MATERNAL EDUCATION AND FAMILY INCOME: IMPACTS ON MATHEMATIC PROFICIENCY LEVEL AS MEASURED BY SARESP

ESCOLARIDADE MATERNA E RENDA FAMILIAR: IMPACTOS SOBRE O NÍVEL DE PROFICIÊNCIA EM MATEMÁTICA MEDIDOS A PARTIR DO SARESP

ESCOLARIDAD MATERNA E INGRESOS FAMILIARES: IMPACTOS EN EL NIVEL DE COMPETENCIA EN MATEMÁTICAS MEDIDO DESDE EL SARESP

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ABSTRACT: The present study consists of an analysis of the characteristics of the family environment and its relationship with school performance, using information collected by the School Performance Assessment System of the State of São Paulo (SARESP). The scores selected here are those obtained by students enrolled in the third year of high school in the state public school system of the state of São Paulo. The selected data are related to the discipline of Mathematics. The parental responses from the socioeconomic questionnaire applied by SARESP, referring to the 2019 edition, were also considered. The research observed the variables family income and maternal education level, to verify their impact on the student's performance. The organization of the data, associated with the analysis of the results obtained, allowed us to conclude that these family factors are limiting elements, such as family income in lower ranges, and drivers, revealed by the mother's higher levels of schooling, on educational performance, in addition to acting on the proficiency in Mathematics recorded in the aforementioned evaluation.

KEYWORDS: Mathematics Performance. High school. Socioeconomic factors. Categorical variables. SARESP.

RESUMO: *O presente estudo consiste em uma análise das características do ambiente familiar e sua relação com o desempenho escolar, utilizando informações coletadas pelo Sistema de Avaliação do Rendimento Escolar do Estado de São Paulo (SARESP). As pontuações aqui selecionadas são as obtidas por alunos matriculados no terceiro ano do Ensino Médio da rede pública estadual de ensino do estado de São Paulo. Os dados selecionados são relativos à disciplina de Matemática. As respostas parentais advindas do questionário socioeconômico aplicado pelo SARESP, referente à edição de 2019, também foram consideradas. A pesquisa observou as variáveis renda familiar e nível de instrução materno, para verificar qual o reflexo destas no desempenho do aluno. A organização dos dados, associada à análise dos resultados obtidos, permitiu concluir que esses fatores familiares se revelam elementos limitadores, tal como a renda familiar em faixas inferiores, e impulsionadores, revelados pelos níveis mais altos de escolaridade da mãe, sobre o desempenho educacional, além de atuar sobre a proficiência em Matemática registrada na referida avaliação.*

PALAVRAS-CHAVE: *Desempenho em Matemática. Ensino médio. Fatores socioeconômicos. Variáveis categóricas. SARESP.*

RESUMEN: *El presente estudio consiste en un análisis de las características del ambiente familiar y su relación con el rendimiento escolar, utilizando informaciones recolectadas por el Sistema de Evaluación del Desempeño Escolar del Estado de São Paulo (SARESP). Los puntajes seleccionados aquí son los obtenidos por los alumnos matriculados en el tercer año de la enseñanza media en el sistema de escuelas públicas estatales del estado de São Paulo. Los datos seleccionados están relacionados con la disciplina de las Matemáticas. También se consideraron las respuestas de los padres del cuestionario socioeconómico aplicado por SARESP, referente a la edición 2019. La investigación observó las variables renta familiar y nivel de escolaridad materna, para verificar su impacto en el desempeño del estudiante. La organización de los datos, asociada al análisis de los resultados obtenidos, permitió concluir que estos factores familiares son elementos limitantes, como el ingreso familiar en rangos más bajos, y los impulsores, revelados por los mayores niveles de escolaridad de la madre, sobre el rendimiento educativo, además de actuar sobre el dominio de la Matemática registrado en la evaluación mencionada.*

PALABRAS CLAVE: *Desempeño en Matemáticas. Enseñanza media. Factores socioeconómicos. Variables categóricas. SARESP.*

Introduction

The learning process is long and complex and analyzes of educational systems – which allow us to better understand this process – have been the object of increasing interest in recent decades. The significant increase in the investigation of factors that influence student performance throughout their school career has occurred due to the confirmation that there are clear influences from both the family environment and the school context.

The influence of families, classmates, schools in which they are enrolled and the classes in which they are inserted is proven on the student's academic performance. It can therefore be seen that human, social, cultural, ethical, and methodological aspects, as a whole, provide information that contributes to improving the quality of teaching.

In this sense, as shown by studies by Ferrão *et al.* (2001), Soares (2005), Alves and Soares (2008) and Franco and Menezes-Filho (2012), Moreira, Jacinto and Begolin (2017), the metric of school performance, from the perspective of educational assessment, is a relevant indicator of the effectiveness of the educational system, however, must be associated with aspects that contextualize the student's educational and family environment. As Carmignolli points out *et al.* (2019), school conduct and children's attitudes towards school are defined by the relationship between cultural capital and ethos, since family attitudes are determining factors for the continuation of studies and, consequently, for academic success of children. In recent years, literature, including studies by Soares and Mendonça (2003), Jesus and Laros (2004), Jesus, Laros and Marciano (2010), Moreira, Jacinto and Begolin (2017) and Carmignolli, Muzzeti and Micheleti (2020), progressively reveals empirical evidence that supports the understanding that different factors, which include intra-school and extra-school elements, affect the student's academic performance. In the aforementioned studies, the results show that, due to the direct link between social inequalities and the educational system, it is imperative to contextualize the evaluation of student performance.

With the purpose of contributing to the investigation of the elements that shape academic performance, the present study aims to investigate the relationship between socioeconomic condition and maternal education on the performance in Mathematics of students who, in 2019, were enrolled in the last year of High School in state public schools located in different regions of the state of São Paulo. The methodology adopted is based on generalized linear models – which incorporate categorical variables, using data correlated to the grades obtained in Mathematics assessments. In this study, data collected from the SARESP in 2019 were used. The answers given by the students' parents to questions about family income and maternal

education, contained in the socioeconomic questionnaire applied during the evaluation, are also incorporated into the analysis. The effects of these variables are estimated using parameters in the proposed models, whose values are derived using the RStudio software.

This article is structured into distinct sections. The first section offers a synthesis of the literature related to studies aimed at identifying and understanding the factors, both internal and external to the school environment, that influence student academic performance. The second section provides details about the student's classification in the levels of proficiency in Mathematics, established by SARESP, and the maternal level of education and socioeconomic condition in the student's family environment. Furthermore, this section reports the distribution of students into proficiency categories, based on income stratifications and maternal educational level, all referring to the year 2019. The third section presents the coding of the qualitative variables, for which data were collected, and statistical models designed to measure performance in Mathematics. The estimated values for the parameters of the selected model are commented on in the fourth section and, at the end, the conclusions arising from this research are presented.

Proficiency in Mathematics and family background

The student learning process is long and complex and the analysis of the educational system has received emphasis in studies carried out in recent years. There is a growing interest in investigating the factors that affect student performance as it is proven to be influenced by multiple aspects arising from both the family context and the school context. During the school period, the student receives influences from their family, peers, the school they are enrolled in and the class they are in, which play a relevant role in the individual's teaching and learning process. In this context, it is of interest to investigate the impacts on students' educational performance, not only arising from factors associated with the school environment, but also those inserted in the family environment, such as human and social aspects, cultural and ethical traditions, in addition to methodological concepts that surround them. The studies, from this broader perspective, aim to offer diverse means to promote improvements in the quality of teaching, in addition to the traditional ones focused on conditions relating to the teacher as an individual.

Thus, with the aim of identifying factors, whether of a human, social, cultural or ethical nature, that may influence students' academic performance, studies addressing investigations

into how academic performance affects individuals' future earnings, impact assessments of educational programs and analyzes of determinants of school performance are increasingly frequent in the literature (FERRÃO *et al.,* 2001; RIANI; RIOS-NETO,   2008; MOREIRA; JACINTO; BEGOLIN 2017; CARMIGNOLLI; MUZZETI; MICHELETI, 2020). Such studies aim to propose educational assessment instruments that allow managers and other actors to verify whether schools are adequately facing the challenges of economic transformations and the desires of Brazilian society.

To detect the variables that, in some way, affect the student's academic performance, the educational contexts of which the individual is a part must be considered, with emphasis on the family environment. The quality of the school infrastructure, with regard to, on the one hand, the availability of materials and resources that the school has and, on the other, the qualification of the teaching staff and school management actors – director, coordinator and supervisor, also characterize factors relevant in this investigation. According to the studies by Soares and Mendonça (2003), Soares and Collares (2006), Laros, Marciano and Andrade (2010), Riani and Rios-Neto (2008) and Menezes-Filho (2012), the analysis of the factors that act on student performance requires the inclusion of variables that reflect different educational contexts, given that social disparities have immediate impacts on education (CARMIGNOLLI; MUZZETI; MICHELETI, 2020). Under this situation, as Barbosa and Fernandes (2001) point out, school performance is influenced by what the student brings with them, as well as by what the school offers in terms of teaching, infrastructure and teaching staff.

The variables considered in the present study are interpreted as proposed by Barros *et al.* (2001), which attribute to per capita household income the sum of income received by all members of the household, divided by the total number of components thereof, and treat parents' education as equivalent to the number of complete years of formal education acquired by parents.

The socioeconomic element resulting from this variable, which covers the income and level of education of the parents, is proven to be a preponderant factor. This is because the parents' available financial resources become their children's educational expenses. This relationship is evidenced by observing that a lower level of education tends to lead to a socioeconomic condition of greater vulnerability, in a long-term perspective, as pointed out by Barros *et al*. (2001). When analyzing the fraction of students whose mothers hold an undergraduate degree, as a criterion for higher socioeconomic status among the students assessed, Franco and Menezes-Filho (2012) found the existence of a significantly positive

correlation between this proportion and academic performance. Students from families with greater financial capacity exhibited higher levels of proficiency, thus reflecting the social stratification present in those served by the Brazilian educational system. The relationship with mothers with secondary education, although less pronounced, also pointed to a positive association with school performance.

Among the authors who addressed this topic, Barros *et al.* (2001) argue that the association between the parents' educational level and the student's academic performance is closer when compared to the relationship between income and performance. This observation is justified by the variable nature of income in contrast to the nature of the educational knowledge acquired by parents. Furthermore, the parents' education is the primary factor in determining family income.

Although the father figure plays a significant role in the child's life, the studies by Rios-Neto, César and Riani (2002) and Riani and Rios-Neto (2008), which emphasized the mother's role in the educational performance of their children, served as the basis for this research, given the concentration on information linked to the mother. The authors investigated the determinants of educational results at the Elementary and High School levels, incorporating family aspects, and the results achieved highlighted the notable influence of the mother's level of education on the indicators that portray the students' school characteristics, thus highlighting the existence of a segmentation in the Brazilian educational context, where the student's educational trajectory is closely related to their social origins.

Within the panorama observed by previous studies, the finding stands out that both the family's socioeconomic condition in which the student lives, and the mother's years of completed schooling, among other characteristics, influence the income obtained by the student during the course of basic schooling.

Proficiency in Mathematics: results from SARESP 2019

To achieve the objectives outlined in this study, in addition to the grades obtained in the performance assessments of the 2019 edition of SARESP, the responses of the students' parents, given to questions relating to income and maternal education, were also incorporated into the analysis. The sample used in this research is sourced from Open Education Data[4].

SARESP, established in 1996, is applied at the end of each educational cycle, covering the 5th, 7th and 9th years of Elementary School, in addition to the third year of High School. Such a system comprises fundamental components, which correspond to the applicability of tests covering different subjects, and questions associated with opinion about the school, school life, parental participation, study and reading habits, school climate, and other basic information distributed to students, responsible for students and educational establishments (teachers, coordinators and directors). This questionnaire provides information on individual characteristics, socioeconomic status, academic background, among others.

Performance, as a translation of abilities and skills in relation to the assessed skills, performed by the student, is the core of the result derived from the assessments. This is understood in accordance with the SARESP Reference Matrix for Mathematics Assessment. Based on the learning expectations in relation to content, skills and abilities established for each year or series of the subject in the São Paulo State Curriculum, the points on the SARESP scale are categorized into four levels: Below Basic, Basic, Adequate and Advanced, as shown in Table 1.

The inquiries regarding maternal education, including the question and its alternatives, are shown as documented in Table 2. During the stage of arranging the collected observations, it was decided to eliminate from the prepared sample students whose mothers (or guardians) selected the option (G) in the questionnaire, since this alternative does not allow knowing the educational background of the student's mother.

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[4]The Open Education Data portal, managed by the São Paulo State Department of Education, provides information on educational indicators, schools and enrollments in the State Education Network.

Table 1 – Description of SARESP Mathematics proficiency levels

Proficiency Levels	Score Ranges	Classification	Description
Below basic	Less than 275	Insufficient	Students demonstrate **insufficient mastery** of the content, skills and abilities desirable for the year/grade they are in.
Basic	Equal to or above 275 and below 350	Enough	Students demonstrate **minimal mastery** of content, skills and abilities, but have the necessary structures to interact with the curricular proposal in the subsequent year/grade.
Adequate	Equal to or above 350 and below 400		Students demonstrate **full mastery** of the content, skills and abilities desirable for the year/grade in which they are.
Advanced	Equal to or above 400	Advanced	Students demonstrate **knowledge and mastery** of content, skills and abilities above what is required in the year/grade in which they are.

Source: SARESP Executive Summary (BRASIL, 2019, p. 18)

Although access to goods and services serves as a representative of the economic situation in which the student lives, in this research we chose to use the answer given to the question about family income, presented in Table 3. Students whose parents (or guardians) indicated alternative (H) were excluded from the analyzed sample because they did not allow knowing the student's socioeconomic level.

Table 2 – Question and alternatives associated with the mother's education.

Up to what grade/level of education did the mother (or guardian) study?
(A) Never studied or did not complete the 4th grade/5th year (former primary school).
(B) Completed the 4th grade/5th year, but did not complete the 8th grade/9th year (former high school).
(C) Completed 8th grade/9th year, but did not complete high school (formerly 2nd grade).
(D) Completed high school, but did not complete higher education.
(E) Completed Higher Education.
(F) Completed postgraduate studies (specialization, master's or doctorate).
(G) I don't know.

Source: Adapted from SARESP (BRAZIL, 2019)[5]

Approximately 1,051,000 students enrolled in public state schools in São Paulo participated in the 2019 edition of SARESP. Of this total, 389,660 were attending the third year of high school. Considering proficiency in Mathematics, 76,391 students were excluded from the database prepared for the analysis proposed in this study, who did not take or achieved zero proficiency in the Mathematics test. The sample drawn up included 183,008 students.

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[5]Available at: https://dados.educacao.sp.gov.br/dataset/question%C3%A1rios-saresp/resource/5498cd0b-f1d5-494a-9bc3-5aef5a50ccc1. Accessed on: 10 Mar. 2023

Table 3 – Question about family income.

What is your family income? (Mark only one answer) [6].
(A) Up to one minimum wage (up to R$998.00).   (B) From one to two minimum wages (from R$998.01 to R$1,996.00).   (C) Two to three minimum wages (from R$1,996.01 to R$2,994.00).   (D) Three to five minimum wages (R$2,994.01 to R$4,990.00).   (E) Five to eight minimum wages (R$4,990.01 to R$7,984.00).   (F) From eight to fifteen minimum wages (R$7,984.01 to R$14,970.00).   (G) More than fifteen minimum wages (more than R$14,970.01).   (H) Does not know/does not want to answer.

Source: Adapted from SARESP (BRAZIL, 2019)[7]

Table 1 lists the student's level of proficiency in the Mathematics subject and the mother's level of education. The organization of the data, considering maternal education according to the level of proficiency in Mathematics, reveals that, at all levels, instruction associated with complete high school, presented in option (D), as shown in Table 2, predominates.

Table 1 – Percentage of students, according to maternal education

Proficiency level	A	B	C	D	E	F
Below Basic (AB)	8,801 (4.81%)	18,893 (10.32%)	15,381 (8.40%)	28,729 (15.70%)	8,995 (4.92%)	2,249 (1.23%)
Basic (BA)	6,509 (3.56%)	16,092 (8.79%)	14,802 (8.09%)	35,257 (19.27%)	10,030 (5.48%)	3,013 (1.65%)
Suitable (AD)	689 (0.38%)	1,958 (1.07%)	1984 (1.08%)	5,879 (3.21%)	1,789 (0.98%)	719 (0.39%)
Advanced (AV)	59 (0.03%)	160 (0.09%)	184 (0.10%)	529 (0.29%)	222 (0.12%)	85 (0.05%)

Source: Prepared by the authors

For students classified at the AB level, although the highest percentage is associated with children of mothers with complete EM, equal to 15.7%, the number of mothers who did not complete EF is significant, corresponding to 10.3% of the sample. Approximately 5% of students at this proficiency level have mothers with complete ES. This percentage also represents the number of mothers who never studied or who did not complete the 4th grade/5th year. Of the total 45.38% of students at the AB level, only 6.15% of mothers have completed higher education or postgraduate studies.

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[6]Monthly family income corresponds to the sum of the salaries of all people who work and live in the same household.

[7]Available at: https://dados.educacao.sp.gov.br/dataset/question%C3%A1rios-saresp/resource/5498cd0b-f1d5-494a-9bc3-5aef5a50ccc1. Accessed on: 10 Mar. 2023

When analyzing the percentages associated with students who reached the Basic level of proficiency in Mathematics, mothers with incomplete EF or who studied up to the 9th year of PE total almost 17%, a quantity close to that observed for mothers with complete EF, equal to 19.3%. Mothers with complete ES, whose children belong to the BA level of proficiency, account for almost 5.5%, somewhat higher when compared to the percentage associated with the AB level. At this level of proficiency, Table 1 shows that the percentage of mothers who have never studied or who have not completed the 4th grade/5th year is lower than that observed for students classified at level AB, that is, who do not have a minimum mastery of the skills and competencies of the series in which they are found.

Among students who reached the AD level, approximately 1% are children of mothers with completed higher education and, at the other end, 0.38% of mothers did not complete the 4th grade/5th year. It is observed that this percentage is similar to that observed for mothers who have completed postgraduate studies, which allows us to conclude that, of the total of 7.11% of students at this level, while 4.29% have mothers with complete EF or EM, the remainder is divided into the lowest education levels, with 1.45% having incomplete PE and 1.37% having completed postgraduate studies. Still in Table 1, the percentages show that, of the total 0.68% of students at the AV level of proficiency, only 0.22% of mothers have less than complete EM education. The remaining 0.46% are distributed across EM, ES and completed postgraduate courses.

The values presented in Table 1 allow us to conclude that, the better the student's classification in proficiency levels, the greater the number of years of study of mothers, since, as one progresses from level AB to AV, they decrease the percentages of mothers who never studied or did not complete the 4th grade/5th year, who did not complete the 8th grade/9th year and who have incomplete EM.

The percentages of students, classified according to the level of proficiency obtained in the 2019 SARESP, are organized in Table 2, considering the family's salary income range, informed through the answer given to the question shown in Table 3.

Camila Fernanda BASSETTO; Driely Turi URSINI and Alvaro Martim GUEDES

Table 2 – Percentage of students in family income ranges (in minimum wages [SM or MW]).

Proficiency level	A	B	C	D	E	F	G
Below Basic (AB)	19,093 (10.43%)	30,278 (16.54%)	18,600 (10.16%)	10,546 (5.76%)	3,343 (1.83%)	875 (0.48%)	309 (0.17%)
Basic (BA)	12,175 (6.65%)	29,525 (16.13%)	21,991 (12.02%)	15,455 (8.44%)	4,950 (2.70%)	1,301 (0.71%)	306 (0.17%)
Suitable (AD)	1,112 (0.61%)	3,766 (2.06%)	3,556 (1.94%)	3,114 (1.70%)	1,102 (0.60%)	316 (0.17%)	52 (0.03%)
Advanced (AV)	94 (0.05%)	325 (0.18%)	313 (0.17%)	322 (0.18%)	138 (0.08%)	44 (0.02%)	3 (0.00%)

Source: Prepared by the authors

These values suggest that the family income of approximately 16.5% of students who participated in the 2019 SARESP, and who classified themselves at the AB level, is concentrated in the range between 1 and 2 MW, that is, they receive R$998.01 to R$ 1,996.00, followed by 10.43% with income of up to 1 SM and 10.2% with income between 2 and 3 SM, which is equivalent to R$ 1,996.01 and R$ 2,994.00. These data show that, in this group, almost 27% have a maximum family income of two minimum wages, suggesting a possible relationship between lower incomes and a lower level of proficiency.

For students at this proficiency level, less than 6% of parents reported having an income of 3 to 5 SM. For students classified at the BA level, family income of 1 to 2 MW prevails, with 16% of families, followed by 12% with income corresponding to the range of values between R$1,996.01 and R$2,994.00. Compared to AB level students, the percentage of families with incomes between 3 and 5 MW is higher and close to 8.5%. At the AD level, percentages close to 2% were observed for incomes between 1 and 2 SM and between 2 and 3 SM, and for students classified at the AV level of proficiency in Mathematics, similar percentages were observed for alternatives (B), (C) and (D), which represent, respectively, the income ranges of 1 to 2 SM, 2 to 3 SM and 3 to 5 SM.

According to the organization of the data shown in Table 2, there is evidence that families with an income of up to one salary, one to two salaries or two to three salaries have a greater chance of having their child or family member at the proficiency level AB or BA.

Models and results

In order to estimate the influence that aspects related to the family environment have on the student's educational performance, linear regression models were structured assuming proficiency in Mathematics as the response variable, which was named Profic_mat, and family income and level of education, represented by Income and Esc_mae, respectively, acted as covariates.

The linear models considered to estimate the impact of family income and maternal education on student performance are given in equations (1), (2) and (3).

Model 1: $Profic_{mat} = \beta_0 + \beta_1 Renda_{familiar} + \varepsilon_i$ (1)

Model 2: $Profic_{mat} = \beta_0 + \beta_1 Esc_{mae} + \varepsilon_i$ (2)

Model 3: $Profic_{mat} = \beta_0 + \beta_1 Renda_{familiar} + \beta_2 Esc_{mae} + \varepsilon_i$ (3)

Model 1 includes only one covariate, represented by family income, to measure the impact of the family context on the student's Mathematics proficiency. In this model, the estimated value for the intercept, represented by β_0, indicates the proficiency in Mathematics achieved by the student whose family income is concentrated in the lowest salary range, that is, below R\$998.00. Similarly, Model 2 proposes, as the only covariate, the mother's education, in which the estimated value of the intercept β_0 associates the student's proficiency with mothers who have never studied or who have not completed the 4th grade/5th year of Elementary School.

Model 3 includes both covariates, Income and Esc_mother, with the aim of estimating the role of family characteristics on the student's academic performance. In this model, the parameter estimate β_0 informs the proficiency in Mathematics achieved in the 2019 edition of SARESP by the student who lives under more precarious conditions – with a family income of less than R\$998.00 – compared to others, and who are children of mothers who have never studied or did not complete the 4th grade/5th year of Elementary School.

In Models 1, 2 and 3, the estimated values for the parameters represented by β_1 and β_2 inform the performance of the covariates Income and Esc_mae, in that order, on the proficiency in Mathematics of students enrolled in the third year of high school in state schools in São Paulo. To allow both the response variable and the covariates to vary per student, the subscript

i was inserted, with $i = 1,...N$ N being the number of students contained in the sample prepared to carry out the present empirical study. The other covariates that could explain the student's performance and that are not present in the statistical model are contained in the error term represented by ε_i.

As shown in Tables 2 and 3, the questions regarding the mother's level of education and the student's socioeconomic condition are structured into alternatives, characterizing the variables as qualitative. Because of this, to insert them into the proposed model, it is necessary to categorize them, establishing, as a basis for comparison with the estimates obtained for the others, one of the available alternatives. For the question regarding the mother's education, Table 2 indicates six available alternatives for answers. Therefore, five categories must be established for this variable. Taking alternative (A) as a basis for comparison, which indicates that the student's mother never studied, the others are considered as shown in expression (4).

$$Esc_{mae} = \begin{cases} 1, para\ m\tilde{a}es\ com\ EF\ incompleto \\ 2, para\ m\tilde{a}es\ com\ EF\ completo \\ 3, para\ m\tilde{a}es\ com\ EM\ completo \\ 4, para\ m\tilde{a}es\ com\ ES\ incompleto \\ 5, para\ m\tilde{a}es\ com\ ES\ completo \end{cases} \qquad (4)$$

In expression (4), EF, EM and ES represent, in this order, Elementary Education, Secondary Education and Higher Education.

A similar procedure is followed for the variable that represents the student's socioeconomic condition. According to Table 3, there are seven alternatives that represent family income, established in amounts of minimum wages (SM). Therefore, it is necessary to define six alternatives, which will have the estimates obtained compared to the base response. Assuming alternative (A) as the base income range, that is, considering income below R\$998.00 as a reference point in comparison with the others, the categories are presented as in expression (5).

$$Renda = \begin{cases} 1, para\ renda\ maior\ ou\ igual\ a\ 1\ SM\ e\ inferior\ a\ 3\ SM \\ 2, para\ renda\ maior\ ou\ igual\ a\ 3\ SM\ e\ inferior\ a\ 5\ SM \\ 3, para\ renda\ maior\ ou\ igual\ a\ 5\ SM\ e\ inferior\ a\ 8\ SM \\ 4, para\ renda\ maior\ ou\ igual\ a\ 8\ SM\ e\ inferior\ a\ 15\ SM \\ 5, para\ renda\ familiar\ maior\ ou\ superior\ a\ 15\ SM \end{cases} \qquad (5)$$

Akaike (AIC) information criteria were used to select the model best suited to the data. While the BIC, proposed by Schwarz (1978), is a criterion based on the evaluation of models

defined in terms of posterior probability, the AIC evaluates the quality of adjustment of the parametric model, estimated by the maximum likelihood method (BOZDOGAN, 2000).

The RStudio software [8]was used to estimate the parameters of Models (1), (2) and (3). At the same time, the BIC and AIC values associated with each model were calculated. These values are shown in Table 3. Although there is little difference in the BIC and AIC values, when comparing the three models, it is observed that the lowest ones are associated with model 3. According to these selection criteria, the most appropriate to the sample considered in this research is model 3. The estimates, together with the standard errors, in parentheses, obtained in the RStudio software, for models 1, 2 and 3, are shown in Table 3, however, the interpretations presented below refer only to model 3, which was selected based on the BIC and AIC values.

The estimates obtained for the parameters β_{11}, β_{12}, β_{13} β_{14} and β_{15} show that the proficiency in Mathematics of students with family incomes allocated in the ranges of 1 to 3 SM, 3 to 5 SM, 5 to 8 SM, 8 to 15 SM and above 15 SM, will be higher than the student's proficiency who lives on the lowest family income, that is, up to 1 MW. This statement is based on the values, positive and significant at 1%, estimated for the parameters associated with that variable. According to estimates, as family income increases, student performance also improves, achieved in SARESP 2019. While students who belong to an income range of 1 to 3 MW have an increase of 13.3 points in proficiency in Mathematics, compared to that of the student whose income is less than 1 SM, for students with family incomes between 3 and 5 SM, the increase is 23 points. This score continues to increase for students with incomes between 5 and 8 MW and between 8 and 15 MW. Income above 15 MW generates increases of approximately 13.7 points in proficiency in Mathematics.

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[8] RStudio is an open source integrated development platform for the R programming language, widely used in statistical analysis and graph generation. More information can be found at https://posit.co/products/open-source/rstudio/.

Table 3 – Estimates obtained for the parameters of the proposed models.

Parameters	Model 1	Model 2	Model 3
β_0	270.9889 (0.4057)	275.5680 (0.5555)	265.3484 (0.6296)
β_{11}	14.7968*** (0.4565)		13.3121*** (0.4601)
β_{12}	25.5683*** (0.5639)		23.0481*** (0.5758)
β_{13}	28.5450*** (0.7955)		25.5593*** (0.8122)
β_{14}	31.2807*** (1.3975)		27.9927*** (1.4117)
β_{15}	16.8083*** (2.9059)		13.6979*** (2.9059)
β_{21}		4.4767*** (0.6657)	2.8678*** (0.6589)
β_{22}		8.3169*** (0.6807)	5.5089*** (0.6758)
β_{23}		15.4312*** (0.6128)	11.1167*** (0.6134)
β_{24}		13.8891*** (0.7378)	11.5421*** (0.7429)
β_{25}		20.8859*** (1.0477)	7.6213*** (1.0625)
AIC	844,741.6	843,346.0	842,791.4
BIC	844,806.7	843,411.1	842,902.9

Source: Prepared by the authors

The symbols ***, ** and * indicate, respectively, significance levels of 1%, 5% and 10% of the estimates

Additionally, the analysis of the values contained in Table 3 shows that maternal education is a relevant factor in the student's proficiency in Mathematics. This relevance is observed from the estimates, positive and significant at the 1% level, obtained in the RStudio software, for the parameters β_{21}, β_{22}, β_{23}, β_{24} and β_{25}, which are associated with this variable. It is observed that, until completing Higher Education, maternal education and proficiency level show a pattern of growth, that is, children of mothers with higher levels of education achieve better results in Mathematics.

The analysis of the estimates obtained for the parameters of the model proposed in expression (3) allows us to conclude that the family context, in which the student is inserted, consists of factors that impact academic performance, given the significance of the variables considered in the present study, that is, family income and the mother's level of education.

It was possible to observe that family income, measured in the amount of minimum wages received by everyone living in the same house, has an influence on the student's proficiency in Mathematics, which increases up to the limit of 15 MW. In the same direction, the level of maternal education acts, demonstrating that children of mothers with more years of study achieved better educational performances. The results obtained corroborate those of Riani and Rios-Neto (2008) and Franco and Menezes-Filho (2012), who investigated the role of

maternal education on the child's academic performance and concluded that higher levels of education have a positive impact on student results.

When considering the variables family income and maternal education level in the analysis of factors that impact an individual's academic performance, the results showed the presence of an educational segmentation in Brazil, since the student's academic path is closely linked to their social origin. In the public policy scenario, it is essential to identify which factors mitigate the influence of the student's social origin, aiming to make the system more equitable.

Conclusion

In summary, this work aimed to verify whether factors associated with the student's socioeconomic condition and maternal education generate impacts on Mathematics performance, obtained at SARESP, of students who are attending the last year of high school, in public state schools located in the regions of the state of São Paulo. In order to achieve this purpose, a methodology was used based on generalized linear models that add categorical variables, applying data correlated to the grades obtained in Mathematics assessments at SARESP in 2019. Data obtained through socioeconomic questionnaire.

Considering the model selected by the BIC and AIC criteria, the parameters associated with the variables in question were estimated using the RStudio software. According to the values obtained, it was possible to observe that both family income and the mother's education play a significant role in the results achieved by students in Mathematics proficiency, as shown in the numbers released by SARESP in 2019. Estimates suggest that family income has an increasing impact on student performance, as socioeconomic status reaches higher levels, measured in amounts of minimum wages. However, this growth is observed up to income of 15 MW. The impact of maternal education on student performance showed similar behavior to that observed for income, as shown by the estimates of the parameters associated with this variable. The estimated values show that children of mothers with higher levels of education achieve better results when assessed in Mathematics.

The results obtained in the present study follow the same direction as the conclusions of Soares (2003), Soares and Mendonça (2003), Alves and Soares (2008), Riani and Rios-Neto (2008) and Franco and Menezes-Filho (2012). In their studies, these authors were able to verify that, while students who live in family environments with more favorable financial conditions have better academic performances, those surrounded by precarious conditions, characterized

by the low amount of minimum wages received by the family, have learning difficulties, which which results in worse educational results. Additionally, the conclusion of this research corroborates Carmignolli 's study *et al.* (2019), who state that individuals from less privileged class groups do not have the same cultural capital as other individuals for a successful schooling process, as academic success is directly linked to the cultural capital acquired in the family environment.

It is important to highlight the fundamental role of public policies for evaluating education as a way of portraying the diversity found in schools in the most varied places in Brazil. SARESP, in particular, brings valuable knowledge about the State of São Paulo, in addition to helping in the construction of other important educational indices, such as IDESP – Education Development Index of the State of São Paulo.

It concludes on the importance of assessment systems, represented in this work by SARESP, as a tool that allows a more accurate assessment of the quality of education offered in the state education network and, concomitantly, of the elements linked to this quality.

Through the questionnaires and problems created, it is possible to categorize students and understand with greater clarity and reliability what is going on, not only the education system, but also the reality of the families with which we are working. The results found in the analyzes corroborate the theory developed by the aforementioned authors. According to the research carried out, family income and the mother's level of education are important, although not the only, motivations for success or failure in the individual's pursuit of quality education.

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