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School Segregation and Education Inequalities at the Start of Schooling in Brazil

Segregação Escolar e Desigualdades Educacionais no Início da Escolarização no Brasil

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The paper describes patterns of school segregation at the start of the formal schooling in the city of Rio de Janeiro, Brazil, and estimates the compositional effect (school mix-effect) on children's learning in the first two years at school. This is an important phenomenon to analyze the process of distributing educational opportunities in public and private schools. The concept of school segregation used in this paper refers to the unequal distribution of students who share specific characteristics within a group of public schools. The study uses the Segregation Index for two characteristics of disadvantaged: 1) color/race; 2) parents' education. The effect of social composition was estimated with data from a longitudinal study and analyzed separately the compositional effect for the first and second years at school. Preliminary results suggest that the patterns of school segregation observed in preschool are similar to those described in the first year of elementary school. There is, therefore, no major impact on segregation patterns in the transition between teaching stages. The models for estimating the effect of the compositional effect on student learning suggest that there is an effect, with more consistent results for the measurement of language.

Keywords: School segregation; School inequality; Compositional effect; Longitudinal Study; Preschool.

O artigo descreve padrões de segregação escolar no início do processo formal de escolarização na cidade do Rio de Janeiro, Brasil, e estima o efeito da segregação escolar (efeito par ou efeito mistura/*compositional effect*) no aprendizado das crianças nos dois primeiros anos na escola. Este é um fenômeno importante para analisar o processo de distribuição de oportunidades educacionais nas redes públicas e privadas de ensino. O conceito de segregação escolar utilizado neste artigo se refere à distribuição desigual de alunos que partilham de uma característica específica em um agrupamento de escolas. O estudo utiliza o Índice de Segregação (Segregation Index) e considera duas características dos alunos: 1) cor/raça; 2) escolaridade dos pais. O efeito da composição social foi estimado com dados de um estudo longitudinal e analisa separadamente o aprendizado no primeiro e segundo ano na escola. Os resultados preliminares sugerem que os padrões de segregação escolar observados na pré-escola são semelhantes aos descritos no primeiro ano do ensino fundamental. Não há, portanto, grande impacto nos padrões de segregação na transição entre as etapas de ensino. Os modelos para estimar o efeito da composição social das escolas (*compositional effect*) no aprendizado dos alunos sugerem que há efeito, com resultados mais consistentes para a medida de linguagem.

Palavras-chave: Segregação escolar; Desigualdades educacionais; Efeito par; Estudo Longitudinal; Pré-escola.

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1. Introduction

This paper describes patterns of school segregation at the start of compulsory education in the city of Rio de Janeiro, Brazil, and estimates the potential effect of school segregation (compositional effect) on children's learning in their first two years at school[1]. Previous studies conducted in Brazil have shown that school segregation is a relevant phenomenon for understanding the distribution of educational opportunities in public and private education systems (Bartholo & Costa, 2018, 2016; Mendes, 2017).

This topic is not new and has already been investigated using secondary data in the city of Rio de Janeiro and other cities in Brazil (Bartholo & Costa, 2016; Bruel & Bartholo, 2012; Carvalho Filho, 2016). However, this work addresses two new dimensions: 1) the use of indicators of school segregation to describe the distribution of students in preschool (four and five years old)– became part of the compulsory education since 2009; and 2) the effect of school segregation on students' learning in their first two years at school, analyzed using longitudinal data.

In this paper, the concept of school segregation refers to an unequal distribution of students who share a specific characteristic in a group of schools. The phenomenon was analyzed based on Gorard's Segregation Index (GS) (Gorard, Taylor, & Fitz, 2003), which was used mainly because it is an index appropriate for longitudinal analyses (Murillo, 2016). The concept of segregation should not be interpreted as a synonym for discrimination or injustice. In fact, in view of the strategy adopted to measure the phenomenon, segregation is almost inevitable. The debate on school segregation is closely linked to the issue of the distribution of educational opportunities and, more broadly, social justice (Rawls, 1971). It is a universal phenomenon that is associated with residential segregation, parental choice, and educational policies. Other factors associated with social inequality and social, economic, and cultural isolation partially explain the variation observed in the phenomenon (Harris, 2012).

It is possible to divide studies on school segregation into two groups. The first seeks to describe the patterns of school segregation and to identify factors associated with this phenomenon. Studies in the field of education focus mainly on public policies that can impact the allocation of students in schools. One example is the policy of school choice, which has been analyzed in several studies alongside an intense discussion of its effects on patterns of school segregation in different countries (Goldhaber, 1995; Gorard, Taylor, & Fitz, 2003; Santos & Elacqa, 2016).

The second group analyses the impacts of segregation on students' educational trajectories and/or results. Studies conducted in different countries suggest different effects. On the one hand, it is possible to argue that clustering students with similar characteristics (for example, students with learning difficulties) can be effective when the intention is to implement policies aimed at helping such groups. On the other hand, evidence suggests that clustering potentially disadvantaged students (for example, poor students or those with learning difficulties) can influence the way they are treated at

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school, their educational aspirations, or the quality of the teaching. More segregated educational systems or policies that intentionally group students with similar characteristics show a greater association between the socioeconomic level of families and the students' learning levels (Haahr et al., 2005; Jenks et al., 1972; Quiroz, Dari, & Cervini, 2020).

The paper is divided into five parts including the introduction. The second part reviews the main findings of Brazilian studies on the patterns of school segregation in the public and private systems and their effects on students' school results. The third part describes the databases used in the analyses and the proposed models for analysis. The fourth part presents the main findings of the study and establishes a dialogue with previous studies conducted in Brazil and other countries in Latin America. Finally, the fifth part presents preliminary conclusions and discusses gaps and ideas for future analyses.

2. School segregation in Brazil: What do we already know?

In Brazil, studies that describe patterns of school segregation and identify factors that explain the phenomenon mainly focused on public schools (Bartholo, 2013; Bruel & Bartholo, 2012; Carvalho & Koslinski, 2015; Érnica & Batista, 2012; Mendes, 2017). We identified a single study that used population data and measured school segregation by incorporating data from the public and private systems in four capitals in Brazil, namely, Rio de Janeiro, São Paulo, Belo Horizonte, and Curitiba (Bartholo & Costa, 2018).

The elements of school segregation that are studied in Brazil can be grouped into the following categories: a) Stratification between public and private systems; b) enrollment rules for the allocation of students in the public system; c) family strategies for school choice; d) patterns of residential segregation and their relationship to school segregation; e) the movement of students between schools; f) allocation in school shifts; and g) the effect of the social composition of schools on student learning. We will explain each of these seven points in detail.

In Brazil, the proportion of students enrolled in the private school system is substantially higher than that observed in the US and most European countries. The proportion of students in fundamental education (aged 6 to 14) enrolled in the private system increased from 13% to approximately 16% between 2010 and 2014. Between 2015 and 2019, the number remained almost stable, reaching 17%. However, when we analyze the data broken down by different cities, it is possible to observe a great variation. In the city of Rio de Janeiro, the proportion of enrollments in the private system increased from 29% in 2010 to 33% in 2014, and remained virtually stable until 2019. In the city of Fortaleza, the capital of the State of Ceará, the numbers are even higher, representing 36% of enrollments in 2010 and 44% in 2014, followed by a slight decrease in 2019 to 42%.

This context creates a dilemma for researchers interested in the topic of school segregation. When working only with public data, the phenomenon of school segregation is necessarily underestimated. This is because the allocation of families between public and private schools is not random and is strongly marked by the socioeconomic profile of families who can afford private school tuition.

Using data on the entire population of students, Bartholo & Costa (2018) measured the effect of including enrollments in the private system on the segregation levels measured over 10 years (2007 to 2016). The data showed an important increase in the levels of school segregation observed in four cities in Brazil. For example, in the city of Rio de Janeiro, the data showed a leap in the calculation of the GS from 15% to 25% when data on black students from the private system were incorporated.

Studies on the impact of enrollment rules have already been conducted in many different countries, including Brazil. Enrollment rules may or may not allow parents to choose which school their child will be enrolled in. Evidence from around the world shows mixed results on this topic. For example, Gorard, Taylor, & Fitz (2003) conducted transversal monitoring over 20 years, calculating the levels of school segregation in the English education system and suggested that the implementation of parental policies (school choice) is associated with a decrease in levels of school segregation. However, a study conducted in Chile observed an increase in school segregation, in addition to residential segregation, as a result of the adoption of a voucher policy. This could be explained by the loose regulation of the Chilean school quasi-market; that is, by the interaction between parents' choice and the barriers imposed by the collection of fees and selective admission processes (Santos & Elacqua, 2016).

Another group of studies conducted in several countries (especially in North America) investigated the association between patterns of residential or socio-spatial segregation and school segregation (Denton, 1995; Frankenberg, 2013; Santos & Elacqua, 2016). However, in Brazil, this relationship was treated only indirectly. For example, some studies aimed at analyzing the relationship between residential segregation and school results suggested that, in addition to the influence of socialization mechanisms in the neighborhood, there was an effect of socio-spatial segregation on school supplies (unequal distribution of school supplies, the student composition, and teacher-student relationships in poorer areas) (Koslinski, Alves, & Lange, 2013). Other studies analyzed the relationship between socio-spatial segregation and the possibility of choosing and moving between more or less prestigious public schools, which in turn impacts school segregation (Koslinski et al., 2014).

The unfettered movement of students between schools was also analyzed by researchers from different countries. The findings suggested that the movements are not random. On the one hand, there are different perceptions of those responsible for the quality of schools and different strategies for obtaining a place in schools with a better reputation. On the other hand, schools can be agents that maximize student movement by suggesting student exchange, imposing barriers to the entry of students with a certain profile, or making students fail, which can lead to them moving from one school to another (Noreisch, 2007; West, Hind, & Pennell, 2004; Zanten, 2005).

When analyzing unregulated student movements, Saporito (2003), Bruel & Bartholo (2012), Bartholo (2014), and Koslinski and others (2014) suggested that the transfer of students from one school to another in the same education system is not random and can increase the levels of school segregation. In the case of some education systems in Brazil, the absence of clear rules and the lack of transparency from public managers may give rise to procedures provided for in the law, such as informal interviews with parents or guardians and the selection of students based on their academic performance in previous years (Alves et al., 2015; Koslinski & Carvalho, 2015; Rosistolato et al., 2019).

The last topic studied in the city of Rio de Janeiro, which is possibly present in other education systems in developing countries, is the non-random allocation of students between school shifts (Bartholo & Costa, 2014). Until 2014, 90% of schools had two teaching shifts: morning and afternoon. In this context, students are allocated by the school management to one of the shifts and attend school in the morning or afternoon. This pattern of school organization is the result of a system with a high demand for basic education and with a limited number of buildings/infrastructures to meet the demand. Some authors compared school segregation when students are allocated in shifts and when they are not. The allocation of students in shifts significantly increased the level of segregation in the system, suggesting non-random allocation (Bartholo & Costa, 2014).

However, a few other studies sought to estimate the impacts of segregation on students' school performance or trajectories. This is a topic widely explored in international studies and still incipient in Brazil. Harker & Tymms (2004) conducted an important review on the subject, especially on the methodological difficulties in measuring the compositional effect and how to interpret the results. According to the authors, this would be the specific effect of a single variable aggregated at the school level on a school result variable, in addition to the contribution of this variable at the individual level. As students are not randomly distributed among schools, we can expect schools with a greater or lesser concentration of students in situations of vulnerability and/or with greater or lesser motivation toward school performance/results. However, the authors argued that the compositional effect is not necessarily limited to interactions between peers and may reflect interactions between the composition of the students and the teachers' actions, school climate, parental involvement, teachers' commitment, and others. That is, students react to school structures/processes and to their peers, and schools react to the composition of the students.

In Brazil, we highlight the studies by Marino (2014), Castro (2016), and Bartholo & Costa (2016) that used longitudinal data to estimate the compositional effect in the city of Rio de Janeiro of different cohorts and ages that vary in fundamental education. The results were mixed but suggested the existence of a compositional effect considering key variables such as poverty and ethnicity/race. The main limitation of the studies was the use of measures obtained via external evaluation that had a large measurement error at the individual level and a high percentage of missing data.

The aforementioned studies conducted in Brazil described the phenomenon of school segregation and attempted to identify factors associated with the observed variation. However, the data used referred to fundamental education (children between 6 and 14 years old). The present study analyses a different stage of schooling: preschool education (children between 4 and 5 years old). This stage became part of compulsory education in 2009 for all States in Brazil and universal access to preschool was scheduled for 2016, according to the current National Education Plan-*Plano Nacional de Educação* (Law 13.005/2014).

3. Design and methods

The paper presents two separate analysis: the first sought to observe patterns of school segregation in preschools and in the first year of fundamental education in public

schools in the municipal system of Rio de Janeiro. The second part aimed at understanding the student composition effect on learning during preschool. To this end, the two parts used different databases and analysis models.

We used databases from the Academic Management System (*Sistema de Gestão Acadêmica*; SGA) of the public municipal education system in Rio de Janeiro to identify patterns of school segregation. The databases of this system allow the identification of the school in which the students are enrolled and some sociodemographic characteristics such as gender, ethnicity, access to cash transfer programs, and parents' education. The organization of the databases allows the calculation of school segregation in preschools between the years 2006 and 2013. School segregation was calculated for two groups of students: a) preschool students (4/5 years old) and b) students in the first year of fundamental education (6/7 years old). The aim of this design was to compare the segregation patterns observed in preschools with those in the first year of fundamental education to reveal similarities and differences in this transition.

It was not possible to calculate segregation indicators for students enrolled in preschools for subsequent years due to a limitation in the database used. The authors intend to update the segregation indicators in a future study. The calculation of school segregation for students enrolled in fundamental school has already been conducted up to 2016 (Bartholo & Costa, 2018). For the calculation of school segregation, we used the GS (Gorard, Taylor, & Fitz, 2003), an indicator that represents what Gorard & Taylor (2002) called a strong compositional invariance, comparing it with another indicator widely used in educational research, the Dissimilarity Index (Duncan, 1955). Moreover, in a thorough comparison between Duncan's Dissimilarity Index, the GS, and the Square Root Index (Hutchens, 2004), Murillo (2016) argues that the GS allows the comparison of school segregation among different groups, being an indicator that stands out from the other two in the longitudinal analysis of the evolution of segregation in a system, which is a prominent feature of the present study.

The GS is represented by the following equation: $GS = 0.5 * \{\sum|Fi / F - Ti / T|\}$

Where:

Fi is the number of potentially disadvantaged students in school "i," and "i" ranges from 1 to the total number of schools investigated;

F is the total number of potentially disadvantaged students from the same set of schools;

Ti is the number of students in school "i," and "i" ranges from 1 to the total number of schools investigated; and

T is the total number of students in schools in the same set of schools (Gorard, Taylor, & Fitz, 2003).

The GS was calculated considering two potential disadvantages: a) parent education and b) ethnicity/race. Parent education was coded with two distinct cutoff points. The first considered parents who had not completed fundamental education (EducF) as a potential disadvantage and the second considered parents who had not completed secondary education (EducS). Parental education is probably one of the best predictors of a child's school trajectory, except for direct measures of student proficiency (Gorard

and See, 2013). Ethnicity/race was coded as a potential disadvantage for black students[2]. In Brazil, several studies in the fields of education, economics, and sociology used ethnicity/race to understand social inequalities associated not only with educational opportunities but also with income, access to the labor market, exposure to violence, etc.

However, the ethnicity variable used in the databases had some limitations. First, more data were missing on the ethnicity of children enrolled in preschool than on children enrolled in fundamental education, representing 17.4% and 4% of cases, respectively. Moreover, ethnicity in Brazil is usually obtained by self-declaration, which represents a limitation given the age range of the children/students analyzed here[3]. The information from the school records was obtained from the parents/guardians of the children, but in some cases, the school's administrative employees entered the information into the system based on their perceptions (hetero-attribution), possibly going against the parents' perceptions.

The second part of the analysis, which sought to identify the effect of student composition on learning during the two years of preschool, used the databases of a longitudinal study that collected data during March 2017 and December 2018 with children enrolled in the municipal system of Rio de Janeiro. This study selected a random probabilistic sample from 46 schools, composed of approximately 2,700 children that were stratified by area and type of school supply. The longitudinal study included three waves of data collection on children: two collections in 2017, at the beginning and end of the school year, at four/five years of age, and one collection at the end of the 2018 school year, at five/six years. For more details on the sample, see Bartholo and others (2019, 2020). The figure below illustrates the design of the longitudinal study.

In waves 2 and 3, children who joined any investigated school during preschool were included. The students' cognitive development was estimated at each wave of the study, using an adapted version of the Performance Indicators in Primary Schools (PIPS) instrument, a tool developed by researchers at Durham University in England (Tymms, 1999).

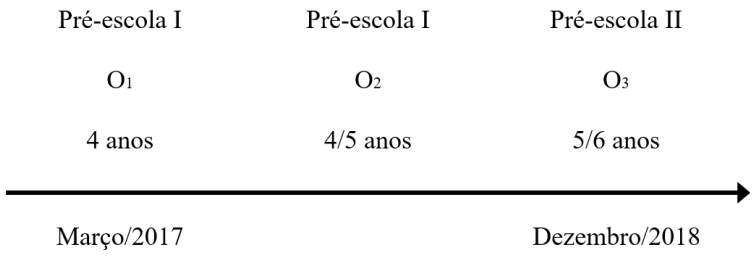

Figure 1. Longitudinal study design

Source: Prepared by the authors.

The instrument measures two dimensions, language and mathematics, which are composed of the following subdimensions: "a) Writing; b) vocabulary; c) ideas about

[2] For this purpose, we used the categories created by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística; IBGE).

[3] Carvalho (2005) explores issues related to race identity in students at the beginning of basic education.

reading-evaluates concepts about prints; c) phonological awareness; d) letter identification; e) word recognition and reading; f) ideas about mathematics; g) counting and numbers; h) addition and subtraction without symbols; i) identification of forms; and j) identification of numbers" (Koslinski & Bartholo, 2019, p. 293).

The scores for language and mathematics were estimated from the items of the cognitive test of the adapted PIPS test using Rasch measures (Boone, 2006) and the Winstep software.

Table 1. Description of the analyzed variables and their sources

NAME	TYPE	DESCRIPTION	SOURCE
Dependent Variables			
Language	Continuous	Language measure on wave 2 or 3	Cognitive test
Mathematics	Continuous	Mathematics measure on wave 2 or 3	Cognitive test
Explanatory Variables			
Level 2 - school			
SES (school)	Continuous	Average indicator of SES aggregated by school	Questionnaire for guardians and parents and SGA/SME
Level 1 – child			
Language	Continuous	Language measure on wave 1 or 2	Cognitive test
Mathematics	Continuous	Mathematics measure on wave 1 or 2	Cognitive test
SES (child)	Continuous	Indicator of the socioeconomic status of the child, calculated using the Rasch model including items on parental education, ownership of assets, household density, and poverty (access to cash transfer programs)	Quest. Guardians and Parents and SGA/SME
Gender	Dichotomous	Indicates the child's gender (0 = Girl; 1 = Boy)	SGA/SME
Age	Continuous	Indicates the child's age in years in wave 1, 2, or 3	SGA/SME
SEN	Dichotomous	Indicates whether a child has special educational needs	

Source: Prepared by the authors.

Table 1 presents the variables used in the multilevel models to estimate the compositional effect for the first and second years at school. The models were interpreted based on the effect of the indicator of the aggregated socioeconomic status for the school (level two of the multilevel model). To minimize the loss of cases over the two years of the study, the models separately estimated the compositional effect in the first and then in the second year at school.

In addition to the children's cognitive data, the longitudinal study collected information from the family context during waves 2 and 3 by administering questionnaires to parents and guardians. The demographic data on the children (age, ethnicity, and gender) and the additional data on the socioeconomic context of the family (education of the parents and participation in the *Bolsa Família* program) were obtained from the Academic Management System of the Municipal Department of Education (Sistema de Gestão Acadêmica da Secretaria Municipal de Educação; SGA/SME).

We estimated models using the individual SES level aggregated at the school level to calculate the compositional effect. The multilevel regression models, in which level 1

refers to the individual/child and level 2 refers to the school, included the level 1 variables centered on the grand mean. The simpler models, which only included SES at level 1 and the aggregated SES per school at level 2, can be expressed by the equation below:

Level 1 model:

$$\text{Cognitive Measure}_{ij} = \beta_{0j} + \beta_{1j}*(SES_{ij}) + r_{ij}$$

Level 2 model:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(SES\ school_j) + u_{0j},$$

$$\beta_{1j} = \gamma_{10}$$

The results of the compositional effect were observed directly from the SES coefficient aggregated by school (γ_{01}), the intra-group effect from the SES coefficient at level 1 (γ_{10}), and the inter-group effect from the sum of the two effects (intra-group and compositional effects) (Harker & Tymms, 2010). In addition to the SES variables at level 1 and aggregated at level 2, subsequent models included other controls related to the children's demographic characteristics (gender, age, and special educational needs) and control of the previous cognitive measure. The tables in the body of the text show the coefficients, standard error, and effect sizes for the compositional and intra-group effects and the sum of the two coefficients that express the inter-effect groups of the estimated models[4]. The article presents the coefficients in effect sizes (ES) to report the difference between the two groups. For more details, see Tymms (2004). An increasing number of studies in the field of education choose to report their results in terms of effect size, and there is an extensive debate on the best forms of interpretation (Higgins, Kokotsaky, & Coe, 2012).

We also estimated similar models including the ethnicity (black) variable at level 1 and aggregated at level 2. Previous work conducted with data from fundamental education found a school racial composition effect (Bartholo & Costa, 2016). However, the models estimated for preschool showed inconsistent results and the estimated coefficients for ethnicity were not statistically significant in any of the estimated models. Given the aforementioned limitations of the ethnicity variable, we chose not to present the results of these models.

4. Segregation patterns at the beginning of formal schooling

Several studies in Brazil have calculated indicators of school segregation using secondary data from the Inep School Census (National Institute of Educational Statistics-Instituto Nacional de Estatística Educacional) or administrative databases of municipal or state education departments (Bartholo, 2013; Bartholo & Costa, 2018; Mendes, 2017). However, the aforementioned studies did not calculate segregation for preschools, which include children of four and five years old, a mandatory period of schooling in Brazil since 2009.

[4] The complete tables are in the appendix.

Table 2 shows the segregation rates between 2006 and 2013 using the GS for two disadvantages –namely, parent education and ethnicity/race– and compares the segregation patterns between preschool and the first year of fundamental education.

Table 2. School segregation patterns in preschool and in the first year of fundamental education (2006–2013)

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Preschool - Ethnicity	17.5	18	18.5	18	18.5	19	18.5	18.5
First Year - Ethnicity	19.5	19	20	20	19	19	20.5	20.5
Preschool - EducF	24	24	22	22.5	24.5	23.5	24	25
First Year - EducF	24	23	22.5	22	21	22	22.5	23
Preschool - EducS	11	11.5	10	10.5	12	12.5	12	13
First Year - EducS	10.5	10.5	10.5	10	10	11.5	12	12

Source: Prepared by the authors.

The data suggest relative stability of the segregation patterns in preschools over the period studied. Even more important, there is great similarity in the levels of segregation described for preschools and the first year of fundamental education. This result reinforces the hypothesis that the factors that influence school segregation in the two stages are similar. Attention should be paid to enrollment rules, which are identical in both age groups. However, two important differences could affect the observed patterns of school segregation. The first is the proportion of children enrolled in public schools in preschool and primary education in the city of Rio de Janeiro. The second is the total number of schools in the public-school system that offer preschool and first-year classes of fundamental education. Both characteristics could change the measured levels of school segregation.

The total number of schools and their relationship with school segregation patterns have already been explored by Bartholo (2014) in a study conducted on the public system of the city of Rio de Janeiro. This study indicated an important reduction in the levels of school segregation measured in the transition between the first and second segments of fundamental education, a period in which most students change from one school to another. In this transition, an average reduction of 45% in the total number of schools was observed, increasing the likelihood of schools presenting a more diversified student profile. Therefore, it is a probabilistic effect, which is also observed in other educational systems when the number of schools decreases significantly (Bartholo, 2014). Table 3 shows the total number of schools with students enrolled in preschool and the first year of fundamental education between 2007 and 2013.

The data show a proportional increase of approximately 18% in the number of schools in the transition between preschool and primary education. This scenario could, at least in theory, increase the level of school segregation in the educational system. However, the data do not suggest this effect.

Table 3. Number of schools and students/children enrolled in the municipal system of Rio de Janeiro by stage

	2007	2008	2009	2010	2011	2012	2013
Number of schools with students enrolled in preschool	731	723	721	708	697	728	709
Number of schools with students enrolled in the first years of fundamental education	870	874	896	852	877	840	833

Source: Statistical synopsis of basic education (Sinopse Estatística da Educação Básica, 2007-2013).

Data from the 2010 Population Census of Rio de Janeiro indicated good family adherence and an increase in the supply of places in preschool and fundamental education: the enrollment rate for children and adolescents aged 6 to 14 (fundamental education) was 97%, while the enrollment rate for children aged 4 to 5 in early childhood education was 88%. Moreover, in the period studied, the private school system was responsible for a higher proportion of enrollments in the preschool stage (ranging from 27 to 45%), compared to the proportion of enrollments in fundamental education (ranging from 18 to 32%). In this way, we expected to find greater homogeneity of students and less school segregation in the preschool stage than among schools that serve students enrolled in the first year of fundamental education. Figure 1 shows the proportion of enrollments in the public system considering all children enrolled in the two stages of education, preschool and the first year of fundamental education.

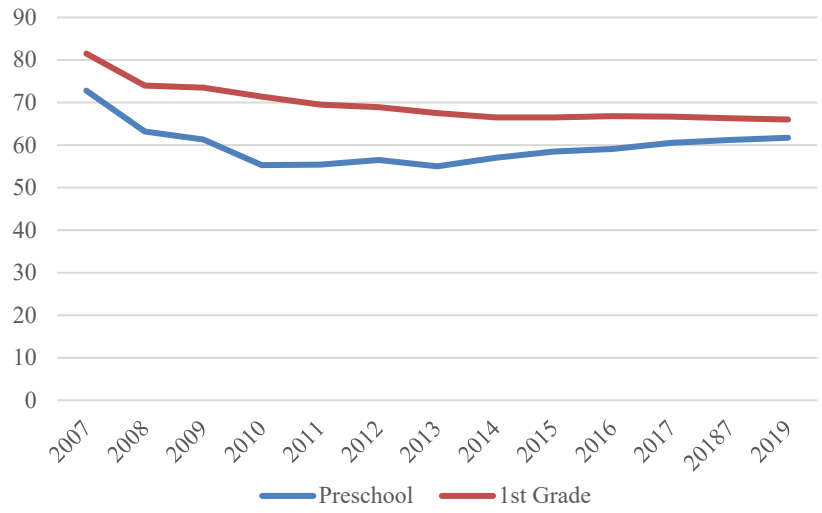

Figure 1. Proportion of enrollments in public schools in preschool and the first year of fundamental education in the city of Rio de Janeiro
Source: School Census, Inep. Prepared by the authors.

It is interesting to note that between 2007 and 2019, the proportion of students enrolled in the public system decreased, showing a proportional increase in enrollment in the private system both in preschool and the first year of fundamental education. This phenomenon deserves to be studied in more detail by researchers in the educational field

and may be associated with the perception of the quality of public education and the differential fall in the birth rate of groups with different socioeconomic profiles in Brazil.

The proportion of children enrolled in fundamental education and preschool in the public system suggests that a greater part of the demand during preschool was met by the private system. This can be explained by the non-mandatory provision of preschool until 2009 and the subsequent establishment of goals for universal access to the school system for children between four and five years old by 2016.

This factor is important because it suggests a double effect on the transition from preschool to fundamental education. The first effect is a migration of students who were in the private system to the public system, possibly due to the lack of places in the preschool stage in the public system. The second effect is the entry of children who were out of school. They started to attend the first year of fundamental education without having attended preschool. These two changes have the potential to significantly change the proportion of students at a potential disadvantage in the public system when comparing preschool with the first year of fundamental education. It is not clear whether students who were out of preschool had a disadvantaged profile, but data on the state of Rio de Janeiro obtained from the 2010 Population Census suggests this. For example, the enrollment rate for children aged 4 and 5 was equivalent to 88% for white children and 83% for black and brown children, reinforcing the idea that more vulnerable children had less access to this stage of schooling.

5. The effect of student composition in the first two years of school

The results of the hierarchical models that estimated children's learning throughout the first and second years at school will be presented in this stage. We divided the analyses into two sets. The first focused on the indicator of socioeconomic status (SES) designed using data from the interviews with guardians and secondary data from the SGA/SME in the first year of school (first year of preschool), with the second replicating the same analyses for the second year at school (second year of preschool). Replication helped to identify a pattern in the results and to refute, albeit partially, what Harker & Tymms (2004) called the phantom effect.

The coefficients of the multilevel regressions are shown in table 4. The models showed the results for mathematics and language, separated into the first and second years at school, including only the SES variable at the individual level and the aggregated SES for school in level two of the model. The results suggested a greater effect of student composition for language, especially in the second year of preschool. This result corroborates the findings of Harker & Tymms (2004) and Bartholo & Costa (2016). It is important to note that the partition of the variance observed in the null model suggested little variation between schools. The value observed in the second year at school was slightly higher than that observed in the first year; however, the difference was still small.

Table 4. Compositional effect of the SES aggregated in mathematics and language

	MATHEMATICS FIRST YEAR		MATHEMATICS SECOND YEAR		LANGUAGE FIRST YEAR		LANGUAGE SECOND YEAR	
	Coef. (ES)	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**
Intra	0.311*** (0.481)	0.028	0.301*** (0.404)	0.031	0.084** (0.419)	0.029	0.172*** (0.379)	0.020
Between	0.428		0.425		0.253		0.304	
Comp.	0.127** (0.196)	0.039	0.124** (0.166)	0.040	0.169*** (0.207)	0.018	0.133*** (0.293)	0.031

Note: *** p< 0,001, ** p < 0,01.
Source: Prepared by the authors.

The model presented in table 5 is very simple and there is a real possibility that the measurement of SES at the individual level and aggregated for the school partially explain the variation in other dimensions absent in the model (for example, age, gender, or even an initial measure of development). Subsequent models included new covariables to identify if the effects observed in the SES at levels one and two of the model continued to partially explain the variation in student learning. Table 5 presents the coefficients of a model that introduced three new variables: gender, age, and special educational needs.

Table 5. Compositional effect of aggregated SES, controlled by other level 1 variables

	MATHEMATICS FIRST YEAR		MATHEMATICS SECOND YEAR		LANGUAGE FIRST YEAR		LANGUAGE SECOND YEAR	
	Coef. (ES)	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**
Intra	0.319*** (0.523)	0.026	0.321*** (0.461)	0.029	0.176*** (0.468)	0.016	0.191*** (0.453)	0.018
Between	0.466		0.474		0.273		0.339	
Comp.	0.147*** (0.241)	0.032	0.153*** (0.220)	0.036	0.097*** (0.257)	0.026	0.148*** (0.352)	0.032

Note: *** p< 0,001.
Source: Prepared by the authors.

The results of the models suggested that there was an effect of student composition for mathematics and language over the first two years at school. It is worth noting that, even after the introduction of other control variables, the effect size observed in the aggregated SES became slightly larger in all of the estimated models. However, these models were still highly fragile because they did not include an initial measure of control over the students' development. Table 6 presents the final model, including all the aforementioned covariables and an initial measure of students' development in mathematics or language.

Table 6. Compositional effect of the aggregated SES, controlling for level 1 variables and previous performance

	MATHEMATICS FIRST YEAR		MATHEMATICS SECOND YEAR		LANGUAGE FIRST YEAR		LANGUAGE SECOND YEAR	
	Coef. (ES)	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**	**Coef. (ES)**	**SE**
Intra	0.120*** (0.270)	0.020	0.042+ (0.093)	0.024	0.061*** (0.210)	0.014	0.052*** (0.178)	0.014
Between	0.174		0.098				0.122	
Compo.	0.055+ (0.123)	0.032	0.055* (0.121)	0.025	0.066* (0.225)	0.025	0.070* (0.241)	0.026

Note: *** p< 0,001, ** p < 0,01, * p <0,05, + p<0,10.
Source: Prepared by the authors.

For the first year of school, the coefficients suggested a compositional effect for the measure of language with the SES indicator aggregated for the school being significant at the 5% level. The introduction of the other covariables, especially the initial measure, did not change the direction of the result for mathematics. However, the effect size of the indicator decreased and the coefficient estimated was only significant at the 10% level. This is a good example of what Harker & Tymms (2004) call the "phantom effect"; that is, when the observed effect disappears, especially after introducing a measure of control over the students' previous cognitive development. This result reinforces the importance of value-added models for research on the effect of schools, the impact of educational programs, or even the effect of student composition. The absence of longitudinal measures of children's development can lead researchers to the wrong results and interpretations.

For the second year at school, the results suggested that there was an effect of the student composition on language and mathematics learning. The effect size for both models decreased but remained statistically significant at the 5% level, even in the final model that controlled the starting point in the cognitive test. It should be noted that in the second year of preschool, there was an increase in variation between schools, which may explain the larger and significant coefficients of composition effect for both language and mathematics. The preliminary results reinforced the findings of Bartholo & Costa (2016) and suggested the existence of a student composite effect for language. The results were less clear for mathematics, suggesting that there is a student composition effect only in the second year of school.

The results presented here used only data on students enrolled in public schools. This is an important limitation of the results. It is reasonable to assume that, when incorporating data from students enrolled in the private system, the results will differ. Bartholo & Costa (2018) showed that when levels of segregation were calculated considering only students enrolled in public schools, they underestimated the phenomenon. The explanation is that there is a clear bias in the socioeconomic profile of students when comparing enrollments in public and private systems. The same argument can be used to understand the effect of student composition. It is likely that the effect size will be larger than that described in the article. When estimating the compositional effect with only a homogeneous section of the students enrolled in the public system, an important part of the variation between schools is not captured in the model.

The results reinforce the need to expand the debate on educational inequalities at the beginning of compulsory schooling. Clear enrollment rules, transparent processes, and policies aimed at making public schools more attractive can help reverse at least part of the observed school segregation patterns (Rosistolato et al., 2019). This is because, in addition to the enrollment rules, the phenomenon of school segregation is influenced by the residential segregation patterns that are characteristic of large Brazilian cities, as the present study deals with stages of the school system that serve young children and those with less mobility with regard to the choice of and access to schools (Érnica & Batista, 2012; Koslinski et al., 2013).

6. Conclusion

There is a growing debate on the importance of early childhood education and, more specifically, on the possibility of using preschools as public policies to reduce educational and social inequalities. It is important to analyze the distribution of educational opportunities in this period of the schooling process to understand the equity of the system.

This study is the first attempt to measure the phenomenon of school segregation in preschool over time (the mandatory period of the schooling process) and to estimate the compositional effect for the first two years of school in the Brazilian context. The preliminary results suggested that the patterns of school segregation observed in preschools are similar to those described in the first year of fundamental education. Therefore, there is no major impact on segregation patterns in the transition between education stages. Future studies should incorporate data from the private system on the preschool stage and describe the impact of the stratification between public and private systems. Nevertheless, the results obtained reinforce the importance of studying the topic of school segregation and reveal for the first time the size of the phenomenon in the four-to-five-year age group in a large city in Brazil.

The models for estimating the effect of the social composition of schools (compositional effect) on student learning suggested that there is an effect, with more consistent results for the measurement of language. We emphasize that the measures of socioeconomic level used in the present study –based on data collected directly from students' parents/guardians– are more detailed, with less missing data and, therefore, are more reliable than the measures present in studies using secondary data based on students' responses. The proposal to present models with an increasing number of control variables reinforces the importance of longitudinal research with two or more measures of children's development. It is also important to note that the absence of students enrolled in the private system likely led us to underestimate the phenomenon of the effect of student composition. Future studies should recalculate the model after including this portion of the population and observe possible changes in the pattern of school segregation in view of the persistent trend of increasing enrollments in the preschool stage in the public system, which has been taking place since 2013.

Future studies should explore other potential disadvantages in an attempt to estimate the compositional effect, such as ethnicity/race or neighborhood of residence, and even consider children living in slums. Furthermore, they could use controls of other variables related to teachers, such as self-efficacy, school processes, and school climate,

which would allow them to differentiate the effect of the student composition from the effects deriving from the school/classroom context.

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Annex

Table A. Multilevel regression models - first year in preschool

	LANGUAGE			MATHEMATICS		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Intercept	0,253***	0,345***	0,269***	-1,875***	-1,821***	-1,869***
SES (school)	0,083*	0,096***	0,065*	0,126**	0,147***	0,054+
Gender		-0,127***	-0,030		-0,026	0,007
Age		0,278***	0,094***		0,454***	0,138***
SEN		-0.926***	-0,405***		-1,000***	-0,859***
SES (child)	0,169***	0,176***	0,061***	0,311***	0,319***	0,119***
Mathematics Wave 1						0,937***
Language Wave 1			0,535***			
INTRCPT1, u0	0,025	0,021	0,017	0,037	0,033	0,015
level-1, r	0,653	0,566	0,338	1,670	1,488	0,784
N1	1955	1952	1951	1955	1952	1951
N2	46	46	46	46	46	46

Note: *** p< 0,001, ** p < 0,01, * p <0,05, + p<0,10.
Source: Prepared by the authors

Table B. Multilevel regression models - second year in preschool

	LANGUAGE			MATHEMATICS		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Intercept	0,920***	1,038***	0,959***	-0,602***	-0,625***	-0,642***
SES (school)	0,132***	0,148***	0,069*	0,123**	0,153***	0,055*
Gender		-0,150***	-0,056*		-0,146*	0,193***
Age		0,247***	0,073***		0,471***	0,116***
SEN		-1,394***	-0,362***		-1,850***	-0,903***
SES (child)	0,171***	0,190***	0,051***	0,301***	0,321***	0,042
Mathematics Wave 2						1,140***
Language Wave 2			0,672***			
INTRCPT1, u0	0,053	0,047	0,033	0,087	0,071	0,026
level-1, r	0,819	0,708	0,334	2,224	1,938	0,836
N1	2704	2670	1920	2704	2670	1920
N2	46	46	46	46	46	46

Note: *** p< 0,001, ** p < 0,01, * p <0,05, + p<0,10.
Source: Prepared by the authors

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