ARTICLES

MULTIDIMENSIONAL INDICATORS TO EVALUATE SCHOOL INFRASTRUCTURE: ELEMENTARY SCHOOLS

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ABSTRACT

This article provides a set of indicators to evaluate the infrastructure of public elementary schools which provide primary and lower secondary education in Brazil. It assumes that infrastructure is a complex construct, which justifies its evaluation on multiple dimensions. It uses data of The School Census on basic education and the National Assessment System for Basic Education, from 2013 to 2015. The results show that the infrastructure improved during this period, but the patterns of inequality known in the literature remained. Rural, small, municipal schools in the North and Northeast regions have lower means for all indicators. There are positive associations between indicators of infrastructure and socioeconomic level and the Index of Development of Basic Education.

SCHOOL INFRASTRUCTURE • EDUCATIONAL INDICATORS • SCHOOL INEQUALITY • BASIC EDUCATION

INDICADORES MULTIDIMENSIONAIS PARA AVALIAÇÃO DA INFRAESTRUTURA ESCOLAR: O ENSINO FUNDAMENTAL

RESUMO

Apresentamos um conjunto de indicadores para avaliar a infraestrutura das escolas públicas de ensino fundamental brasileiras. Partimos do pressuposto que a infraestrutura é um construto complexo, o que justifica a sua avaliação por múltiplas dimensões. Utilizamos os dados do Censo Escolar da Educação Básica e do Sistema de Avaliação da Educação Básica (Saeb), de 2013 e 2015. Os resultados apontam para melhora da infraestrutura no período, mas os padrões de desigualdade conhecidos da literatura se repetem. As escolas rurais, pequenas, municipais, do Norte e Nordeste têm médias mais baixas em todos os indicadores. Também verificamos associação de mesmo sentido dos indicadores de infraestrutura com o nível socioeconômico e o Índice de Desenvolvimento da Educação Básica (Ideb).

INFRAESTRUTURA ESCOLAR • INDICADORES EDUCACIONAIS • DESIGUALDADES ESCOLARES • ENSINO FUNDAMENTAL

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INDICATEURS MULTIDIMENSIONNELS POUR L'ÉVALUATION DE L'INFRASTRUCTURE SCOLAIRE À L'ÉDUCATION DE BASE

RÉSUMÉ

Cet article présente une série d'indicateurs pour évaluer l'infrastructure des établissements scolaires publics brésiliens. Nous partons de l'hypothèse que l'infrastructure est une construction complexe, ce qui justifie une évaluation multidimensionnelle. Nous avons utilisé les données du *Censo Escolar da Educação Básica* [Rencensement de l'Éducation de Base] et du *Sistema de Avaliação da Educação Básica* (*Saeb* [Système d'Évaluation de l'Éducation de Base]), de 2013 et de 2015. Les résultats ont montré que l'infrastructure s'est améliorée au cours de cette période, bien que les degrés d´inégalité recensés par la littérature persistent Les petites écoles des communes rurales des régions Nord et Nord-Est enregistrent des moyennes plus basses pour tous les indicateurs. Nous avons également vérifié qu'il existait des associations positives entre les indicateurs d'infrastructure, le niveau socio-économique et l'*Índice de Desenvolvimento da Educação Básica* (Ideb [Indice de Développement de l'Éducation de Base]).

INFRASTRUCTURE SCOLAIRE • INDICATEURS DE L'ÉDUCATION • INÉGALITÉS SCOLAIRES • EDUCATION DE BASE

INDICADORES MULTIDIMENSIONALES PARA EVALUACIÓN DE LA INFRAESTRUCTURA ESCOLAR: LA EDUCACIÓN BÁSICA

RESUMEN

Presentamos un conjunto de indicadores para evaluar la infraestructura de las escuelas públicas brasileñas de educación básica. Partimos del supuesto de que la infraestructura es un constructo complejo, lo que justifica su evaluación por múltiples dimensiones. Utilizamos los datos del Censo Escolar da Educação Básica *[Censo de la Educación Básica] y del Sistema de Avaliação da Educação Básica (Saeb [Sistema de Evaluación de la Educación Básica]), de 2013 y 2015. Los resultados muestran que la infraestructura mejoró en el periodo, pero los estándares de desigualdades mencionados en la literatura se repiten. Las escuelas rurales, pequeñas, municipales, del Norte y Noreste presentan promedios más bajos para todos los indicadores. También verificamos asociaciones positivas entre los indicadores de infraestructura con el nivel socioeconómico y el* Índice de Desenvolvimento da Educação Básica *(Ideb [Índice de Desarrollo de la Educación Básica]).*

INFRAESTRUCTURA ESCOLAR • INDICADORES EDUCACIONALES • DESIGUALDADES ESCOLARES • EDUCACIÓN BÁSICA

SCHOOL INFRASTRUCTURE IS AN ISSUE OF GREAT INTEREST IN BRAZIL DUE TO THE heterogeneity of the educational provision in the country and the relationship of this issue with educational outcomes (CERQUEIRA; SAWER, 2007; SÁTYRO; SOARES, 2007; SOARES; ALVES, 2013; SOARES NETO et al., 2013a). Studies on this theme contain an abundance of public data produced by the National Institute for Educational Studies and Research "Anísio Teixeira" (local acronym is INEP) , which provides systematic information on the material conditions of schools in Brazil.[1]

The importance of infrastructure is recognized by The Law of Guidelines and Bases of National Education (local acronym LDB) and in the national education plans. Although the LDB does not refer directly to infrastructure, it establishes minimum quality standards for educational provision and defines supplementary and redistributive actions between the federal and state levels to ensure the financing of these standards (BRASIL, 1996).

The 2001 National Education Plan (local acronym is PNE) established the minimum infrastructure standards for elementary schools which provide primary and lower secondary education and set deadlines for schools to meet them (BRASIL, 2001)[2]. However, these goals were not fully achieved in the decade. The 2014 PNE maintained the provision of appropriate infrastructure as strategic for quality of education, not only for elementary school but for all stages of basic education and educational modalities (BRASIL, 2014c).[3]

1 INEP is a research agency linked to the Ministry of Education in Brazil. It is responsible for assessing basic education and higher education nationally. It also provides educational statistics that help formulate, implement, monitor, and evaluate educational policies at the federal, state and local government levels. Information available at: <http://portal.inep.gov.br/web/guest/about-inep>. Access: August 28, 2018 (BRASIL, 2018a).

2 Translator's note: According to the International Standard Classification of Education (ISCED) the Brazilian education system is structured on two levels: basic education and higher education. The basic education consists of three stages: (i) ISCED 0, or early childhood education, which includes provision for *(cont.)*

The 2014 PNE provides for the development of institutional evaluation indicators to follow up and contextualize its goals and strategies (BRASIL, 2014c, art. 11, paragraph 1, item II). Therefore, this article aims to contribute to this effort by presenting a set of indicators to evaluate the infrastructure of elementary school, which, according to the International Standard Classification of Education (ISCED), provide primary education and lower secondary education, or ISCED 1 and ISCED 2 (BRASIL, 2016a).

From a review of the literature on the topic, we defined infrastructure dimensions and indicators based on data from the Census on Basic Education – better known as School Census – and from the National Assessment System for Basic Education (local acronym is SAEB), both produced by INEP. Aiming to describe types of schools, we constructed twelve indicators – eleven to measure specific aspects of school infrastructure and a general indicator to synthesize those eleven.

We focused on elementary schools, since the other stages and modalities of education have particularities regarding infrastructure and their relationship with the pedagogical work. Therefore, it would be arbitrary to deal with them in the same theoretical and empirical scope. Nevertheless, we kept in the analyses the elementary schools which, in addition to primary and lower secondary education, also provide early childhood or upper secondary education.

This study is organized in five sections. After this introduction, we present the review of the literature that guided the definition of indicators. In the methodology, we describe the data used, the treatment of variables, and the statistical procedures employed. Then, we present the results of the indicators. In the final considerations, we discuss contributions, limitations and possible uses of the indicators.

LITERATURE REVIEW

The concept of infrastructure in education is multifaceted. The term includes the architectural design of the schools, educational and administrative environments, equipment and educational resources, practices, curriculum, teaching and learning processes, as well as teacher training to use available resources. In order to understand these concepts, we reviewed the literature on quantitative empirical research on infrastructure and school resources or related features since 2000.

The Brazilian literature includes many studies that use Brazilian School Census data to characterize infrastructure (ALMEIDA et al., 2011; CERQUEIRA; SAWER, 2007; GOMES; DUARTE, 2017; MATOS; RODRIGUES, 2016; PASSADOR; CALHADO, 2012; PIERI; SANTOS, 2014; PONTILI; KASSOUF, 2007; RIANI; RIOS-NETO, 2008; SOARES; ALVES; XAVIER, 2016; SÁTYRO; SOARES, 2007; SOARES NETO et al.,

2 *(cont.)*
children from 0 to 3 years of age (nursery schools) and from 4 to 5 (pre-school); (ii) elementary schools, divided into ISCED 1 or primary education, for children aged from 6 to 10 years of age, and ISCED 2 or lower secondary education, for children aged approximately 11 to 14 years; and (iii) ISCED 3 or upper secondary education, with a minimum of three years' attendance, from 15 to 17 years of age (BRASIL, 2016a).

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2001 and 2014 PNEs are ten-year plans, drawn up by constitutional requirement and approved as federal laws, which establish goals, guidelines and strategies aimed at directing efforts and investments to improve the quality of education in Brazil.

2013a; 2013b). Among them, we draw attention to those that describe the methodological solutions employed to summarize the data into understandable measures on infrastructure.

Cerqueira and Sawer (2007), based on the 2000 Brazilian School Census, built a typology of schools considering the social context, infrastructure (available resources and facilities) and functional features. The method employed was the Grade of Membership (GoM), which led them to identify three major groups of schools. The first group, which included 58.4% of the units, consisted of poorly-equipped schools, mostly small elementary schools, located in rural areas in the north and northeast regions. In the second group, which included 24.7% of the schools, schools were medium or large sized, and offered equipment and basic facilities, but were not computerized. The third group, including 14.7% of the schools, was composed of well-equipped computerized schools, which had good facilities, usually in urban areas located in the south, southeast and mid-west regions. In addition to these, Cerqueira and Sawer identified a small number of schools with hybrid profiles.

Based on the 1997 to 2005 Brazilian School Census data, Sátyro and Soares (2007) observed an improvement in elementary schools during this period. The percentage of schools that did not have access to energy fell from 41% in 1997 to 16% in 2005. In 1997, only 26% of the schools had positive values for the school facilities infrastructure index and, at the end of the period, there were 42% of them. This index was calculated using factor analysis. The percentage of schools with a library or reading room increased from 57% in 1997 to 64% in 2005. However, rural and municipal schools remained far behind at the end of the period.

Soares Neto et al. (2013a) developed an infrastructure scale that synthesized 24 items from the 2011 Brazilian School Census data on access to public services, administrative and pedagogical spaces, equipment, and others. The authors employed a model of Item Response Theory (IRT) to reduce these items to a single scale, which was divided into four levels: elementary, basic, appropriate, and advanced. 44.5% of schools were at the elementary level, providing only items such as water, health, energy, sewage, and kitchen, and were mainly municipal rural schools in the northern and northeastern regions. 40% of schools were classified at the basic level, because, in addition to the previous category, they provided items typical of an educational facility such as a principal's room, TVs, DVDs, computers, printers. At this level, state and private schools stood out, with a great variety of this equipment. 14.9% of schools were at the appropriate infrastructure level, providing environments more conducive to teaching and learning, such as a teachers' lounge, library, computer lab and bathrooms for early childhood

education, sports court, playground, and additional equipment like photocopiers and internet access. Only 0.6% of the schools reached the advanced level of infrastructure. Such schools usually had, in addition to the previous items, science labs and appropriate facilities to cater to special needs students. The schools of these last two groups were above all federal and private, located in urban areas in the south, southeast and mid-west regions.

In another publication deriving from this same survey, Soares Neto et al. (2013b) focused on small schools, those with 10 to 200 students. This segment was composed mostly by rural schools, located in the states of the North and Northeast of Brazil, and most of them provided simple infrastructure (51.8%).

Based on the 2013 Brazilian School Census data, but limiting the analysis to public elementary schools, Gomes and Duarte (2017) described a much better situation in comparison to previous studies. They created four profiles of schools using a Latent Class Model (LCM) which summarized 26 items regarding basic facilities and resources, as well as equipment and teaching facilities. The higher profile, with better infrastructure, included most elementary schools (42%), comprising 81.2% of primary and lower secondary education enrollment. These schools had virtually all items considered in the analysis, except a science lab and resource room, which were not consistent with any of the profiles. The middle-upper profile included 23.7% of the schools and 14.7% of the enrollment. These had no teaching facilities, and only limited basic facilities and teaching resources. 22.7% of the schools were classified in the medium-low profile, which accounted for 3% of the enrollment. These schools lacked equipment and teaching facilities, and offered limited services and basic facilities. Finally, only 11% of the schools were included in the low infrastructure profile, with only 1.1% of students. They were schools that had barely any facilities, just the building and water. In addition to these profiles, 0.1% of the schools were classified as having an ambiguous profile.

It should be noted that the studies reviewed so far converge strongly on the Brazilian School Census items used to describe infrastructure. However, there are differences in the interpretation of the distribution of the quality of this attribute. After all, do we really have very few schools with good infrastructure (SOARES NETO et al, 2013a; CERQUEIRA; SAWER, 2007)? Or, is it that most public schools have a higher quality profile (GOMES; DUARTE, 2017)? Although school infrastructure is still unsatisfactory, has it been improving (SÁTYRO; SOARES, 2007)?

The empirical basis of the analyses partially explains these differences: that is, whether the authors analyzed all educational sectors and stages, or only public schools or elementary schools, or whether

they considered data from one or more editions of the Brazilian School Census data. The methodologies can also contribute to different results: for example, if continuous scales or infrastructure categories (groups) were estimated. Another influencing factor can be the type of item of the Brazilian School Census data. Most of them measure the presence or absence of an attribute (dichotomous scale), a metric that does not quite highlight the subtle differences among schools.

SAEB data's advantage lies in this last aspect. The questionnaires of this evaluation consist of ordinal variables that measure the existence and conditions of use of school facilities and resources. In general, researchers reduce these variables to an infrastructure factor using multivariate statistical techniques. The estimated ranges, given the ordinal metrics for items, have more points for measuring the differences among schools. However, SAEB's coverage is much lower compared to the Brazilian School Census data, although it is representative of the school profiles eligible for this assessment.[4] It is worth mentioning that, in studies of educational evaluation, the focus is not on the infrastructure but on the association of this factor with school performance, which is always positive in Brazil (ALVES; FRANCO, 2008; ALVES; SOARES, 2013; BARBOSA; FERNANDES, 2001; SOARES; CÉSAR; MAMBRINI, 2001; SOARES; ALVES; XAVIER, 2015; SOARES et al., 2012).

We also reviewed international research. Part of this literature, as in Brazilian studies, focuses on the basic operating conditions of schools, including special needs students (DUARTE; JAUREGUIBERRY; RACIMO, 2017; GIBBERD, 2007; VALDÉS et al., 2008). However, especially in developed countries, researchers are interested in understanding how learning environments, technologies and external spaces create the necessary conditions and environments to promote the well-being of students, to mediate the relationship between teachers and students and to promote academic achievement (BLACKMORE et al., 2011; CUYVERS et al, 2011; SCHNEIDER, 2002; YOUNG et al., 2003).

The review of the literature showed that the definition of school infrastructure is closely linked to the available empirical data. In general, the studies consider the existence of basic items for the building's operation (access to services, bathrooms), educational spaces (libraries, teachers' lounges, laboratories) and support spaces (administrative rooms, dining areas), teaching resources (computers, books, TVs) and accessibility. Less evident in Brazilian empirical studies, but no less important, are issues related to favorable environments for teaching and learning, such as thermal and acoustic comfort and safety, in addition to respect for gender differences and the requirements for special needs education.

4 SAEB is composed of the National Assessment of School Performance (local acronym is ANRESC), better known as Prova Brasil, the National Assessment of Basic Education (ANEB) and the National Literacy Assessment (ANA). (BRASIL, 2018b)..

Moving from concept to measurement constitutes a major challenge to social research. Many concepts present definitions with subtle nuances, and it is difficult to identify their limits exactly. When trying to operationalize concepts, a loss of detail, foreseen by the researcher, is expected. In the absence of a clear agreement on how to measure a particular concept, it is recommended to measure it in different ways and, if it has multiple dimensions, to try to measure them all (BABBIE, 2010). This was the path taken in this research.

Initially, we proposed a set of theoretical constructs related to infrastructure. Then, we translated them into empirical indicators using public Brazilian data, as we shall explain in the next section. The testing process was complex, with several rounds of tests. Therefore, in this article we present only the final solution.

METHODOLOGY: DATA AND PROCEDURES

DATA

We used data from the Brazilian School Census and SAEB databases, both from 2013 and 2015. The choice of these editions is justified because, whenever possible, we reconciled the Brazilian School Census data, which is an annual survey, with the SAEB data, which are biennial and whose latest version, at the time of the study, was from 2015. From the Brazilian School Census database, we used the questionnaires about schools and classes, from which we obtained information about school location, operating conditions, characteristics of the facilities, existence of pedagogical resources, accessibility, and more. From the SAEB database, we used information from the questionnaires regarding the schools, as well as those filled out by the principals.[5]

Although our main objective is to evaluate the infrastructure of public schools, during the estimating processes we included private schools both from the Brazilian School Census and the SAEB database, to diversify the profiles of educational establishments. Table 1 summarizes the data used. In total, 143,170 public and private elementary schools that provide primary and lower secondary education, exclusively or not, are analyzed.

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In the initial phases of the research, we also considered items from the teacher questionnaire, but they did not adjust well to the indicators constructed.

TABLE 1
NUMBER OF SCHOOLS ACCORDING TO EDITION AND RESEARCH

Year	Census*	SAEB**
2013	143,170	54,835
2015	135,939	53,470

Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.
Notes: *The number of schools analyzed will always match the total number of schools from the School Census, as SAEB schools are also part of the School Census, and the inverse is not true;
** SAEB combines Prova Brasil (public schools) and ANEB in the same database – the sub-sample of schools not eligible for *Prova Brasil*, representing private and public schools with fewer than 20 students.

As the focus of the present study is standard elementary schools, which provide primary and lower secondary education, we excluded establishments which provide only early childhood, upper secondary or adult education. However, elementary schools that provide primary or lower secondary education, as well as other stages and modalities, were kept in the analysis. In 2015, they represented 72.9% of the schools in the Brazilian School Census and received 57.2% of enrollment in early childhood, primary, and secondary education.[6]

Initially, we selected all variables in the questionnaires that could characterize school infrastructure. Thus, we identified 158 variables which measured the theoretical constructs related to infrastructure, and other variables that would be used later just as discriminants (for example, school location, stage, etc.). However, some variables were excluded after each phase of analysis. These decisions are described below.

In the Brazilian School Census questionnaire of schools, the variables selected are identical in the two editions, except for one, related to their having multifunction printers, which was absent in 2013. This did not prevent the use of this information, due to the model used for the estimation of indicators.

The classroom variables of the Brazilian School Census questionnaire were aggregated to obtain a single measure per school. The number of classrooms that had infrastructure items was counted. Then, the counting variables were added to the database of the schools.

At the database of the Brazilian School Census, interval level variables were recodified as ordinal, such as: (1) all variables from the database of the classrooms that were obtained from counting one item within each school; and (2) all the original variables from the database of schools that reported the number of a particular item in the school (for example, number of TV sets).

From the SAEB database, we used the information from the questionnaires of schools and principals but, in this case, it was more difficult to reconcile data from 2013 and 2015. Some variables were not present in the two editions, or the items of the questionnaires were

6 There are 186,441 schools of basic education (considering early childhood, primary, lower and upper secondary, vocational, adult, and special education) and 48,796,512 enrollments in all levels or modalities (BRASIL, 2016b).

different from one year to the following one, even when addressing the same topic. We reconciled the information as best we could. Solutions were analyzed on a case-by-case basis, using the most recent scale as reference (2015).

Finally, we merged in the same database information from the Brazilian School Census and the SAEB data.

CONSTRUCTION OF INDICATORS

The methodology for estimating the infrastructure indicators consisted of adjusting models of Item Response Theory (IRT), appropriate for variables with binary or graded response data (HAMBLETON, 1993; SAMEJIMA, 1969). The models assume unidimensionality, that is, the existence of a single, latent, dominant construct in the data set. To test this assumption, we used Principal Components Analysis (PCA) and Polychoric correlation. PCA is an exploratory method for synthesizing a matrix of data to express its structure in a smaller number of dimensions, frequently used as the first step in modeling. Polychoric correlation is indicated because the tested variables are ordinal or dichotomous. Additionally, we analyzed the Item Characteristic Curves (ICC) and the Item Information Curves (IIC). The ICC reflects the different probabilities of an individual choosing a response category, given the score in the latent dimension (indicator), and IIC reflects the contribution of each item to the construct to be estimated.

Our analyses showed that the indicators fit our theoretical assumptions, with some exceptions. A few variables presented negative correlation with others and were excluded. We also excluded some SAEB variables that had a correspondent in the Brazilian School Census data and whose categories, although on an ordinal scale, have a dichotomous distribution. As the information from the Brazilian School Census data is always much more representative, it did not make sense to keep SAEB variables that did not provide additional information. Finally, from the Brazilian School Census data, we combined variables that measure the same construct, creating new variables with an ordinal scale that fit the model better.

For example, there were two variables regarding schoolyard: one measured the presence of a covered schoolyard and another of an uncovered schoolyard. From these two, we created a single variable with the categories: (1) there is no schoolyard, (2) there is a schoolyard (either covered or uncovered), and (3) there are both a covered and an uncovered schoolyard. As another example, we grouped into one ordinal variable the types of sewage system, originally separate items, into these categories: (1) nonexistent, (2) only cesspool, and (3) only public sewage system or both (2) and (3). In this case, we made a value judgement, attributing the greatest quality to the public sewage

system, but without ignoring the schools that did not have this service for reasons outside of educational policy. The same was done with similar items. These solutions allowed the categories of the items to be distinguished appropriately, improving their capacity to provide information about the respective indicators.

In the end, we used 61 items to estimate eleven indicators: basic services, building facilities, damage prevention, maintenance, comfort, pleasant environment, pedagogic spaces, equipment for administrative support, equipment for pedagogic support, accessibility, special needs education. To synthesize these eleven indicators, a general infrastructure indicator was also calculated that allowed identifying the relative weight of the 61 items and to describe school typologies. Descriptive statistics for the items are shown in Table A1 in the Appendix. We also show, in the Appendix, an example of an analysis of the items to test their adjustment to the assumptions of the IRT (Table A2 and Figures A1 and A2).[7]

The original scores of the indicators obtained by the IRT models are expressed in standard deviations. To make them more interpretable, they were transformed into a scale from 0 (zero) to 10 (ten) points. It is important to emphasize that a value of zero does not mean lack of infrastructure, neither does a value of 10 mean the entirety of what could exist in a school. They measure the gradual growth from a worse situation (expressed in the value of zero) to the best situation (expressed in the value of ten) in relation to the items analyzed in the present study.

As mentioned above, we selected a set of discriminant variables in the databases. In this article, we used the following: school sector, location, region, states, educational stages, grade levels, and number of students. In addition to these, we brought the following indicators, developed by INEP, to the analyses: level of management complexity, Index of Socioeconomic Status (SES), Index of Development of Basic Education (IDEB) of the primary education and lower secondary education.[8] The descriptive statistics for these variables are shown in Table A3, in the Appendix.

RESULTS

DIMENSIONS, INDICATORS AND VARIABLES OF SCHOOL INFRASTRUCTURE

The indicators and discriminant variables were organized into five dimensions of school infrastructure: school conditions, teaching and learning conditions, equity conditions, space conditions, and school organization types.

7 Due to issues of space, we do not show the analyses of all indicators. They can be sent to interested parties upon request.

8 About SES and the management complexity indicator, see: Brasil (2014). For more information about IDEB, see: Brasil (2007).

The *school conditions* dimension measures the quality of the building and the spaces in which the school functions, including the indicators of basic services, building facilities, damage prevention, building maintenance, comfort of the facilities, and pleasant environment. The dimension *teaching and learning conditions* refers to the aspects most closely linked to the pedagogic work of the school and includes the pedagogic spaces, equipment for administrative support and equipment for pedagogical support. The *equity conditions* dimension encompasses indicators that measure accessibility and the provision of a special needs education. Ideally, this dimension should contain more indicators of inclusion and respect for differences such as gender, ethnicity and age, but the available data do not permit us to measure them.

The discriminant variables are distributed into two dimensions. The *space conditions* dimension comprises variables intended to characterize important enclaves of Brazilian education, such as the school location in either an urban or a rural area, the regions and the states. The *school organization types* dimension shows variables that measure the educational stages, grade levels and school size. Other discriminant variables were systematized (e.g., capital or countryside, school schedules, modalities of instruction), but were not analyzed in the present study.

CORRELATION AMONG INFRASTRUCTURE INDICATORS

To test the coherence of the eleven indicators, with the assumption that they measure the same construct, we did a correlation analysis among them as well as with the general indicator. According to Table 2, all correlations are positive and statistically significant, indicating that they consistently measure dimensions of school infrastructure. The weaker correlations were found between the special needs education indicator and the others, and among the indicators estimated using only SAEB data (damage prevention, maintenance and comfort) and the others.

TABLE 2
LINEAR CORRELATION MATRIX OF THE INDICATORS OF SCHOOL INFRASTRUCTURE QUALITY

Indicators	Linear correlation coefficients										
1. Basic services	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
2. Building facilities	0,73										
3. Damage prevention	0.33	0.34									
4. Maintenance	0.18	0.25	0.56								
5. Comfort	0.19	0.26	0.48	0.62							
6. Pleasant atmosphere	0.59	0.67	0.27	0.20	0.20						
7. Pedagogical spaces	0.63	0.72	0.30	0.17	0.22	0.56					
8. Equipment for administrative support	0.76	0.78	0.35	0.18	0.23	0.62	0.80				
9. Equipment for pedagogical support	0.68	0.71	0.26	0.14	0.16	0.58	0.69	0.82			
10. Accessibility	0.42	0.50	0.20	0.22	0.17	0.44	0.49	0.49	0.44		
11. Special needs education	0.20	0.28	0.08	0.04	0.04	0.18	0.29	0.28	0.26	0.28	
12. General infrastructure	0.83	0.87	0.68	0.81	0.64	0.69	0.80	0.89	0.85	0.54	0.27

Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.
Note: All the coefficients are statistically significant at 1%.

DESCRIPTIVE ANALYSIS OF INFRASTRUCTURE INDICATORS

The descriptive analysis is an important step in the validation of indicators. By comparing their means according to categories of the discriminant variables, we can verify whether the scores found corresponded to our expectations in relation to what we know of the educational reality of the country. Table 3 shows this analysis for 2013 and 2015. We highlight that, in Brazil, all indicators improved during the period except the indicators of maintenance, comfort and pedagogic spaces, which remained constant.

TABLE 3

MEANS OF SCHOOL INFRASTRUCTURE INDICATORS (*) FOR BRAZIL AND BY SECTOR, LOCATION AND REGIONS, 2013 AND 2015

	Year	Brazil	Sector				Location		Region				
			Federal	State	Municipal	Private	Urban	Rural	North	Northeast	Southeast	South	Midwest
Basic services	2013	6.9	9.7	8.3	6.0	9.3	8.8	4.5	4.4	6.1	8.9	8.1	7.8
	2015	7.1	9.7	8.3	6.2	9.3	8.8	4.6	4.5	6.4	9.0	8.2	7.9
Building facilities	2013	6.0	8.6	7.5	5.3	7.1	7.7	4.2	4.4	5.1	7.5	7.3	6.9
	2015	6.3	9.0	7.6	5.6	7.4	7.8	4.4	4.6	5.4	7.7	7.6	7.2
Damage prevention	2013	6.4	8.4	6.6	6.1	9.1	6.6	4.8	5.2	5.3	7.2	7.2	6.6
	2015	6.6	8.8	6.6	6.4	9.2	6.7	5.1	5.4	5.6	7.2	7.3	6.6
Maintenance	2013	6.5	8.5	6.5	6.4	9.0	6.6	5.7	5.9	5.9	7.1	6.6	6.4
	2015	6.5	8.5	6.4	6.5	9.1	6.6	5.9	6.0	6.0	7.0	6.7	6.2
Comfort	2013	6.8	9.0	7.2	6.4	9.2	6.9	5.5	5.7	5.6	7.7	7.4	6.6
	2015	6.8	8.7	7.0	6.5	9.2	6.9	5.6	5.6	5.7	7.6	7.4	6.4
Pleasant atmosphere	2013	3.3	6.4	4.0	2.5	5.6	4.3	1.5	1.6	2.2	4.8	5.3	4.2
	2015	3.8	7.1	4.3	3.0	6.2	4.7	2.0	2.0	2.9	5.1	5.9	4.8
Pedagogical spaces	2013	3.1	8.0	5.0	2.3	4.0	4.8	1.3	1.7	2.1	4.4	4.9	4.5
	2015	3.1	7.6	5.0	2.4	3.9	4.7	1.3	1.7	2.1	4.4	4.9	4.4
Equipment for administrative support	2013	3.6	8.2	5.6	2.6	5.4	5.5	1.4	2.0	2.5	5.3	5.3	5.3
	2015	3.8	7.2	5.6	2.9	5.3	5.4	1.7	2.1	2.8	5.3	5.3	5.2
Equipment for pedagogical support	2013	3.9	7.4	5.6	3.1	4.9	5.6	2.0	2.1	3.0	5.2	5.5	5.1
	2015	4.3	7.0	5.7	3.7	5.4	5.8	2.5	2.4	3.6	5.5	5.9	5.5
Accessibility	2013	3.3	5.1	4.3	2.7	4.4	4.7	1.7	2.3	2.7	3.8	4.5	5.5
	2015	3.8	5.2	4.8	3.2	4.8	5.2	2.1	2.6	3.2	4.2	5.5	5.9
Special needs education	2013	0.7	0.3	1.2	0.7	0.1	1.6	0.2	0.5	0.3	0.8	1.5	1.3
	2015	0.9	1.2	1.5	0.9	0.1	1.9	0.3	0.7	0.5	1.1	1.7	1.6
General infrastructure	2013	5.2	7.7	6.3	4.6	6.5	6.4	3.7	3.7	4.6	6.3	6.3	6.1
	2015	5.4	7.7	6.3	4.9	6.6	6.5	4.0	3.9	4.9	6.4	6.5	6.2

Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.

Note: (*) Scale from 0 (zero) to 10 (ten) points where zero does not mean absence of infrastructure, but the worst situation, and 10 means the best situation in the scale.

The second group of means in the table refers to the school sector (federal, state, municipal, and private schools). Educational segregation, according to sector, is a fact known in the literature, and the differences in the conditions of school infrastructure are evidence of this phenomenon (SÁTYRO; SOARES, 2007; SOARES NETO *et al*, 2013a). This pattern is repeated in this study. Federal and private schools systematically present higher averages than do state and municipal schools. The federal schools stand out in the general indicator and especially in the indicators for basic services, building facilities, pleasant environment, pedagogic spaces, equipment for administrative support, equipment for pedagogical support, and accessibility. For three indicators – damage prevention, maintenance and comfort –, the highest means pertain to private schools. However, those schools present the lowest mean for special needs education, for which the highest means are in the state schools. This may indicate that regular classrooms in the private sector have not incorporated the principle of equity in education.

Regarding the evolution of the indicators, two stand out: pleasant environment and accessibility. For the latter, the most notable growth occurs in state and municipal schools, reflecting the investment in this area. On the other hand, the indicators referring to maintenance, comfort, pedagogic spaces, and equipment for administrative support showed a slight drop in at least two sectors. These results show that the indicators that suffer most over time and that require constant maintenance are the ones that improve the least.

The differences in infrastructure between urban and rural schools are highlighted both in the Brazilian (CERQUEIRA; SAWYER; 2007; GOMES; DUARTE; 2017; SÁTYRO; SOARES, 2007; SOARES NETO et al., 2013a; 2013b) and in the international literature (DUARTE; JAUREGUIBERRY; RACIMO, 2017; GIBBERD, 2007). Table 3 shows that the means of the urban schools are higher than those of the rural schools, which corroborates the literature. Part of our results may reflect the way that the indicators were measured. The items from the Brazilian School Census and the SAEB data were not developed to describe the specificities of rural schools in a deeper way, especially those from different locations, like indigenous and *quilombola* ones.[9] We also know that rural areas have less access to public services which directly affect the schools (CAMPELLO, 2017). In spite of this, even items that do not reflect the territory directly show very distinct differences. For example, the indicator for pedagogic spaces in the rural area is more than three times lower than this indicator in the urban area.

However, the indicators reveal that, even among urban schools, there are aspects that deserve attention. For example, the low mean value of the special needs education indicator. In rural schools,

9 Translation note: *Quilombola* refers to the inhabitant of quilombos, which are places of refuge for escaped slaves from farms during the Brazilian colonial and imperial periods. Currently, there are still hundreds of *quilombos* in Brazil, made up of descendants of slaves who live on subsistence agriculture and maintain cultural manifestations that have a strong link with the past.

although they have lower averages than in urban schools, the growth was greater for almost all indicators except for accessibility and special needs education.

The descriptive statistic output of the indicators, by the Brazilian Federal states, forms a very extensive table; that is why only the regions are presented in Table 3. The results per state are in the Appendix (Table A4). We found that the patterns of regional inequalities are similar to those in the literature (GOMES; DUARTE, 2017; CERQUEIRA; SAYWER, 2007; SOARES NETO et al., 2013a; 2013b). Schools in the South and Southeast systematically have higher averages than schools in the North and Northeast. The Midwest appears almost always in the middle, except for the Federal District, which has several higher indicators. However, it should be noted that, in the Northeast, the state of Ceará showed the highest mean for the general indicator as well as for several indicators for the year 2015. In the North, Rondônia and Tocantins states stand out even with scores lower than those found in the South and Southeast states.

Keeping in mind that the focus of our study is on public elementary schools, private schools were excluded from the analyses which follow, in Table 4. We did the same with federal schools, since only 46 of them offer primary or lower secondary education (0.1% less than all schools).

Table 4 shows the distribution of the means of the indicators according to the educational stage, school grade levels, the number of students, the level of complexity of management, the SES Index, and the IDEB of the primary education and lower secondary education. We present only data from 2015 for this set of discriminant variables.

According to the first group of means in Table 4, public schools that provide primary, lower and upper secondary education generally have higher means than schools without upper secondary education. This result may be explained by the fact that the schools with more advanced grades have facilities and resources that were assessed in this study; for example, science laboratories. Soares Neto et al. (2013a) and Gomes & Duarte (2017) observed a different pattern of this item in the assessment of the infrastructure of elementary schools with primary and lower secondary education. Our results reinforce these findings. However, we support the inclusion of science laboratories because this is one of the educational spaces included in the minimum quality standards for this level of education (BRASIL, 2015). Elementary schools need to improve their extracurricular pedagogic spaces, not only in schools that provide advanced grades of education.

In relation to schools that share space with early childhood education, the assessment of infrastructure for small children (nursery and pre-school) should be conducted according to very specific

parameters for this stage. However, it is strange that indicators for the equity dimension (accessibility and special needs education) and pleasant environment, which are essential for small children, also have low scores for schools that provide early childhood education. This infrastructure is only appropriate in the very large schools with all stages of basic education.

In the second group of means in Table 4, the schools that provide only 1st to 5th grades have lower infrastructure scores for nearly all indicators, except for damage prevention, maintenance and comfort. In general, the higher scores are concentrated in the schools that provide only 6th to 9th grades. These results should be analyzed contextually since 68.3% of the municipal schools provide only 1st to 5th grades and they are more concentrated in the rural areas of the country (information in Table A2, Appendix). In other words, a part of this pattern is due to the location of these schools, which present the most weaknesses. Obviously, this caveat does not justify the lack of policies to match the conditions of the provision.

The total enrollment in the municipal and state schools in 2015 is a *proxy* to school size. In the literature reviewed, the infrastructure of small schools appears as less appropriate and, in general, they are in rural areas in the North and Northeast (CERQUEIRA; SAWYER, 2007; SOARES NETO et al., 2013b). We found the same pattern. The highest scores are concentrated in schools with more than 400 students. At the other extreme are the schools with 50 or fewer students. The differences are substantial, and for some indicators the means are around five points (basic services, building facilities, pedagogic spaces, equipment for administrative support and equipment for pedagogical support). For the general indicator, the scores of schools with more than 400 students are 3.5 points higher than the scores of schools with 50 students or fewer.

TABLE 4

MEANS OF SCHOOL INFRASTRUCTURE INDICATORS BY STAGE, GRADE LEVELS, NUMBER OF STUDENTS, MANAGEMENT COMPLEXITY, SES AND IDEB 2015

Discriminants Variables	Indicators*	Basic services	Building facilities	Damage prevention	Maintenance	Comfort	Pleasant atmosphere	Pedagogical spaces	Equipment for administrative support	Equipment for pedagogical support	Accessibility	Special needs education	General infrastructure
Educational stages	Primary and lower secondary education	7.2	6.4	6.5	6.5	6.7	3.5	3.3	3.9	4.4	4.0	1.4	5.5
	Early childhood, primary and lower secondary education	5.7	5.3	6.2	6.5	6.4	2.8	2.0	2.6	3.4	2.8	0.7	4.6
	Primary, lower and upper secondary education	8.7	8.1	6.7	6.4	7.1	4.6	5.7	6.1	6.2	5.3	1.5	6.6
	Early childhood, primary, lower and upper secondary education.	7.4	7.7	6.8	6.5	7.5	5.3	4.9	5.3	5.7	5.2	2.1	6.4
Grade levels	1st to 5th grade	6.0	5.2	6.6	6.7	6.7	2.7	2.0	2.6	3.3	2.8	0.7	4.6
	6th to 9th grade	8.7	8.0	6.7	6.4	6.9	4.4	5.3	5.8	6.0	5.1	1.3	6.5
	1st to 9th grade	6.9	6.8	6.2	6.3	6.5	3.9	3.8	4.3	4.9	4.4	1.6	5.7
Number of students	Up to 50	4.0	3.5	4.5	6.0	6.8	1.3	0.7	0.8	1.4	1.5	0.0	3.2
	More than 50 to 150	5.8	5.3	5.5	6.1	6.2	2.9	2.1	2.8	3.7	2.6	0.4	4.8
	More than 150 to 400	7.8	7.1	6.2	6.3	6.4	4.3	3.8	4.6	5.3	4.5	1.5	6.2
	More than 400	8.9	8.3	6.8	6.6	7.0	4.9	5.3	5.9	6.1	5.7	2.3	6.7
Complexity of management index levels	1 (lower)	4.6	4.0	6.5	6.6	6.9	1.8	1.1	1.3	1.9	1.8	0.1	3.6
	2	6.8	5.9	6.5	6.6	6.7	3.3	2.5	3.4	4.1	3.2	0.9	5.2
	3	7.2	6.8	6.5	6.5	6.7	4.0	3.6	4.3	4.9	4.3	1.5	5.8
	4	7.5	6.9	6.6	6.4	6.9	3.8	4.2	4.6	5.0	4.4	1.3	5.8
	5	7.4	6.8	6.3	6.3	6.4	3.6	3.7	4.3	4.9	4.4	1.5	5.8
	6 (higher)	8.5	8.1	6.4	6.4	6.6	4.6	5.3	5.7	6.0	5.7	2.4	6.6

Discriminants Variables	Indicators*	Basic services	Building facilities	Damage prevention	Maintenance	Comfort	Pleasant atmosphere	Pedagogical spaces	Equipment for administrative support	Equipment for pedagogical support	Accessibility	Special needs education	General infrastructure
SES Index levels	Very low	4.4	5.2	4.0	5.5	5.1	2.2	1.7	2.4	3.5	2.0	0.4	4.8
	Low	6.2	6.1	4.9	5.8	5.4	3.1	2.8	3.6	4.7	3.4	0.8	5.6
	Medium low	7.6	6.9	5.5	6.0	5.7	3.7	3.8	4.4	5.3	4.7	1.5	6.1
	Medium	8.5	7.8	6.4	6.3	6.4	4.4	4.6	5.3	5.8	5.4	2.0	6.4
	Medium high	9.2	8.4	7.3	6.9	7.5	5.3	5.3	6.1	6.3	5.5	2.2	6.8
	High	9.5	8.5	7.8	7.1	7.9	5.8	5.7	6.3	6.5	5.6	2.4	7.0
	Very high	9.4	8.3	8.0	7.9	8.2	6.0	5.9	6.5	6.7	5.6	1.6	7.1
IDEB of primary education	Low	6.7	6.2	4.8	5.6	5.1	3.2	2.7	3.5	4.4	3.4	0.9	5.7
	Medium low	7.6	7.0	5.5	5.9	5.6	3.9	3.5	4.2	5.1	4.7	1.6	6.1
	Medium	8.4	7.7	6.4	6.4	6.5	4.7	4.4	5.2	5.8	5.4	2.3	6.5
	Medium high	9.1	8.2	7.2	7.0	7.4	5.2	5.0	5.8	6.2	5.6	2.5	6.8
	High	9.3	8.3	7.6	7.3	7.8	5.5	5.2	6.1	6.4	5.5	2.4	6.9
IDEB of lower secondary education	Low	7.8	7.5	5.7	5.8	5.7	4.1	4.3	4.8	5.4	5.1	1.7	6.2
	Medium low	8.4	8.0	6.4	6.3	6.6	4.6	5.1	5.5	5.9	5.6	2.2	6.5
	Medium	8.8	8.2	6.9	6.8	7.3	5.0	5.5	6.0	6.3	5.9	2.6	6.8
	Medium high	9.0	8.4	7.5	7.2	7.9	5.5	5.7	6.2	6.4	5.9	2.5	7.0
	High	8.7	8.1	7.4	7.6	7.6	5.6	5.7	6.1	6.4	6.3	2.5	7.0

Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.

Notes: * scale from 0 (zero) to 10 (ten) points, where zero means not the absence of infrastructure, but the worst situation, and 10 means the best situation in the scale.

The management complexity indicator from INEP synthesizes the variables already presented in the "school organization types" dimension (educational stage, school grade levels and number of students), but also includes other variables from the Brazilian School Census data, such as modalities of instruction and school schedules. The indicator is divided into six categories, where group 1 corresponds to the lowest level of complexity and group 6 to the highest level. In schools with lower levels of complexity, the scores of the twelve indicators are also lower. This result confirms previous analyses.

The management complexity indicator implicitly assumes that school management is more difficult in larger schools with more stages and greater range of grade levels. This assumption is strongly embedded in the well-known relationship between this indicator and educational results (ALVES; SOARES, 2013). But it is not the same in the case of infrastructure. More complex schools are better prepared in terms of infrastructure. For example, the existence of an auditorium or sport courts may be limited by the physical space available in schools. However, we know that most schools have lower complexity: almost 70% of them are at complexity groups 1, 2 or 3 (Table A2, Appendix). For this reason, the group of specialists designated by the Ministry of Education to study the implementation of the PNE 2014 strategies on student cost/quality recommended that schools use community infrastructure to compensate for space limitations (BRASIL, 2015).

The educational literature shows that students from less advantaged social origins attend schools with weaker infrastructure conditions (GOMES; DUARTE, 2017; SOARES NETO et al., 2013b). Our study confirms this by analyzing the SES index, whose scale was divided into seven groups: group 1 corresponds to the lowest level and group 7 to the highest level. As the SES index was calculated based on the data from educational assessments conducted by INEP, there are valid scores for the schools which participated in those assessments. Thus, only 48% of the elementary schools were analyzed. However, the sample is representative of the set of Brazilian basic education schools. Table 4 shows that the higher the SES, the higher the scores of the infrastructure indicators, with the exception of the special needs education indicator. The evidence is that schools with higher SES are less equitable in this aspect.

Several studies in Brazil have shown that the infrastructure of schools influenced educational results (ALVES; SOARES, 2013; BIONDI; FELÍCIO, 2007; CERQUEIRA; SAWER, 2007; SOARES; ALVES, 2013; SOARES; ALVES; XAVIER, 2016). Two of these results are considered in IDEB: pass rate and performance. Thus, we take this indicator as a measure of school quality. For the purpose of our study, the original index scale (from 0 to 10 points) was divided into five groups, as specified

in Soares & Xavier (2013). As IDEB involves data from educational assessments, when we analyzed the relationship between the index and infrastructure indicators, we were dealing only with the schools that participated in *Prova Brasil*. We found that, in primary education (1st to 5th grade), the highest scores of the infrastructure indicators are concentrated in the highest levels of IDEB. In lower secondary education (6th to 9th grade), the pattern is similar. However, at this stage, the means for some indicators at the "high" level of IDEB are slightly lower than those found at the "medium high" level. This result may be showing only that, at this level, students are in schools with more resources than those for small children, among those analyzed in this study.

GENERAL INDICATOR OF INFRASTRUCTURE

The description of school infrastructure with these indicators emphasized a multiple view of this construct. However, to interpret the meaning of a school with high, medium or low scores, we need the items to be comparable. We did this with the general indicator, which synthesizes the 61 items used in the previous analyses.

To do this, all the items were placed in ascending order, according to their respective B parameters, estimated using IRT. The nature of the infrastructure scale is equivalent to the already known proficiency scale for national educational assessments. The B parameter refers to the difficulty of the item and is expressed in the same scale as the proficiency. The higher the B value, the more difficult the item and the higher the proficiency is. Thus, the B parameter informs the position of the item on the scale of the latent trace. In this study, the latent trace refers to the infrastructure quality; that is, the higher the B value is, the more the item is associated with a better infrastructure. For example, in the TV item, the category "one TV" has the B parameter equal to 3.74 points, a lower value than the "Computer Lab", which is 5.12 points.[10] This is because, although the latter is necessary for contemporary pedagogic work, it is still less common than TV sets and, therefore, is associated with a higher quality of infrastructure. Figure A3 of the Appendix shows the mapping with the scaling of all items.

The next step was to analyze this mapping by creating quality levels for general infrastructure. There are appropriate methodologies for defining cutoff points in proficiency scales (ZIEKY; PERIE, 2006). Use of expert judgment is one of these methodologies. We chose to define the cutoff points on the infrastructure scale in this way, which allowed us to consider the specificity of the school. Following this decision, the scale was sectioned into six points according to the B parameter scores of the general infrastructure items. This created seven levels, which are: (I) up to 2 points, corresponding to the least appropriate situation; (II) more than 2, up to 4 points; (III) more than 4, up to 5 points; (IV) more

10 The original scale of the B parameters in standard deviations was transformed into the scale of 0 to 10, just as we did with the scales of all the indicators.

than 5, up to 6 points; (V) more than 6, up to 7 points; (VI) more than 7, up to 8 points; and (VII) more than 8 points, corresponding to the most appropriate situation. These levels reflect the gains in quality, according to the attributes measured using the variables and their respective categories.

Table 5 summarizes the interpretation of the levels of the scale of the general infrastructure. The first column shows the seven groups. The second column summarizes the characteristics of the schools described by the items placed at the same intervals as the values, according to the mapping shown in Figure A3 in the Appendix. The last column describes the typical profile of the school at that level, obtained from a descriptive analysis of the levels by discriminant variable. We emphasize that this analysis included all public and private schools.

According to the descriptions in Table 5, at level I, the infrastructure fails with respect to the human dignity of the students and teachers, as there is not even one bathroom in the building. Moving from one level to another, schools begin to incorporate quality with better operating conditions, especially from level V, which contain installations, spaces and equipment for pedagogical work. However, only schools at the highest levels (VI and VII) are equipped and adapted to serve all types of students, with accessibility and special needs education resources.

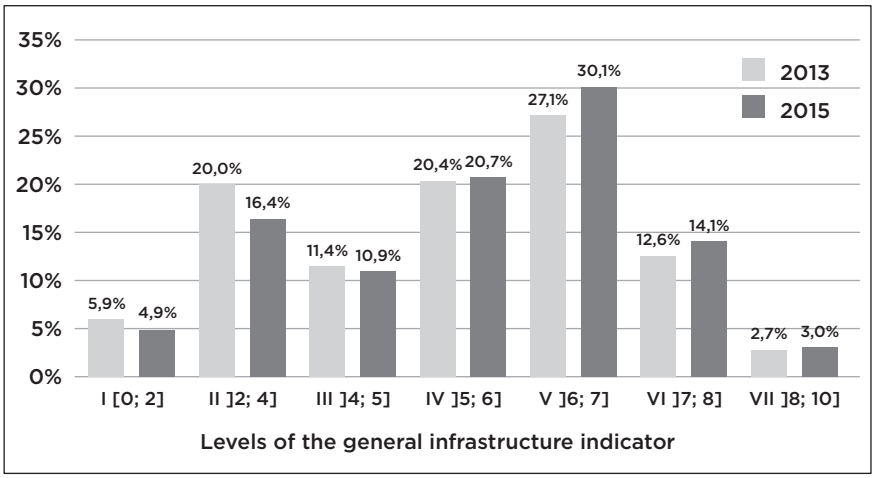
TABLE 5
LEVELS OF GENERAL INFRASTRUCTURE SCALE, ITS INTERPRETATION AND TYPICAL SCHOOL PROFILE

Level	Interpretation	Typical profile*
I (<= 2)	There are no toilets, or if there are, they are outside the building; there is no running water, or, when there is, it is from a river, a well or a natural source; there is no electricity or it uses a generator or something similar; there is no sewer, but in this group there are schools with a septic tank; there may be a kitchen and filtered water.	North region; rural; municipal sector; up to 50 pupils; elementary school or elementary and preschool (-); very low SES.
II (+ 2 a 4)	There is water from an artesian well, bathroom inside the school and electricity; 1 TV and 1 DVD player; and there is little sign of depredation.	North and Northeast regions; rural; municipal sector; up to 50 pupils or more than 50 up to 150 pupils; elementary and pre-school or only elementary school; very low and low SES.
III (+4 a 5)	There are: water and electricity from the public system and waste collection; a teachers' lounge; a schoolyard; a sound system; a camera; a printer; a computer for administrative use; 1 to 5 computers for pupils; Internet (but not broadband). There are: physical and equipment security; classrooms, kitchen, corridors, roofs, paved floors, doors, etc. There is regular maintenance, but windows and external lighting are in bad shape; but the classrooms are lit.	Northeast region; rural; municipal sector; up to 50 pupils, or more than 50 up to 150 pupils; elementary and preschool; very low or low medium SES.
IV (+5 a 6)	In addition to the previous items, there is sewage; the maintenance of walls, windows, floors, etc. is good, without depredation; the maintenance of the schoolyard, plumbing and electrical installations and the bathrooms is regular; outdoor lighting and fire protection is bad or regular; there are: a library or reading room, a computer lab, an outdoor schoolyard, pantry and warehouse, airy and well-lit classrooms, airy and well-lit library, multimedia equipment, a photocopier, broadband internet, 2 printers, 2 TV sets, 2 sound systems, 3 DVD players, 2 to 3 computers for administrative use, 6 to 10 computers for pupils, barely adequate accessibility.	Northeast and Midwest regions; urban; state (+) and municipal sector; more than 50 to 400 pupils; all levels of basic education; very low and medium SES.
V (+6 a 7)	In addition to the previous items, there are: a science lab, 4 to 7 computers for administrative use, 11 to 20 computers for pupils, at least 3 printers, of which one is multifunctional, at least 3 TV sets, sound systems, DVD players, 2 cameras, multimedia equipment (2), 2 photocopiers, bathrooms with showers in good condition, an indoor court, a green area, children's playground, indoor and outdoor schoolyards, a cafeteria, and accessible facilities and bathrooms. Fire protection is regular or good; outdoor lighting is good; plumbing and electrical installations are good; good general state of maintenance.	Midwest, Southeast and South regions; urban; state, municipal and private sector; from 150 to 400, or more than 400 pupils; all levels of basic education; low to high medium SES.
VI (+ 7 a 8)	In addition to the previous items, there are: a reading room and library; auditorium; outdoor and indoor courts; 20 or more computers for pupils; 7 or more computers for administrative use; multimedia equipment (3 or more), photocopiers and cameras; 2 multifunction printers; infrastructure for the disabled is appropriate.	Southeast, South and Midwest (-) regions; urban; federal, state and private sector; more than 400 students; elementary school or elementary school and upper secondary education; high medium to very high SES.
VII (> 8)	In addition to all previous items, there are 3 or more multifunctional printers; accessible information technology; resources for special needs education (alternative augmentative communication, Soroban, Braille).	South and Southeast region; urban, federal sector; more than 400 pupils; all levels of basic education; high and very high SES.

Source: Based on the School Census data from 2013 and 2015, or SAEB data from 2013 and 2015.
Note: *Schools from all the administrative sectors are considered to describe the typical profile.

Figure 1 shows the distribution of public and private elementary schools in the seven levels of the general infrastructure indicator. Most of the schools have scores between 6 and 7 points, corresponding to level V of the scale. There was improvement in the quality of the indicator from 2013 to 2015: the reduction of the percentage of schools in the lowest levels (I to III) and growth in the number of schools from level IV.

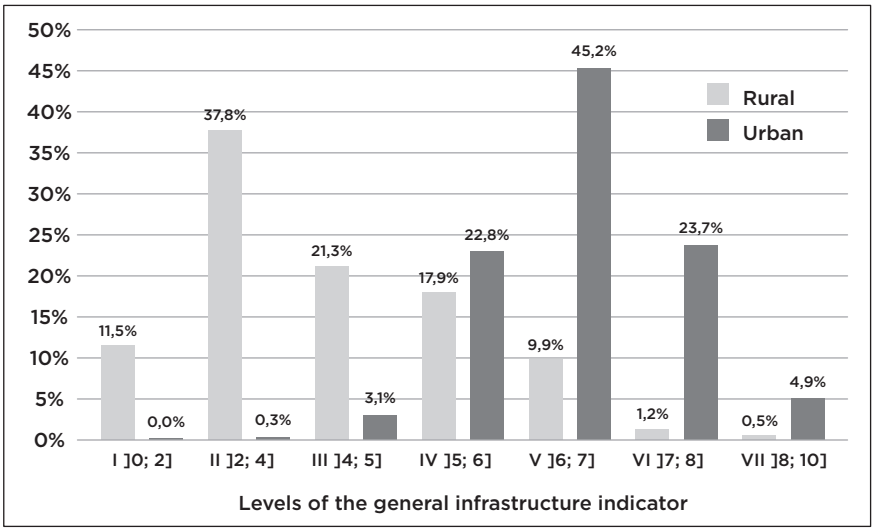
FIGURE 1
PERCENTAGE OF ELEMENTARY SCHOOLS (PUBLIC AND PRIVATE) BY LEVELS OF THE GENERAL INFRASTRUCTURE INDICATOR – 2013 AND 2015



Source: Based on the School Census data from 2013 and 2015, or SAEB data from 2013 and 2015.

Rural schools predominate at the lowest levels of the scale, according to Figure 2, which shows the percentages of the levels by location in 2015. There are urban and rural schools along the entire scale; however, rural schools are concentrated at levels I to IV and urban schools from level IV on. We know that rural schools need more investment in order to improve their infrastructure. This result reflects what had previously been demonstrated by the description of the eleven indicators. However, specific studies to capture the particularities of rural schools are needed.

FIGURE 2
PERCENTAGE OF ELEMENTARY SCHOOLS (PUBLIC AND PRIVATE) BY LOCATION (URBAN AND RURAL) AND INFRASTRUCTURE INDICATOR – 2015



Source: Based on the School Census data from 2013 and 2015, or SAEB data from 2015.

FINAL REMARKS

In this study, we presented a set of indicators for evaluating school infrastructure, focusing on public elementary schools which provide primary and lower secondary education. The concept of infrastructure, such as several others in social research, is multifaceted and its limits are not very clear or consensual. It is often up to the researcher to assign meaning to it, as well as to specify how the concept can be operationalized empirically.

In this article, we assume that infrastructure is part of the educational provision (input) and, at the same time, a mediating factor for teaching and learning (process), and it is considered an attribute that guarantees the right to education. In addition, it assumes that school infrastructure should be investigated in multiple dimensions; the way of dealing with the concept is one of the innovations of the present study.

Thus, we estimated twelve indicators of school infrastructure. Eleven of them feature different aspects of infrastructure, which is presented in a multidimensional perspective. Based on these indicators, it is possible not only to capture variations in the Brazilian territory, but also to observe which infrastructure aspect needs more attention in a given municipality or school. This is relevant as it allows more accuracy in the monitoring and targeting of educational policies. In turn, the general indicator has three main purposes: to identify the relative weight of all the items in the general scale, to georeference the

distribution of infrastructure quality by territory, and to be included as an independent variable for studies on school effectiveness. The first purpose was explored in the present study and the other two will be developed in future studies.

We also highlight some innovations of the present study in database treatment. One of them was gathering items from different sources and different editions. Thus, from the Brazilian School Census databases, we obtained information about various items of interest; and, from the SAEB databases, the maintenance conditions and use of some of them. At the same time, when we established the estimation parameters for two editions of the study, we were able to show the evolution of the indicators from 2013 to 2015. Another innovation was grouping some dichotomous items of the Brazilian School Census data into ordinal variables. In this way, we could maximize the information of the items in the indicators and refine the differences among schools.

Despite the limitations of the data to assess all dimensions, we realized that the Brazilian School Census and SAEB produce the best information to characterize Brazilian schools. The results obtained proved to be robust for distinguishing elementary schools from a multidimensional perspective. Even so, when dealing with the challenge of constructing indicators to measure empirical phenomena in the social field, researchers should use their experience and knowledge to assess critically the empirical analyses and, thus, avoid the risk of reification of the measure (JANNUZZI, 2002).

In general, we observed that our findings are consistent with those in the literature and that both the eleven indicators and the scale of the general indicator converge with other studies. However, we interpreted the distribution of quality differently from previous studies.

Our results show that schools are, in a general way, better than shown in some previous studies (CERQUEIRA; SAWER, 2007; SOARES NETO et al., 2013a). This may be due to the fact that more investments have actually been made in education in recent years. Direct public investment in education per basic student grew 205% from 2002 to 2015 (BRASIL, 2018c). There was also improvement in access to the public services that make up one of the indicators measured. For example, in 2015, 99.2% of private households had access to electric power. The biggest growth in access, compared to 2002, occurred in rural areas in the North and Northeast, among the poorest and the residents of *quilombola* and remote areas (CAMPELLO, 2017).

Although schools are better, our results do not show that most students are enrolled in public schools with high quality conditions, according to Gomes and Duarte (2017). There is still a lot be done, mainly for municipal rural schools in the North and Northeast. Despite

the increase in resources for education, investment is far from ideal to ensure quality cost deployment per student as stipulated in the 2014 PNE, or to reduce asymmetries in the vast national territory (CAVALCANTI, 2016). As previously pointed out, the indicators can assist in monitoring infrastructure, but funding issues go beyond the scope of our research.

It should be emphasized that the indicators are not ideal for assessing school conditions in specific locations, such as sustainable use units in indigenous lands or remnants of *quilombo* communities. These schools are very few and have special characteristics regarding the use of the territory, which are not addressed in the study questionnaires. This limitation is not unique to the present study. No quantitative study that we reviewed conducted a specific analysis of these establishments that are subsumed within the category of "rural location".

Regarding the reliability of the indicators, this needs to be reviewed carefully according to criteria external to the empirical data. The infrastructure construct is not fixed and may undergo more abrupt changes than those constructs related to individuals (SES, for example). In other words, infrastructure can improve or worsen depending on the investment in education and on the capacity of educational systems to expand spaces and to keep environments and resources in good condition. School infrastructure also goes through continuous change as new resources appear, while others become obsolete and demands, which were neglected in the past, are no longer ignored. For example, special needs education resources are very poorly distributed among schools, but today they are recognized as necessary for inclusive pedagogical work to ensure the effective right to education for all.

Finally, we hope that this article encourages discussion regarding the information necessary for a systemic evaluation of school infrastructure, guided by civic values and having as reference the quality of education, equity and human rights as stated in the current National Education Plan (BRAZIL, 2014).

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APPENDIX

TABLE A1
DESCRIPTIVE STATISTICS (%) OF THE INDICATOR VARIABLES

Indicator	Variables	Categories	2013	2015
Basic services	Water	Nonexistent	5.9	5.7
		Natural source/River/Well	18.4	16.3
		Artesian well	14.1	14.2
		Public system	61.6	63.8
	Electricity	Nonexistent	5.6	4.5
		Generator/others	2.4	2.4
		Public system	91.9	93.1
	Sewer	Nonexistent	7.2	6.7
		Cesspool	54.9	53.7
		Public system/cesspool	37.9	39.7
	Waste	Other destination/burning/burying/ dumped elsewhere	35.6	32.4
		Periodical collection	64.4	67.6
Building facilities	Bathroom	No	5.1	4.8
		Only outdoors	10.4	9.0
		Only indoors, or indoors and outdoors	84.4	86.2
	Kitchen	No	10.1	9.2
		Yes	89.9	90.8
	Cafeteria	No	72.7	68.4
		Yes	27.3	31.6
	Pantry	No	57.3	49.9
		Yes	42.7	50.1
	Filtered water	No	11.9	15.0
		Yes	88.1	85.0
	Principal's office	No	36.5	35.3
		Yes	63.5	64.7
	Teachers' lounge	No	45.8	43.5
		Yes	54.2	56.5
	Secretariat	No	47.9	39.8
		Yes	52.1	60.2
	Warehouse	No	69.4	64.2
		Yes	30.6	35.8

(continued)

(Continuation)

Indicator	Variables	Categories	2013	2015
Damage prevention	Fire protection (*)	Nonexistent	41.1	39.0
		Bad	10.5	10.8
		Regular	19.3	20.4
		Good	29.1	29.8
	Outdoors and indoors lighting (*)	Nonexistent	8.9	6.6
		Bad	16.6	17.0
		Regular	29.8	31.1
		Good	44.7	45.3
	School security (*)	No	22.3	20.4
		Yes	77.7	79.6
	Equipment security (*)	No	10.9	10.2
		Yes	89.1	89.8
Maintenance (continued)	Roof (*)	Bad	13.2	12.9
		Regular	30.2	31.1
		Good	56.6	56.0
	Wall (*)	Bad	7.7	7.2
		Regular	31.7	32.4
		Good	60.6	60.4
	Floor (*)	Bad	12.7	11.2
		Regular	29.4	29.7
		Good	57.9	59.2
	Building entrance (*)	Bad	10.3	9.1
		Regular	29.2	28.8
		Good	60.5	62.1
	Schoolyard (*)	Bad	15.6	14.1
		Regular	29.3	29.7
		Good	55.1	56.2
	Corridors (*)	Bad	11.3	10.0
		Regular	25.9	26.7
		Good	62.8	63.3
	Classrooms (*)	Bad	8.7	8.5
		Regular	35.0	35.7
		Good	56.3	55.8
	Doors (*)	Bad	15.7	15.5
		Regular	36.7	37.6
		Good	47.6	46.9
	Windows (*)	Nonexistent	3.6	3.5
		Bad	12.8	12.9
		Regular	30.4	31.8
		Good	53.2	51.8

(continued)

(Continuation)

Indicator	Variables	Categories	2013	2015
Maintenance	Bathroom (*)	Bad	22.7	20.6
		Regular	35.2	36.8
		Good	42.1	42.6
	Kitchen (*)	Bad	14.2	12.6
		Regular	30.1	30.6
		Good	55.6	56.8
	Plumbing (*)	Bad	19.6	18.3
		Regular	35.0	36.1
		Good	45.4	45.6
	Electric installations (*)	Bad	22.1	22.0
		Regular	33.2	33.8
		Good	44.7	44.2
	Signs of depredation (*)	Yes, a lot	8.5	8.6
		Yes, a little	34.5	36.1
		No	56.9	55.2
Comfort	Classroom lighting (*)	None/less than half	13.3	12.6
		More than half	22.3	23.1
		All	64.4	64.2
	Airy classrooms (*)	None/less than half	20.0	20.7
		More than half	21.4	21.5
		All	58.5	57.8
	Well-lit and airy library/reading room (*)	No	36.7	36.4
		Yes	63.3	63.6
Pleasant atmosphere	Schoolyard	No	45.6	36.9
		One (indoors or outdoors)	39.3	44.5
		Indoor and outdoor schoolyard	15.1	18.6
	Bathroom with shower	No	70.4	63.6
		Yes	29.6	36.4
	Green area	No	75.2	71.2
		Yes	24.8	28.8
	Playground	No	77.8	76.8
		Yes	22.2	23.2

(continued)

(Continuation)

Indicator	Variables	Categories	2013	2015
Pedagogical spaces	Information technology lab	No	48.6	48.5
		Yes	51.4	51.5
	Computers for the students	None	39.5	43.2
		1 to 5	17.1	14.0
		6 to 10	13.1	12.7
		11 to 15	8.2	8.7
		16 to 20	12.2	11.5
		More than 20	9.9	9.9
	Reading room and library	Neither	49.7	47.4
		Only reading room	12.8	13.0
		Only library	28.7	29.4
		Both	8.8	10.2
	Court	None	63.8	60.7
		Only outdoors	13.9	13.6
		Only indoors	17.6	20.6
		Indoors and outdoors	4.7	5.1
	Science lab	No	88.4	87.8
		Yes	11.6	12.2
	Auditorium	No	91.8	90.2
		Yes	8.2	9.8
Equipment for administrative support	Photocopier	None	52.3	50.6
		1	32.1	31.2
		2	10.4	11.9
		3 or more	5.1	6.3
	Printer	None	32.9	29.6
		1	25.4	27.4
		2	14.0	15.8
		3	10.0	10.7
		4 or more	17.8	16.4
	Multifunctional printer	None	-	67.5
		1	-	16.8
		2	-	8.3
		3 or more	-	7.4
	Computer for administrative use	None	33.6	36.8
		1	20.1	15.8
		2 or 3	21.4	20.7
		4 to 7	16.8	17.4
		More than 7	8.0	9.3
	Internet	No	44.8	37.5
		Yes, without broadband	9.6	11.3
		Yes, with broadband	45.6	51.2

(continued)

(Continuation)

Indicator	Variables	Categories	2013	2015
Equipment for pedagogical support	TV	None	26.5	21.0
		1	34.1	33.8
		2	17.4	20.0
		3 or more	22.0	25.2
	DVD player	None	29.0	24.8
		1	40.7	41.2
		2	16.5	18.6
		3 or more	13.8	15.4
	Sound system	None	37.9	29.9
		1	27.6	29.3
		2	12.6	15.0
		3	7.9	9.2
		4 ou more	14.0	16.6
	Multimedia equipment	None	53.8	44.2
		1	28.5	32.5
		2	10.1	12.4
		3 or more	7.6	10.9
	Camera	None	50.5	41.4
		1	35.2	38.7
		2	9.7	13.1
		3 or more	4.6	6.8
Accessibility	Accessible bathroom	No	73.5	66.5
		Yes	26.5	33.5
	Accessible facilities	No	77.7	73.3
		Yes	22.3	26.7
	Accessible infrastructure (*)	No	31.4	24.2
		Yes, but barely appropriate	48.0	51.4
		Yes, sufficiently appropriate	20.7	24.5
Special needs education	Braille	No	97.7	97.1
		Yes	2.3	2.9
	Alternative and augmentative communication	No	94.8	93.0
		Yes	5.2	7.0
	Soroban	No	96.6	95.8
		Yes	3.4	4.2
	Accessible information technology	No	92.4	89.6
		Yes	7.6	10.4

Source: Based on the School Census data from 2013 and 2015, or SAEB data from 2013 and 2015, when variable is marked (*).

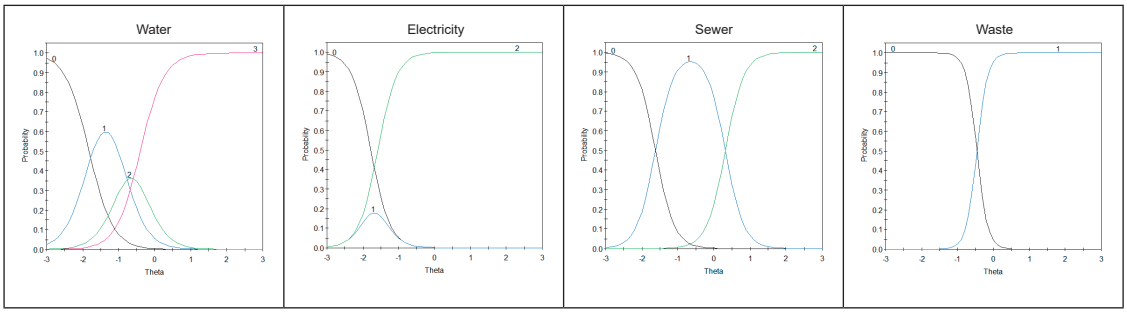
TABLE A2
POLYCHORIC CORRELATION AMONG VARIABLES OF THE BASIC SERVICES INDICATOR

	Sewer	Water	Electricity	Waste
Sewer	1.00	0.78	0.78	0.86
Water	0.78	1.00	0.70	0.85
Electricity	0.78	0.70	1.00	0.85
Waste	0.86	0.85	0.85	1.00

Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.

The correlation matrix shows that all items are positively correlated with each other; then the unidimensionality assumption of the construct is satisfied.

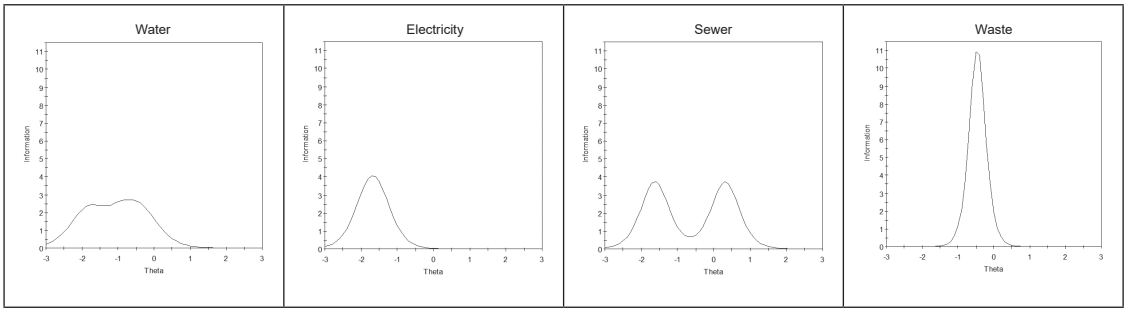
FIGURE A1
ITEM CHARACTERISTIC CURVE (ICC) FOR BASIC SERVICE INDICATOR ITEMS



Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015.

The ICCs show the relationship between the probability of an individual choosing a response option from each of the items and the measured construct. The IICs indicate the range of values in the scale of the construct in which each of the four items provides more information.

FIGURE A2
ITEM INFORMATION CURVE (IIC) FOR BASIC SERVICE INDICATOR ITEMS



Source: Based on microdata from the School Census data and from SAEB data, 2013 and 2015

TABLE A3
PERCENTAGE OF THE DISCRIMINANT VARIABLES BY SCHOOL SECTOR (2015)

		School sector				
		Brazil	Federal	State	Municipal	Private
Location	Urban	56.5%	97.8%	80.9%	38.5%	98.6%
	Rural	43.5%	2.2%	19.1%	61.5%	1.4%
Region	North	14.8%	10.9%	13.7%	17.7%	5.2%
	Northeast	41.2%	19.6%	16.2%	49.5%	36.1%
	Southeast	26.9%	52.2%	38.5%	19.6%	42.2%
	South	11.6%	10.9%	21.6%	9.5%	9.3%
	Midwest	5.4%	6.5%	10.0%	3.7%	7.2%
State	Rondônia	0.8%	0.0%	1.6%	0.7%	0.4%
	Acre	1.1%	2.2%	2.4%	1.0%	0.1%
	Amazonas	3.6%	2.2%	2.2%	4.8%	0.9%
	Roraima	0.5%	2.2%	1.5%	0.3%	0.1%
	Pará	7.3%	4.3%	2.5%	9.8%	3.0%
	Amapá	0.5%	0.0%	1.5%	0.3%	0.2%
	Tocantins	1.0%	0.0%	1.9%	0.9%	0.5%
	Maranhão	7.8%	4.3%	1.7%	10.6%	3.1%
	Piauí	3.0%	0.0%	1.3%	3.9%	1.6%
	Ceará	4.5%	2.2%	0.8%	5.1%	5.8%
	Rio Grande do Norte	2.1%	2.2%	2.1%	2.0%	2.2%
	Paraíba	3.4%	2.2%	2.5%	3.7%	3.4%
	Pernambuco	5.7%	4.3%	2.9%	5.9%	7.8%
	Alagoas	1.9%	0.0%	0.8%	2.2%	1.9%
	Sergipe	1.4%	2.2%	1.3%	1.4%	1.4%
	Bahia	11.5%	2.2%	2.7%	14.6%	8.7%
	Minas Gerais	8.3%	10.9%	13.5%	6.8%	8.3%
	Espírito Santo	1.7%	0.0%	1.7%	1.9%	0.9%
	Rio Janeiro	5.7%	39.1%	3.3%	4.2%	13.9%
	São Paulo	11.2%	2.2%	20.1%	6.7%	19.0%
	Paraná	4.6%	2.2%	8.0%	3.6%	5.1%
	Santa Catarina	2.4%	2.2%	3.9%	2.2%	1.7%
	Rio Grande do Sul	4.6%	6.5%	9.7%	3.8%	2.6%
	Mato Grosso do Sul	0.8%	2.2%	1.3%	0.6%	1.2%
	Mato Grosso	1.5%	0.0%	2.7%	1.2%	1.3%
	Goiás	2.5%	2.2%	3.8%	1.9%	3.5%
	Distrito Federal	0.6%	2.2%	2.2%	0.0%	1.3%
Educational stages	Primary and lower secondary education	31.5%	15.2%	39.7%	35.4%	8.3%
	Early childhood, primary and lower secondary education	52.9%	13.0%	3.0%	64.3%	61.6%
	Primary, lower and upper secondary education	11.5%	60.9%	56.3%	0.2%	7.9%
	Early childhood, primary, lower and upper secondary education.	4.1%	10.9%	1.0%	0.1%	22.2%
Grade levels	1st to 5th grade	55.5%	17.4%	17.8%	68.3%	46.5%
	6th to 9th grade	11.8%	43.5%	47.9%	3.9%	4.1%
	1st to 9th grade	32.7%	39.1%	34.3%	27.9%	49.4%
Number of students	Up to 50	25.5%	0.0%	7.9%	34.5%	9.9%
	More than 50 up to 150	21.7%	2.2%	10.7%	22.3%	31.0%
	More than 150 up to 400	27.4%	8.7%	26.6%	25.2%	36.3%
	More than 400	25.4%	89.1%	54.9%	18.0%	22.8%

(continued)

(Continuation)

		School sector				
		Brazil	**Federal**	**State**	**Municipal**	**Private**
Complexity of management index levels (*)	1 (lower)	20.7%	0.0%	7.4%	26.8%	11.3%
	2	25.4%	19.6%	12.1%	26.9%	33.3%
	3	22.2%	39.1%	19.4%	21.6%	27.6%
	4	15.2%	21.7%	32.0%	8.0%	25.2%
	5	12.1%	4.3%	17.9%	13.4%	1.3%
	6 (higher)	4.4%	15.2%	11.2%	3.3%	1.3%
SES Index levels (*)	Very low	1.6%	0.0%	0.4%	2.5%	0.1%
	Low	8.7%	0.0%	3.5%	13.0%	0.2%
	Medium low	19.2%	0.0%	14.5%	25.0%	0.9%
	Medium	23.8%	2.3%	30.2%	23.6%	5.3%
	Medium high	30.7%	4.5%	40.2%	28.2%	15.9%
	High	12.0%	38.6%	11.1%	7.7%	38.7%
	Very high	4.1%	54.5%	0.1%	0.1%	38.9%
IDEB of primary education (*)	Low	7.0%	0.0%	3.4%	8.0%	0.0%
	Medium low	21.5%	0.0%	12.0%	23.9%	0.0%
	Medium	29.1%	0.0%	27.4%	29.6%	0.0%
	Medium high	30.3%	33.3%	38.8%	28.1%	0.0%
	High	12.1%	66.7%	18.4%	10.4%	0.0%
IDEB of lower secondary education (*)	Low	26.3%	0.0%	23.2%	28.3%	0.0%
	Medium low	41.8%	6.7%	43.4%	40.7%	0.0%
	Medium	27.0%	13.3%	29.0%	25.7%	0.0%
	Medium high	4.7%	60.0%	4.3%	4.9%	0.0%
	High	0.3%	20.0%	0.1%	0.4%	0.0%

Source: Based on microdata from the School Census data and from SAEB data, 2015
Note: * Indexes calculated by INEP.

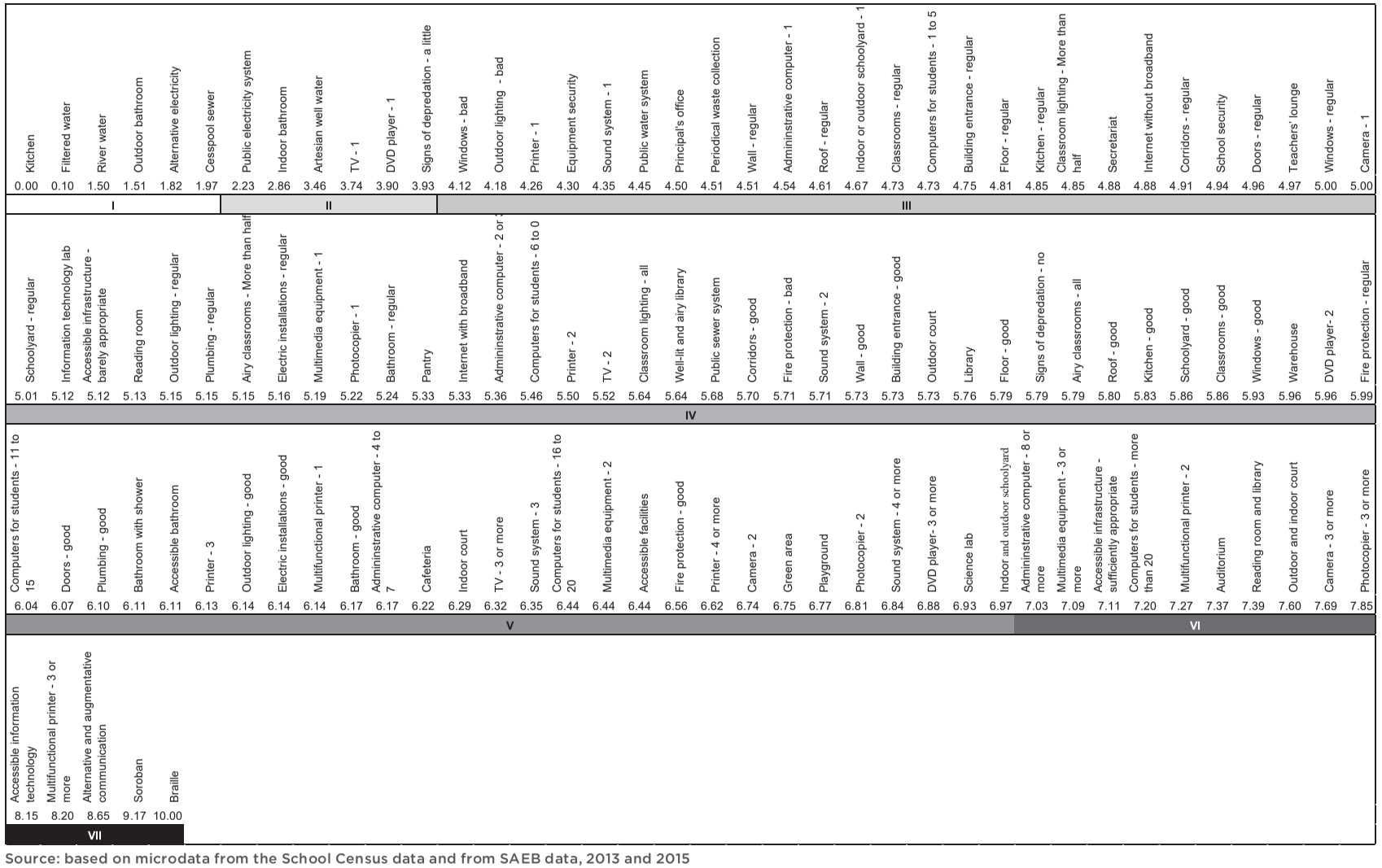
TABLE A4
MEANS OF SCHOOL INFRASTRUCTURE INDICATORS (*) BY BRAZILIAN FEDERAL STATES, 2013 AND 2015

Indicators	Year	North							Northeast									Southeast				South			Midwest			
		RO	AC	AM	RR	PA	AP	TO	MA	PI	CE	RN	PB	PE	AL	SE	BA	MG	ES	RJ	SP	PR	SC	RS	MS	MT	GO	DF
Basic services	2013	5.5	3.5	3.7	4.5	4.1	5.0	6.1	4.6	5.2	6.4	6.6	5.8	5.8	6.1	6.9	5.9	7.8	7.4	8.9	9.4	8.1	7.8	7.9	7.6	6.3	7.6	9.3
	2015	5.7	3.5	3.7	4.5	4.2	5.0	6.3	4.7	5.5	6.6	6.7	6.0	6.1	6.2	7.0	6.2	8.0	7.6	8.9	9.4	8.2	7.9	7.9	7.7	6.4	7.7	9.3
Building facilities	2013	6.1	4.0	3.5	4.4	4.1	5.5	5.8	4.1	4.7	6.1	5.8	5.2	5.0	5.6	5.5	4.6	6.6	6.6	8.2	8.3	7.6	6.9	7.1	7.5	6.4	6.6	7.4
	2015	6.5	4.2	3.6	4.5	4.3	5.7	6.2	4.3	5.1	6.5	6.1	5.5	5.2	5.8	5.8	4.9	7.0	6.9	8.4	8.3	7.8	7.3	7.3	7.7	6.6	6.9	7.6
Damage prevention	2013	6.2	5.6	5.8	5.0	4.5	4.9	6.0	5.0	5.3	5.3	5.1	6.1	5.3	4.9	5.8	5.2	5.9	6.8	7.6	7.9	7.4	7.1	7.1	7.0	6.5	6.3	7.3
	2015	6.4	5.5	5.9	5.5	4.8	4.9	6.1	5.2	5.3	5.8	5.3	6.3	5.6	5.2	6.2	5.5	6.0	7.0	7.6	7.9	7.5	7.2	7.2	6.9	6.7	6.3	7.1
Maintenance	2013	6.4	5.9	6.5	5.1	5.6	5.8	6.0	5.6	5.9	6.1	5.8	6.1	6.0	5.5	5.8	5.8	6.4	6.4	7.1	7.5	6.6	6.6	6.5	6.7	6.0	6.3	6.9
	2015	6.3	5.8	6.6	5.7	5.7	5.7	5.9	5.7	5.9	6.6	5.7	6.3	6.2	5.9	6.1	5.9	6.4	6.5	7.0	7.3	6.7	6.7	6.6	6.5	6.1	6.2	6.6
Comfort	2013	6.3	5.5	6.6	4.6	5.1	5.3	6.1	5.4	6.3	5.7	5.2	6.2	5.7	5.1	5.6	5.6	7.0	6.7	7.6	8.3	7.4	7.4	7.5	6.8	6.3	6.5	7.2
	2015	6.8	5.5	6.5	5.3	5.1	5.0	6.1	5.3	6.2	6.1	5.2	6.4	5.6	5.1	6.0	5.7	7.0	6.4	7.6	8.2	7.2	7.5	7.6	6.4	6.7	6.1	6.7
Pleasant atmosphere	2013	3.1	0.9	1.0	1.9	1.2	2.0	2.6	1.3	2.1	2.9	2.0	1.5	1.6	2.6	3.1	1.6	3.3	3.4	5.1	5.1	5.5	4.7	4.8	4.9	2.8	3.4	4.9
	2015	3.8	1.3	1.1	2.2	1.6	2.4	3.5	1.7	2.7	3.5	2.8	2.0	2.2	3.2	4.0	2.2	3.8	3.9	5.5	5.1	6.0	5.4	5.4	5.6	3.5	4.0	5.5
Pedagogical spaces	2013	3.0	1.3	1.3	1.7	1.3	2.4	3.0	1.1	1.7	3.4	2.8	2.2	2.0	2.4	2.2	1.7	3.8	3.6	4.6	4.8	5.1	4.8	4.8	5.6	4.0	4.2	5.1
	2015	3.0	1.2	1.2	1.7	1.4	2.4	2.9	1.1	1.7	3.5	2.8	2.3	2.0	2.4	2.1	1.8	3.9	3.5	4.5	4.9	5.0	4.8	4.8	5.5	4.0	4.2	4.8
Equipment for administrative support	2013	4.1	1.5	1.4	1.9	1.5	2.5	4.1	1.2	1.9	3.4	2.9	2.2	2.2	2.5	2.7	2.2	4.3	3.7	5.0	6.0	5.4	4.9	5.1	5.8	4.6	5.0	6.2
	2015	4.3	1.5	1.4	2.0	1.7	2.6	4.1	1.5	2.4	3.8	3.2	2.4	2.5	2.8	3.0	2.5	4.5	3.8	5.0	6.1	5.5	4.9	5.1	5.7	4.7	5.0	5.9
Equipment for pedagogical support	2013	4.0	1.7	1.5	2.1	1.6	2.8	3.8	1.6	2.3	4.4	3.5	3.0	3.1	3.2	3.5	2.8	4.5	4.1	5.1	6.2	5.7	5.5	5.3	5.7	4.6	5.1	6.2
	2015	4.4	1.9	1.6	2.2	2.0	3.0	4.2	2.1	3.0	5.1	4.1	3.5	3.7	3.8	4.2	3.4	4.8	4.5	5.8	6.2	6.1	5.8	5.7	6.0	4.9	5.5	6.3
Accessibility	2013	4.0	2.3	1.8	2.2	2.0	2.6	3.4	2.0	2.3	3.3	3.4	2.8	2.4	2.9	3.2	2.2	3.5	3.6	4.6	3.8	4.2	4.6	4.1	6.2	4.2	4.9	6.4
	2015	4.6	2.4	1.8	2.6	2.3	3.0	4.0	2.3	2.9	4.0	4.0	3.3	2.8	3.3	3.9	2.7	4.0	4.2	5.1	4.1	5.4	5.4	4.9	6.4	4.6	5.5	6.6
Special Needs Education	2013	1.3	1.2	0.2	0.9	0.3	1.6	1.3	0.2	0.3	0.9	0.7	0.5	0.4	0.6	0.5	0.3	0.8	1.3	1.0	1.5	1.6	1.6	1.6	2.4	1.5	1.2	2.7
	2015	1.9	1.3	0.2	1.2	0.6	1.8	1.6	0.3	0.5	1.3	1.0	0.7	0.6	0.9	0.8	0.4	1.2	1.7	1.2	1.7	1.7	2.1	2.0	2.7	2.2	1.8	2.6
General infrastructure	2013	5.2	3.2	3.2	3.7	3.5	4.5	5.2	3.7	4.2	5.4	5.0	4.6	4.5	4.8	5.0	4.3	5.6	5.4	6.4	6.7	6.3	6.2	6.2	6.5	5.5	6.0	6.7
	2015	5.4	3.3	3.2	3.7	3.7	4.6	5.3	3.9	4.6	5.7	5.2	4.8	4.8	5.0	5.3	4.6	5.8	5.6	6.5	6.7	6.5	6.3	6.3	6.5	5.7	6.1	6.7

Source: based on microdata from the School Census data and from SAEB data, 2013 and 2015
Note: (*) scale from 0 (zero) to 10 (ten) points where zero means not the absence of infrastructure, but the worst situation, and 10 means the best situation in the scale.

FIGURE A3

SCALE OF GENERAL INFRASTRUCTURE INDICATOR ITEMS (0 TO 10 POINTS) ACCORDING TO B PARAMETER ESTIMATED BY IRT



Source: based on microdata from the School Census data and from SAEB data, 2013 and 2015