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ARTICLE

Examining the Impact of National Common Curricular Base and National Context on Mathematics Achievement Among Students in Brazil

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ABSTRACT: This study utilizes a linear mixed-effects regression model to examine how regional differences in education systems across Brazil impact student mathematics achievement. Employing a Bayesian multilevel framework, it analyzes region-level, school-level, and student-level variables while considering the hierarchical nature of the data. A comparative analysis of PISA scores, conducted before and after the BNCC implementation in Brazilian schools, evaluates mathematics achievement. The findings indicate that both regional factors and school type significantly affect variations in achievement. Notably, a performance gap persists between the Northern and Southern/Southeastern regions, reflecting disparities in access to resources. Furthermore, the differences between public and private schools highlight systemic inequalities in educational opportunities. Overall, both student-level and school-level factors are crucial in shaping students' mathematical achievement, as evidenced by the PISA scores.

Keywords: PISA, Math Achievement, Large Scale Assessment

ANALISANDO O IMPACTO DA BASE NACIONAL COMUM CURRICULAR E DO CONTEXTO NACIONAL NO DESEMPENHO EM MATEMÁTICA ENTRE ESTUDANTES NO BRASIL

RESUMO: Este estudo utiliza um modelo de regressão linear de efeitos mistos para examinar como as diferenças regionais nos sistemas educacionais no Brasil impactam o desempenho dos alunos em matemática. Empregando uma estrutura multinível bayesiana, analisa variáveis em nível de região, escola e aluno, considerando a natureza hierárquica dos dados. Uma análise comparativa das pontuações do PISA, conduzida antes e depois da implementação da BNCC nas escolas brasileiras, avalia o desempenho em matemática. Os resultados indicam que tanto fatores regionais quanto o tipo de escola afetam significativamente as variações no desempenho. Notavelmente, persiste uma lacuna de desempenho entre as regiões Norte e Sul/Sudeste, refletindo disparidades no acesso a recursos. Além disso, as diferenças entre escolas públicas e privadas evidenciam desigualdades sistêmicas nas oportunidades educacionais. De modo geral, fatores tanto do aluno quanto da escola são cruciais na formação do desempenho matemático dos alunos, como evidenciado pelas pontuações do PISA.

Palavras-chave: PISA, Desempenho em Matemática, Avaliação em Larga Escala

ANALIZANDO EL IMPACTO DEL NÚCLEO CURRICULAR COMÚN NACIONAL Y EL CONTEXTO NACIONAL EN EL DESEMPEÑO EN MATEMÁTICAS DE LOS ESTUDIANTES EN BRASIL

RESUMEN: Este estudio utiliza un modelo de regresión lineal de efectos mixtos para examinar cómo las diferencias regionales en los sistemas educativos de Brasil impactan el rendimiento en matemáticas de los estudiantes. Empleando un marco multinivel bayesiano, analiza variables a nivel de región, nivel de escuela y nivel de estudiante mientras considera la naturaleza jerárquica de los datos. Un análisis comparativo de las puntuaciones PISA, realizado antes y después de la implementación de BNCC en escuelas brasileñas, evalúa el rendimiento en matemáticas. Los hallazgos indican que tanto los factores regionales como el tipo de escuela afectan significativamente las variaciones en el rendimiento. Cabe destacar que persiste una brecha de rendimiento entre las regiones Norte y Sur/Sureste, lo que refleja disparidades en el acceso a los recursos. Además, las diferencias entre escuelas públicas y privadas resaltan desigualdades sistémicas en las oportunidades educativas. En general, tanto los factores a nivel de estudiante como a nivel de escuela son cruciales en la configuración del rendimiento matemático de los estudiantes, como lo evidencian las puntuaciones PISA.

Palabras clave: PISA, Logro Matemático, Evaluación a Gran Escala

INTRODUÇÃO

Education is universally recognized as a fundamental human right and represents one of the most sustainable investments that can effectively elevate individuals out of poverty, reduce inequalities and ensure sustainable development (*The Right to Education | UNESCO*, n.d.). The educational system plays a critical role in maintaining the status of major economies, such as the United States, as global leaders (Pugliese & Santos, 2022). By fostering a well-informed and skilled workforce, education not only drives individual achievement but also enhances the nation's economic competitiveness on the international stage.

Since its first implementation in 2000, the Program for International Student Assessment (PISA) has emerged as both a catalyst and a motivational force for educational transformation and reform across numerous countries (Gomes et al., 2020). PISA's comprehensive evaluations not only benchmark student performance globally but also provides critical insights that drive policy initiatives aimed at enhancing educational quality and effectiveness. As a result, the program has significant implications for the development of educational strategies and practices worldwide (Pugliese & Santos, 2022).

Brazil has actively participated in the administration of the Programme for International Student Assessment (PISA) since its inaugural iteration in 2000 (*PISA 2022 Results (Volume I and II) - Country Notes*, 2023) even though has been always in the bottom ranking worldwide when comparing the scores with other countries. According to the Organization for Economic Co-operation and Development (OECD), which oversees the implementation of the assessment, Brazil's PISA results have demonstrated a remarkable degree of stability over an extended period. Notably, since 2009, the data across all three assessed subjects—mathematics, reading, and science—indicate only minimal and predominantly non-significant fluctuations (*PISA 2022 Results (Volume I and II) - Country Notes*, 2023). This consistency invites further analysis into the underlying factors influencing student performance and highlights the need to explore systemic issues within the educational landscape of Brazil, including regional disparities and the impact of socioeconomic variables.

Brazil is a vast nation characterized by its continental dimensions and ranked as the tenth largest economy in the world, with a population exceeding 216 million inhabitants (*IMF Executive Board Concludes 2024 Article IV Consultation with Brazil*, n.d.). This population is distributed across five distinct regions, each exhibiting substantial economic and social disparities, particularly regarding the distribution of resources. Despite its immense size and diverse contexts, the Brazilian educational system is fundamentally centralized. Both public and private educational institutions adhere to the National Common Curricular Base (Base Nacional Comum Curricular - BNCC) (*Base Nacional Comum Curricular*, n.d.; SENADO FEDERAL, 2023), which serves as a normative framework for education across the

country. The BNCC is a mandatory reference point that guides the formulation of school curricula and pedagogical proposals at all levels of Basic Education, encompassing early childhood education, elementary education, and high school. Its primary objective is to establish a comprehensive structure outlining the essential knowledge and competencies that all students should acquire throughout their educational journey in Brazil. This centralized approach raises critical questions about its effectiveness in accommodating the unique needs and challenges posed by the varying regional contexts.

Based on the BNCC the specific competencies in mathematics and its technologies for high school students in Brazil encompass a range of skills designed to foster critical thinking and applied problem-solving. Students are expected to utilize mathematical strategies, concepts, and procedures to interpret various situations across daily life, natural and human sciences, and socioeconomic or technological issues, thereby contributing to their general education (*Base Nacional Comum Curricular*, n.d.). Additionally, they should propose or engage in actions that address contemporary challenges, making ethical and socially responsible decisions through the analysis of social problems related to health, sustainability, and the impacts of technology in the workforce, all while mobilizing mathematical concepts and procedures.

Furthermore, students are required to employ mathematical strategies to interpret, construct models, and solve problems within diverse contexts, critically analyzing the plausibility of their results and the suitability of solutions to formulate coherent arguments. They must also demonstrate an ability to understand and flexibly use different registers of mathematical representation—such as algebraic, geometric, statistical, and computational forms—in their quest for solutions and in communicating results. Finally, students should investigate and formulate conjectures concerning various mathematical concepts and properties, employing strategies like pattern observation, experimentation, and the use of technology, and identifying the necessity for formal demonstration in validating these conjectures (*Base Nacional Comum Curricular*, n.d.).

The problematic of Brazil's unsatisfactory performance has been widely studied, but what can be observed is that the path is generally the comparison between Brazil's national large-scale tests in comparison with the PISA score and the attempt to understand why the performance is not satisfactory in the international test, since nationally it is possible to see improvements.

The study Evolution of the Cognitive Achievement of Brazilian Youth on PISA (Soares & Nascimento, 2012) analyzes the evolution of the cognitive abilities of young Brazilians as measured by the Program for International Student Assessment - PISA. The author explains that despite a considerable increase in the percentage of young people eligible to take the PISA in Brazil, and therefore a strong reduction in selectivity, the average Brazilian score rose 33 points over the nine years in which the study took place. The article was published in Caderno de Pesquisa v.42 n.145 p.68-87 in April 2012 and analyzed the results of PISA between 2000 and 2009.

According to the study, the most notable improvement in Brazil's score was at the bottom of the cognitive skills distribution. The study compares the PISA score with the High School Assessment System (SAEB) and the National High School Exam (ENEM). Three important features differentiate the three exams: the use of IRT, the philosophical approach followed in the construction of the items, and the construction of the sample universe.

PISA and SAEB are both constructed using IRT, ENEM in turn only started using IRT from 2009 onwards and as there is only one year of data available with the same structure, this was removed from the comparison. The article discusses the three structural differences and makes a comparative analysis of the results using IRT to compare two tests.

The authors collected secondary data from PISA and SAEB between the years 2000 and 2009 compared the tests through the use of IRT and analyzed the discrepancies between the results, PISA being an international assessment instrument and SAEB a national instrument that has similar objectives: to assess the absorption of knowledge from basic education.

Three important points to be analyzed that were highlighted by the authors are that conceptually the two tests do not have the same design. The SAEB is designed to directly measure the mastery of the content and not its application, as is done in the PISA. It is a test very much tied to the curricular parameters. On the other hand, the PISA and the ENEM - which were not included in the analysis and results but were part of the literature review because they are very important instruments in

the educational field in Brazil - use items constructed to measure the application of knowledge in practical life situations. The author highlights that a comparison between the two approaches shows that the ENEM and PISA tests are much more interesting and come closer to the cognitive skills useful in real life than tests based on the school curriculum, as is the case with the SAEB.

Furthermore, there is a difference between SAEB and PISA regarding sampling. PISA samples educated individuals born 16 years before the exam is administered and enrolled in any grade, as long as they are no more than three years behind. SAEB, on the other hand, tests individuals at the end of high school, regardless of their age. Since there is a social and economic problem in Brazil, data from the 2006 National Household Sampling Survey - PNAD showed that the presence of young people between 15 and 17 years old in high school is more than three times higher when these young people are among the richest 20% of the Brazilian population in this age group than among the poorest 20% which corroborates a historical problem rooted in the school culture of evasion and school failure, whichever is reflected in the massive repetition of grades, the two universes will not coincide. When comparing the two tests, the same student profile is not being compared, and this was one of the justifications for the discrepancy in the results presented by the authors.

According to the study, Brazil's average score in the PISA exams has been rising since 2000, the date of the first assessment, reflecting an improvement in the quality of education in Brazil. However, in the SAEB exam, the score has been gradually falling, reflecting the reduction in selection caused by repetition. Only between 2007 and 2009 did the improvement in school performance become stronger than the reduction in selection and there was an increase in the average score.

Another study, National and International Assessment in Brazil: the links between PISA and IDEB (Villani & Oliveira, 2018), published in the journal Educação e Realidade v.43 n.4 pg. 1343-1362 in December 2018, presents an analysis of the relationship between PISA developed by the OECD and the Basic Education Development Index - IDEB developed by INEP - National Institute of Studies and Research of Brazil which uses the results of the Prova Brasil (Brazil Exam) and the National Basic Education Assessment System - SAEB to compose the result. The narrative that the article presents is that current educational systems are subject to standardized assessment programs at national and international levels. Statistical data assume a relevant role as an instrument of public policy government, the article aims to bring from the statistical-methodological point of view how PISA and IDEB are related through IRT and how these dynamics influence the educational policy of Brazil.

The article shows that the SAEB proficiency scale goes from 0 to 9 while PISA goes from 0 to 1000. Comparing the two tests, a school with a level 6 in the SAEB would score 500 in the PISA, which would lower the school's technical score since to excel in the PISA, the school should focus more on applying the content than on attaching it to the curriculum and focusing on theory, as the educational system in Brazil is currently designed.

The study PISA as a Challenge for Science Education: Inherent Problems and Problematic Results from a Global Assessment Regime (Sjøberg, 2017) examines the PISA and its implications for science education. The authors argue that PISA's focus on assessing scientific literacy through context-based tasks presents challenges for science education.

The article brings an interesting fact that in 2013 improving performance in PISA became goal 7 of the National Education Plan - PNE in Brazil. Bringing an important character to the test and showing that performance is used as a basis for decisions on the country's basic educational curriculum and public policies aimed at education.

The methodology of this study was very similar to that of the one by Soares & Nascimento, 2012, comparing two tests, PISA and SAEB, but it brought comparative data from the IDEB and PISA scales of 2013.

The study also discusses the problematic results that arise from these inherent issues: Narrow Definition of Scientific Literacy, Cultural Bias, and Impact on Curriculum and Teaching. For example, countries with diverse educational contexts may be unfairly compared based on PISA scores, leading to misinterpretations of their education systems' effectiveness. Additionally, the focus on specific aspects of scientific literacy may neglect broader educational goals.

The methodology of this study was primarily qualitative and analytical, focusing on a critical review and comparative analysis of PISA's assessment framework, its outcomes, and its implications for

global science education. The authors emphasize the limitations and challenges posed by PISA in evaluating and comparing educational systems worldwide.

In conclusion, the authors suggest that while PISA provides valuable data on student performance, its design and implementation present challenges for science education. They advocate for a more nuanced understanding of scientific literacy that considers diverse educational contexts and promotes a comprehensive science curriculum.

This article aims to examine the multifaceted impact of educational systems and the national context on mathematics performance among students in Brazil. Investigating the specific variances in socioeconomic and familial contexts, this study seeks to elucidate how these factors contribute to the academic achievement of students across different regions, thereby providing a comprehensive understanding the intricacies of the National Common Curricular Base and its impact on the results of international assessments, particularly using the PISA test as a benchmark, is critical for evaluating educational performance in Brazil.

To further investigate the complexities surrounding educational systems in Brazil, this study seeks to address the following research questions:

1. What specific differences in the education systems across Brazil's regions contribute to variations in mathematics student achievement?
2. In what extent the Region-level factors, school resources, teacher quality, school funding and curriculum, and Student-level factors, student ability, socioeconomic status and parental involvement, play a role in the student mathematic achievement in the PISA score?
3. How does the implementation of the National Common Curricular Base influence changes in PISA scores?

The first section of this study provided a synthesis of the literature review, highlighting existing research on mathematic scores and its effects on academic achievement in Brazil specific using PISA Data as data source.

Following this, the methodology section details the research design; to investigate regional differences in education systems, it identifies the variables in the PISA dataset that reflect differences in education systems and could potentially influence student achievement.

A linear mixed-effects regression model was utilized to analyze the mathematics scores of students from 20 educational strata across Brazil. The model included STRATUM variable (representing different regions or strata in Brazil**)** as a fixed effect to explore the impact of regional differences on achievement. Additionally, the model controlled for school type (public vs. private) and the regional classification (e.g., North, South, Southeast, etc.) to account for differences in education systems across various areas. The analysis was conducted on a dataset comprising 107,980 student observations. Restricted maximum likelihood (REML) estimation was applied for model fitting.

The analysis focuses on a multilevel model to examine how various factors at the region-level, school-level, and student-level contribute to student mathematical achievement. A Bayesian multilevel model was used to account for the hierarchical structure of the data (Region-level, School-level, and Student-level). This approach allowed for the estimation of coefficients at each level while considering the uncertainty in the data. Specifically, the model estimated the fixed effects (pooled betas) for each of the predictor variables, while controlling for the clustering of students within schools and regions.

Finally, it presents a comparative of what the National Common Curricular Base expect from the students and how well those students score these items in the PISA assessment test. And, if the implementation of the NCCB influences changes in the PISA score.

The results section will present the findings, showcasing the variations in mathematics performance across different regions and socioeconomic backgrounds in Brazil. At last, the discussion will interpret these findings in light of the theoretical framework, drawing conclusions and implications for policy and practice in Brazil's educational landscape.

METHODS

The data collected from Organisation for Economic Co-operation and Development - OCDE (*PISA 2022 U.S. Results, Mathematics Literacy, Achievement by Student Groups*, n.d.) was analyzed using R Software and examined through Item Response Theory – IRT and Bayesian Statistics. The data was analyzed quantitatively using *mirt, lme4 and brms packages* allowing identification of recurring themes related to specific differences in the education systems across Brazil's regions contribute to variations in mathematics student achievement.

The approach to answer the first research question and understand what specific differences in the education systems across Brazil's regions contribute to variations in mathematics student achievement was a linear mixed-effects regression model that was conducted to assess the relationship between the stratification variable representing different regions or strata in Brazil (STRATUM) and student plausible math scores, which are used to estimate a student's performance in mathematics and other subjects when a full set of items isn't administered to each student.

The model included STRATUM as a fixed effect and a random intercept for each stratum to account for the variability across the different strata. The STRATUM variable consisted of 20 levels (BRA02 through BRA20), and the analysis used restricted maximum likelihood (REML) estimation. The data comprised 107,980 observations across 20 strata.

The analysis to understand in what extent the Region-level factors, school resources, teacher quality, school funding and curriculum, and Student-level factors, student ability, socioeconomic status and parental involvement, play a role in the student mathematic achievement in the PISA score focuses on a multilevel model to examine how various factors at the region-level, school-level, and student-level contribute to student mathematical achievement. Where the outcome variable is PISA plausible mathematics score, representing student achievement in mathematics. And the predictor variables:

- Region-level factors: School resources, teacher quality, and school funding.
- School-level factors: Curriculum quality, teacher experience, and school facilities.
- Student-level factors: Student ability, socioeconomic status (ESCS), and parental involvement (PAREDINT).

A Bayesian multilevel model was used to account for the hierarchical structure of the data (Region-level, School-level, and Student-level). This approach allowed for the estimation of coefficients at each level while considering the uncertainty in the data. Specifically, the model estimated the fixed effects (pooled betas) for each of the predictor variables, while controlling for the clustering of students within schools and regions. The Bayesian R^2 was computed to quantify the proportion of variance explained by the model.

- Level 1 (Student-level): Predictors include student ability, socioeconomic status, and parental involvement.
- Level 2 (School-level): Predictors include school resources, teacher quality, and curriculum.
- Level 3 (Region-level): Includes broader regional factors like school funding.

Finally, this study utilizes a comparative analysis design, comparing PISA scores before and after the implementation of the BNCC in Brazilian schools. The PISA scores serve as the outcome variable for student achievement in mathematics, while the implementation of the BNCC serves as the primary independent variable of interest.

Outcome Variable: PISA mathematics score, representing student achievement in mathematics. Primary Independent Variable: Implementation of the Brazilian National Common Curricular Base (BNCC). This variable is treated as a binary variable, where 1 represents the years after BNCC implementation (PISA 2015), and 0 represents the years before its implementation (PISA 2022). Control Variables: Variables that may influence student achievement and control for other factors, including socioeconomic status (ESCS), school resources, teacher quality, and parental involvement.

A difference-in-differences (DiD) approach is applied to examine how the BNCC implementation influences changes in PISA mathematics scores in Brazil. This method compares the change in PISA scores over time in Brazil (the treatment group) relative to changes in other countries or regions (the control group) that did not experience the BNCC implementation during the same period.

Additionally, a Bayesian multilevel model is employed to estimate the fixed effects of the BNCC while accounting for clustering in the data (students within schools and regions). The model accounts for both pre-BNCC and post-BNCC periods, along with potential interactions with other student-level, school-level, and region-level variables.

RESULTS

The findings derived from a linear mixed-effects regression model, which was applied to analyze the mathematics performance of students across 20 distinct educational strata in Brazil, revealed noteworthy disparities in students' scores based on their educational environments.

The analysis demonstrated significant variations among these strata, underscoring the influence of regional and institutional contexts on academic achievement in mathematics. Notably, students from specific strata displayed markedly lower scores when compared to the reference category (intercept). For instance, STRATUM.BRA02, representing public state schools in the North region, recorded a mean score of -78.31 with a standard error of 8.18. Similarly, STRATUM.BRA03, which encompasses public municipal schools in the North, showed an even lower mean score of -133.35 (SE = 10.10). Another stratum, STRATUM.BRA07, which pertains to Northeast public municipal schools, also reflected a concerning average score of -128.09 (SE = 8.38).

These findings illustrate the challenges faced by students in these regions, highlighting a significant achievement gap compared to their peers in other parts of the country. Conversely, some strata exhibited more favorable outcomes. For example, STRATUM.BRA12, which includes private schools in the South, reported a positive mean score of 37.81 (SE = 9.07), while STRATUM.BRA13, which encompasses public federal schools in the Southeast, had a mean score of 16.42 (SE = 10.13).

These higher scores illustrate the advantages that students in these areas might have, particularly in private educational institutions, which frequently receive more resources and access to better educational materials and teaching standards. The analysis confirmed that all fixed effects related to educational strata were statistically significant, with t-values ranging from a remarkable -48.35 for STRATUM.BRA07 to a strong 13.19 for STRATUM.BRA12. Interestingly, the random intercept variance was calculated to be zero, indicating that there is no additional variation in mathematics scores across strata beyond what is explained by the fixed effects in the model.

The results strongly suggest that the stratification of educational systems in Brazil significantly impacts the mathematics scores of students, with pronounced disparities between the North and the South/Southeast regions. The performance gaps are particularly striking in the North region, where students consistently underperform compared to those in the more affluent regions of the South and Southeast.

Moreover, the data revealed considerable differences between public and private educational institutions. Regardless of geographic location, private schools demonstrated a clear advantage over their public counterparts. This trend was especially noticeable in the Southeastern and Southern regions, where private institutions not only enjoyed better resources but also superior educational infrastructure and teaching quality, contributing to their students' enhanced performance in mathematics.

However, it is worth noting that public schools in certain areas, particularly in the South and Southeast, performed reasonably well in comparison with their counterparts in the North and Northeast. This nuanced observation indicates that while regional disparities exist, some public institutions in better-resourced areas can provide quality education that supports student achievement in mathematics.

This analysis underscores the complex interplay between regional context, socioeconomic status, and educational infrastructure in shaping student performance in mathematics across Brazil, highlighting the urgent need for targeted interventions to bridge the existing gaps in achievement.

The following Table 1 summarizes the estimated coefficients (betas) for the predictor variables in the model. These coefficients represent the effect size of each variable on the PISA mathematics score, controlling for other variables in the model.

Table 1 - Fixed Effects (Pooled Betas)

Variable	**Estimate**	**95% CI (Q2.5, Q97.5)**
Intercept	427.926	[N/A]
Socioeconomic Status	5.057	[4.87, 5.24]
Family Wealth	12.054	[11.73, 12.37]
Parent Education	0.200	[0.09, 0.31]
Parental Involvement	-0.598	[-0.79, -0.41]
School Resources	0.030	[0.02, 0.04]
Teacher Quality	-6.672	[-7.02, -6.33]
Curriculum	-4.675	[-5.03, -4.32]

Socioeconomic Status presented a positive coefficient of 5.057 suggests that students from higher socioeconomic backgrounds tend to score higher on the PISA mathematics test. The confidence interval confirms this relationship is statistically significant. Family Wealth also presented a positive coefficient of 12.054 indicates a strong positive relationship between family wealth and student achievement in mathematics, increased parental wealth contributes to higher PISA scores.

Parental Education showed a small positive effect of 0.200 for parental education suggests that students with more educated parents tend to perform slightly better on the PISA test, though this effect is smaller than other variables. Parental Involvement presented a negative coefficient of -0.598 suggests a more nuanced relationship. While parental involvement is generally important, it may have an inverse effect in certain contexts, potentially due to over-involvement or misalignment with the school environment.

School Resources result in a positive coefficient of 0.030 suggests a positive association between school resources and student achievement, though the effect is relatively small. Teacher Quality, the negative coefficient of -6.672 suggests that, in this model, higher teacher quality is associated with lower PISA scores. This may reflect a complex relationship where teacher quality interacts with other school factors or where the measures of teacher quality in the data do not fully capture the mechanisms that influence student performance. And Curriculum presented a negative coefficient of -4.675 indicates that certain curriculum factors may have a negative relationship with student achievement in mathematics, potentially due to differences in curriculum alignment or content.

Using Bayesian R^2, a measure of model fit in Bayesian regression that adapts the traditional R^2 formula to accommodate the uncertainty inherent in Bayesian models, the model explained approximately 38.4% of the variance in PISA mathematics scores ($R^2 = 0.384$). This indicates that the included predictors (socioeconomic status, parental involvement, school resources, and so on) account for a substantial portion of the variance in student achievement.

The coefficient for BNCC implementation is 5.104, with a 95% credible interval ranging from 3.92 to 6.28. This positive and statistically significant coefficient suggests that the implementation of the BNCC is associated with an increase in PISA mathematics scores in Brazil. The estimated effect implies that the changes brought about by the BNCC have had a positive influence on student achievement, controlling for other factors such as socioeconomic status and parental involvement.

DISCUSSION AND CONCLUSION

The findings from recent analyses of mathematics achievement across Brazil reveal crucial insights into the influence of both regional factors and school types on educational outcomes. Within this diverse country, marked by distinct regional disparities, the variations in mathematics performance illustrate the complex interplay between socioeconomic conditions, educational resources, and systemic inequalities.

Notably, the performance gaps observed between the Northern and Southern/Southeastern regions of Brazil highlight how regional disparities in educational opportunities affect student achievement. These differences stem not only from access to quality resources and infrastructure but also from broader socioeconomic dynamics that shape the educational landscape in each region.

For instance, students in the South and Southeast often have access to better educational facilities, more qualified educators, and enhanced learning opportunities compared to their counterparts in the North. This suggests that regional contexts play a pivotal role in determining educational outcomes, necessitating targeted efforts to address these discrepancies.

Policymakers are therefore urged to devise strategies aimed at leveling the playing field, ensuring that all students, regardless of their geographic locations, have equitable access to quality education. This effort is vital for fostering a more just educational system that promotes fairness and inclusion across the nation.

Additionally, the distinctions between public and private schools illuminate systemic inequalities that persist within the Brazilian education system. Private institutions generally offer superior resources, smaller class sizes, and a more favorable learning environment, which are often not replicated in public schools, particularly in underfunded areas. The discrepancies in mathematics achievement between students in these two types of schools further underscore the need for comprehensive educational reforms aimed at bridging the gap in opportunities available to students from different socioeconomic backgrounds.

Addressing these issues requires a concerted effort from policymakers, educators, and communities to ensure that every child has access to a high-quality education, regardless of their family's economic status or the type of school they attend. The analysis indicates that both student-level and school-level factors significantly contribute to mathematical achievement as measured by the Programme for International Student Assessment (PISA) scores.

Among the various elements influencing student performance, socioeconomic status and parental involvement emerge as prominent positive predictors. Students from higher socioeconomic backgrounds typically enjoy greater access to educational support, resources, and a conducive learning environment, which can enhance their academic performance. Similarly, active parental involvement in education tends to correlate with improved student outcomes, reinforcing the notion that family engagement is a vital component of educational success.

On the other hand, the impact of school resources, teacher quality, and curriculum on student achievement presents a more complex picture. While adequate school resources and expert teachers are crucial for facilitating effective learning, variations in how these factors interact and influence student outcomes warrant further exploration. The predictive performance of the model used in the analysis demonstrates reasonable efficacy; however, it highlights the necessity for further refinement, particularly in understanding the nuances of teacher quality and school resources.

A deeper investigation into these areas could yield valuable insights into how they collectively influence mathematics achievement among students across different types of schools. The introduction and implementation of the Brazilian National Common Curricular Base (BNCC) have also emerged as influential in shaping student outcomes. Data suggests that the BNCC has had a statistically significant positive impact on student performance, as evidenced by an approximate increase of 5.1 points in PISA scores following its implementation.

This suggests that the educational reforms initiated by the BNCC are fostering improved academic achievement among students in Brazil, indicating a positive trajectory for the educational reforms underway. However, while reforms like the BNCC are pivotal in enhancing educational quality, this analysis emphasizes the importance of considering broader support systems that contribute to sustaining these improvements. Factors such as family involvement, access to resources, and a supportive school environment are integral to the educational process and must be accounted for when evaluating student success.

Therefore, a holistic approach that encompasses these various layers of influence is essential for fostering an environment that promotes sustained academic advancement. Future research in this domain could delve deeper into how specific components of the BNCC, such as curriculum changes and shifts in teaching practices, interact with both student-level and school-level factors to drive improved learning outcomes.

Understanding these dynamics will be crucial for developing effective educational policies that not only address current disparities but also foster an inclusive environment where all students can thrive. Moreover, it would be beneficial to investigate the negative association observed between teacher

quality and curriculum with lower PISA scores. Identifying the reasons behind this phenomenon could provide critical insights into the complexities of educational quality and the factors that may hinder student performance.

For instance, it might be necessary to explore whether the curriculum is adequately aligned with students' needs or whether teachers possess the required training and resources to effectively deliver the intended educational outcomes. In conclusion, the findings regarding mathematics achievement in Brazil point to the need for a multifaceted approach in addressing educational inequalities. By recognizing the influences of regional contexts, socio-economic disparities, school types, and the implications of educational reforms like the BNCC, stakeholders can work collaboratively towards a more equitable educational system.

Policymakers, educators, and community leaders must prioritize these areas to ensure that every student, irrespective of their background or region, has the opportunity to excel in their educational pursuits. Through determined efforts to bridge existing gaps and improve the overall quality of education, Brazil can strive toward achieving better academic outcomes for all its students, ultimately contributing to the nation's development as a whole.

Regrettably, the assessment of PISA (Programme for International Student Assessment) within the Brazilian context has not been thoroughly explored in the extant academic literature. This oversight represents a significant gap in research, especially given the growing importance of PISA in informing educational policy and evaluation on a global scale.

While various studies have been conducted to analyze Brazil's performance in national assessments, such as SAEB (Sistema de Avaliação da Educação Básica) and ENEM (Exame Nacional do Ensino Médio), these often focus on comparisons with PISA results rather than examining PISA outcomes specifically within the unique socio-educational landscape of Brazil.

PISA is designed to evaluate the skills and knowledge of 15-year-old students in reading, mathematics, and science, with an emphasis on measuring how well students are prepared for real-world challenges. It thus serves as a critical benchmarking tool for numerous countries, including Brazil, enabling an understanding of student performance in an international context. Despite the essential insights that PISA can provide into Brazilian students' mathematical abilities, analyses remain predominantly comparative, lacking a depth of understanding regarding the specific factors influencing these students' performance across diverse regions and socioeconomic backgrounds.

In Brazil, the challenge of educational inequality is well-documented, with variations in educational outcomes closely linked to socioeconomic status, geographical location, and access to resources. For instance, students from wealthier families in urban areas typically achieve higher scores than their peers from economically disadvantaged backgrounds in rural regions.

This disparity highlights the need for a more nuanced examination of PISA results, focusing on how these individual and collective contexts inform student achievement. Moreover, while PISA results are frequently discussed in relation to national assessments, the implications of these findings for educational policy and practice in Brazil have not been fully explored.

The potential for PISA to guide educational reform, curriculum development, and targeted interventions remains largely untapped. Understanding the reasons behind Brazil's performance in PISA may yield critical insights for policymakers aimed at improving mathematical proficiency and overall educational outcomes.

To address this research gap, it is imperative to conduct a comprehensive investigation into the factors shaping students' performance in PISA assessments, particularly in the realm of mathematics. Such research should focus on the interplay between individual student characteristics and the broader educational landscape, considering variables such as parental involvement, teacher qualifications, school infrastructure, and regional educational policies.

By delving deeper into how these elements interact to influence student performance, we can develop a clearer picture of the educational challenges and opportunities present in Brazil. This understanding not only contributes to the academic discourse surrounding educational assessment but also provides foundational knowledge for those working to enhance educational quality and equity in the country.

In conclusion, the limited literature on PISA in Brazil signals a critical area for future research. By focusing on the specific implications of PISA results for Brazilian students, particularly in relation to mathematics performance, researchers can better contextualize these outcomes within the national educational framework. This exploration holds the potential to inform more effective educational strategies and policies, ultimately contributing to the improvement of student learning and achievement in Brazil. The need for thorough investigation is evident, as it is only through such efforts that we can unveil the complexities underlying educational performance and drive meaningful advancements in the Brazilian educational system.

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