternal education level, the better the students' exam performance, corroborating the importance of analyzing and studying family variables within the scope of student proficiency.

Table 6: Distribution of Students and Mathematics Proficiency in the ENEM 2022 by Maternal Education.

	Students	1st Quartile	Median	Mean	3rd Quartile
No Education	7,678 (1.1%)	400.9	448.4	465.2	513.2
5th Grade Incomplete	47,887 (6.9%)	414.9	470.6	486.9	547.2
9th Grade Incomplete	61,188 (8.8%)	426.3	488.8	503.4	570.7
Elementary School	78,723 (11.33%)	434.9	501.5	514	584.8
High School	257,281 (37%)	457.3	537.2	542.9	619.4
Undergraduate Degree	109,173 (15.7%)	504.6	599.7	596.1	679.3
Postgraduate Degree	107,578 (15.5%)	517.6	613.6	608.8	693.6
Unknown	25,500 (3.67%)	418.1	476.5	494.4	557.3

Source: Elaborated by the authors (2024).

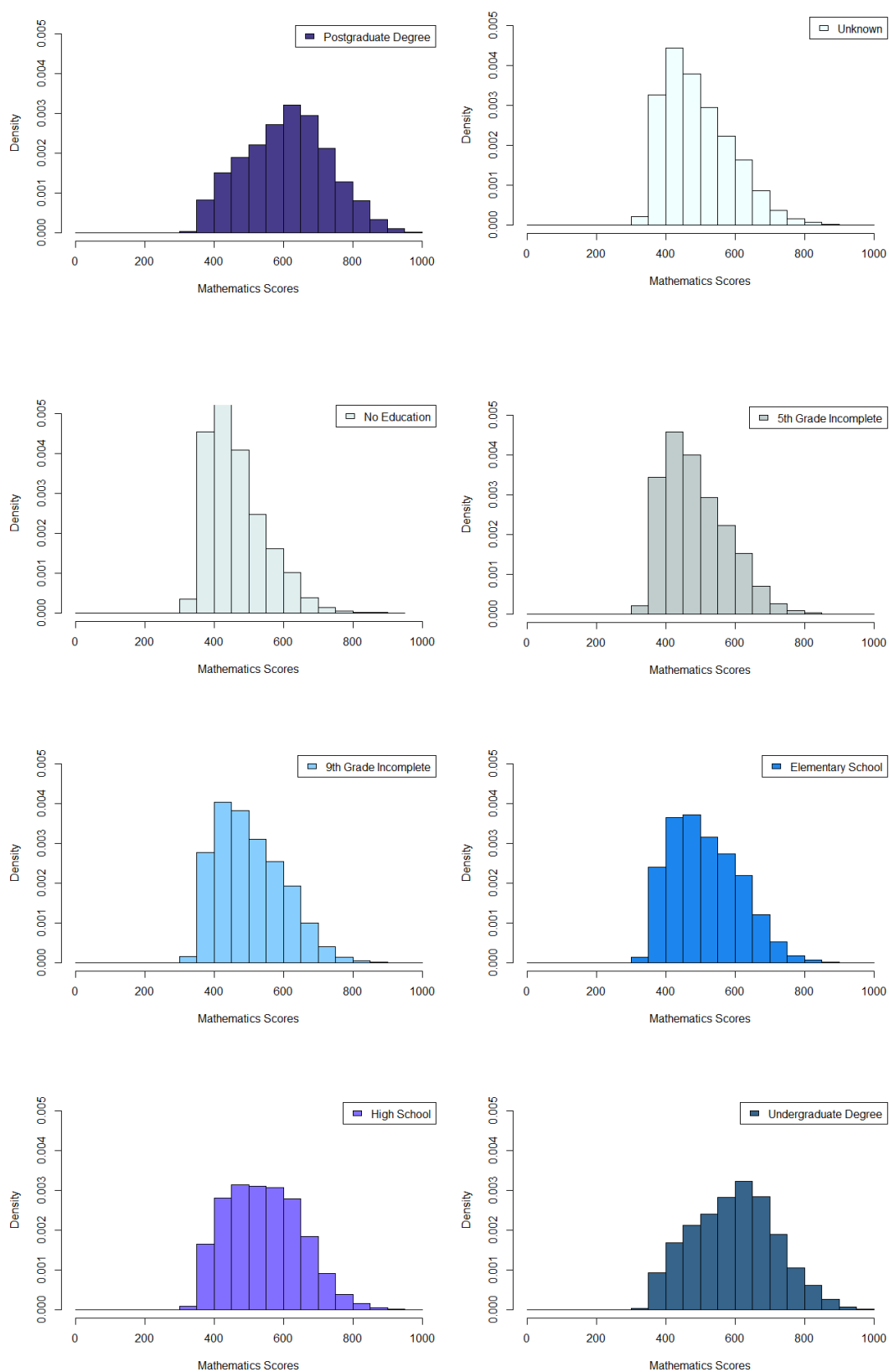
When analyzing family income and maternal education variables together, it can be observed from Table 7 that students whose mothers have lower levels of education, such as "No Education," "5th Grade Incomplete," and "9th Grade Incomplete," are mostly concentrated in the income range of less than or equal to one minimum wage (although a reasonable percentage falls within the one-to-four minimum wage range), with average scores of 457.2, 471.4, and 480.1, respectively. This association between low education, low income, and low average scores is common, as the lower the education level and income, the worse the academic performance tends to be. It is important to note that these statements refer to students' average performance. For example, quota students in universities achieve the highest ENEM scores within their respective quotas, indicating that these students stand out. Identifying why this occurs is beyond the scope of this article, as it would require comparing data from quota students with those from the general student population who did not gain university admission. It can also be observed that only a small number of individuals (12 people) in the "No Education"

maternal education category have significantly high incomes, indicating that they are exceptions within their group. However, despite this, they still present an average score of 562.3, which is considered low compared to other education levels. Additionally, it is noteworthy that a large portion of students in the "Unknown" maternal education category falls within the income range of less than or equal to one minimum wage, making it likely that their education levels are among the lowest.

The "High School" maternal education category has the highest number of individuals, comprising 257,281 students out of 695,008 identified in the database, as observed in Table 6. The majority is concentrated in the income range between one and four minimum wages, but there is a growing tendency toward higher salary ranges compared to lower education levels previously described. Regarding elementary education, an increase of 6.4% is observed in the number of students with a family income between four and nine minimum wages, and 2.6% in those with an income above nine minimum wages within this group. Despite this, the average Mathematics score in the ENEM for this category remains below 600 points, except for the income range above nine minimum wages, which has an average score of 621.8. It is observed that all categories below the high school education level have average Mathematics scores lower than 600 points, which progressively increase as family income and maternal education level rise.

For higher education levels, such as "Undergraduate Degree" and "Postgraduate Degree", a large proportion of students belong to higher income brackets. For the undergraduate category, although the highest percentage is concentrated in the income range between one and four minimum wages, the income brackets between four and nine minimum wages and above nine minimum wages together account for 46.4% of cases, demonstrating a significant increase in average scores, which exceed 600 points. For the "Postgraduate Degree" category, incomes equal to or greater than four minimum wages account for 62.2% of cases, with the highest average score reaching 670.8. This represents a difference of approximately 214 points compared to the average score of students whose mothers have "No Education" and whose family income is less than or equal to one minimum wage (the highest percentage within this category).

Figure 2: Relationship between Maternal Education and Mathematics Scores in the ENEM 2022.



Source: Elaborated by the authors (2024).

Table 7: Mathematics Proficiency by Family Income and Maternal Education in the ENEM 2022.

		Family Income			
		<= 1 salary	1-4 salaries	4-9 salaries	> 9 salaries
No Education	1st Quartile	397.9	417.9	436.6	472.4
	Median	441.6	473.5	538.4	570.9
	Mean	457.2	490.7	551.1	562.3
	3rd Quartile	500.8	552.9	632.9	608.1
Students (%)		5,977 (77.85%)	1,633 (21.27%)	56 (0.73%)	12 (0.15%)
5th Grade Incomplete	1st Quartile	406.3	436.3	460.3	488.4
	Median	455.5	502.4	542.9	575.5
	Mean	471.4	512.7	548.3	567.4
	3rd Quartile	523	580.8	625.5	637.8
Students (%)		31,080 (64.9%)	15,584 (32.5%)	1,046 (2.2%)	177 (0.4%)
9th Grade Incomplete	1st Quartile	411.9	444.2	478.9	507.8
	Median	463.9	513.3	562.2	592.6
	Mean	480.1	522.2	563.9	584.1
	3rd Quartile	535.8	593.3	639.7	657.5
Students (%)		30,610 (50%)	27,529 (45%)	2,562 (4.2%)	487 (0.8%)
Elementary School	1st Quartile	417.4	447.5	489	512.3
	Median	471.8	519.1	573.1	598.2
	Mean	486.9	526.3	569.4	593.9
	3rd Quartile	545.1	598.2	645	674.1
Students (%)		32,219 (41%)	40,211 (51%)	5,180 (6.6%)	1,113 (1.4%)
High School	1st Quartile	426.6	464.1	511.7	543.9
	Median	487.8	542.6	597.6	627.9
	Mean	500.4	545.5	592.6	621.8
	3rd Quartile	564.5	619.6	668.7	701.5
Students (%)		67,143 (26%)	146,152 (57%)	33,750 (13%)	10,236 (4%)
Undergraduate Degree	1st Quartile	436.4	482.2	540.6	594.7
	Median	505	568.9	626.1	673.8

	Mean	516.7	567.4	619.6	667
	3rd				
	Quartile	589.1	644.8	697.3	746.8
			49,616	30,745	19,863
Students (%)		8,949 (8.2%)	(45.4%)	(28.2%)	(18.2%)
	1st	430.4	477.2	534.4	597.4
	Quartile				
	Median	493.7	564.1	620.9	677.4
	Mean	511.3	563	614.8	670.8
	3rd				
	Quartile	583.1	640.6	692.6	753.3
			36,473	36,955	29,988
Students (%)		4,162 (3.9%)	(33.9%)	(34.3%)	(27.9%)
	1st	405.4	434.1	489	509.1
	Quartile				
	Median	452.7	500.9	576.5	612.7
	Mean	468.7	511.9	575.4	603.9
	3rd				
	Quartile	518.7	581.1	653.2	700.5
		13,989	9,301		
Students (%)		(54.9%)	(36.5%)	1,568 (6.1%)	642 (2.5%)

Source: Elaborated by the authors (2024).

In this context, the relationship between family income, maternal education, and performance in the ENEM is a topic of great importance in the educational field, as it highlights the socioeconomic differences that directly impact students' academic trajectories. In Moraes, Peres, and Pedreira (2021), the debate on school effectiveness and family variables was conducted with a primary focus on the pandemic period, pointing out the challenges ahead to prevent the gap from widening even further after this period. The effects of maternal education and family income are reflected not only in the household environment but also in access to various types of resources (pre-university courses, high-quality educational materials, extracurricular experiences, etc.), the cultural emphasis on valuing education, and the quality of life provided to students throughout their educational journey. The study conducted by Couto, Tavares, and Costa (2021) discusses the funding mechanisms that can, in some way, improve the quality of Basic Education, emphasizing the importance of public policies.

Conclusions

In this article, we discussed how maternal education and family income directly impact the Mathematics scores of students who took the ENEM exam in 2022. For this purpose,

microdata provided by the National Institute for Educational Studies and Research Anísio Teixeira (INEP) were used, covering a sample of 695,008 students distributed across the five main regions of Brazil (South, Southeast, North, Northeast, and Central-West).

The results of this study corroborate the existing literature, which had already pointed to the decisive influence of socioeconomic and educational conditions on students' development. As family income increases, a corresponding improvement in students' performance is observed. Additionally, maternal education has proven to be an equally significant factor, suggesting that a mother's educational level has a direct and positive effect on her children's academic performance. This issue reinforces the need for public policies that primarily encourage maternal education as a strategy for improving future generations.

The present study also highlights the regional disparities that continue to characterize the Brazilian educational system. Economically more developed regions, such as the Southeast, tend to exhibit superior performance compared to areas like the North, where socioeconomic conditions are, on average, less favorable. This discrepancy suggests that educational policies, such as improving school infrastructure, expanding basic sanitation, and promoting social mobility, need to be adapted to regional realities, taking into account the structural inequalities that affect access to quality education.

In summary, the results of this research confirm the importance of socioeconomic conditions in determining the academic performance of Brazilian students and emphasize inequalities as a persistent challenge in the educational system. Promoting integrated public policies that consider both family income and maternal education as critical factors for academic success is essential to achieving greater equity in access to quality education. The findings confirm the initial hypothesis that these variables play a significant role in students' academic performance, directly demonstrating the influence of the family context and maternal education on the educational development process.

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