

# The Challenge of School Dropout in Brazil: An Analysis of Over Two Decades

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## Abstract

School dropout is a critical challenge for Brazilian education, having a multicausal nature and the potential to disrupt academic trajectories. This paper contributes to discussions on school dropout by covering primary and secondary educational levels. We conducted an extensive exploratory analysis of data provided by the National Institute of Educational Studies and Research Anísio Teixeira (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira - INEP) from 1996 to 2022, considering factors such as government transitions and unforeseen events (e.g., financial crises and the COVID-19 pandemic). Thus, we handled millions of instances from the INEP database to explore data using Google Colab. We focused on the relationship between student dropout rates and various other factors, including categorical variables such as school location, type of administrative management, geographical region, and year, as well as numerical variables such as the number of classes, number of teachers, number of approved students, and number of failed students. Our goal was to identify which combination of these characteristics contributed most to the increase in student dropout rates. Our findings evidence that schools in urban areas of the Northeast region, whether municipal or state-run, have the highest student dropout rates in basic education in Brazil. The state of Alagoas shows a more pronounced duality in its education networks than the rest of Brazil, as the highest rates in elementary education occur in municipal schools. In contrast, state schools are the major contributors to high numbers of dropout. Alagoas faces the most concerning dropout rates in high school education. The results showed periods of growth and decline in student dropout rates, aligning with government transitions, certain financial crises, and the COVID-19 pandemic. There is also a correlation between dropouts and failures in both elementary and high school education, with the correlation being much stronger in elementary education.

**Keywords:** School Dropout; Data Analytics; Public Education.

## 1 Introduction

Brazil's gross domestic product stands at 10.9 trillion reais, placing it among the largest economies in the world (IBGE, 2024). However, there is significant social inequality, with some regions experiencing it more acutely than others. Several public sectors, especially education, need careful planning and resource allocation to reduce such disparities. School dropout is an example of a critical challenge for Brazilian education, potentially disrupting academic trajectories (de Almeida Teodoro e Kappel, 2020).

There are many studies on school dropout across most nations worldwide (Jiménez-Gutiérrez et al., 2024). However, as it is a social issue, it is deeply tied to the environment in which it occurs and the cultural identity of each region. Therefore, linking the causes and solutions of dropouts as something universal to all countries becomes a highly complex and potentially unsolvable task. For a deeper understanding, it is essential to investigate its origins locally and, at most, compare areas with similar socioeconomic conditions.

In Brazil, 5.9% of students in high school dropped out in 2021, highlighting the impact of the COVID-19 pandemic (INEP, 2023). At that time, approximately 68 million adults in Brazil still needed to complete basic education, illustrating the long-term consequences of dropout rates. From a socioeconomic perspective, the issue disproportionately affects lower-income families, as 11.8% of adolescents aged 15 to 17 from the poorest households had abandoned school without completing high school, compared to only 1.4% among wealthier families (IBGE, 2019).

Thus, due to the lack of studies on descriptive data analysis to understand the dropout rates in Brazil, this paper focuses on exploring existing research that examines influencing factors. Previous studies highlight dropout as a multifaceted issue driven by socioeconomic conditions, school environment, and external factors. Silva, 2016 emphasized the role of social integration in preventing dropout. In contrast, S. G. Ferreira et al., 2022 discussed the declining rates over the past two decades, but raises concerns about a post-pandemic reversal of this trend. Rosa et al., 2023 analyzed regional disparities, identifying the Southeast and Northeast as the most affected areas. Additionally, Barbosa, 2023 examined the impact of public policies on mitigating dropouts, proposing financial incentives as a potential solution. Furthermore, S. C. Ferreira e Teixeira, 2024 conducted a multilevel analysis of Alagoas, revealing that academic failure and socioeconomic vulnerability significantly contribute to high rates.

Although existing studies provide valuable insights into this phenomenon in Brazil, yet a broader descriptive data analysis is needed to assess the long-term trends and key influencing factors comprehensively. Thus, these studies still present significant limitations: many studies restrict analyses to short periods, specific regional contexts, or isolated variables, which prevent a comprehensive understanding of how internal school factors interact with external conditions. Previous studies provide relevant contributions but do not offer a long-term perspective based on large-scale datasets. We address this gap by analyzing millions of records from the National Institute of Educational Studies and Research Anísio Teixeira (*Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira* - INEP) over 26 years, which allows us to:

- identify long-term trends;
- examine interactions between variables; and

- provide a solid foundation for more targeted and effective educational policies.

The research problem addressed in our study consists of identifying which factors and characteristics most significantly contribute to the increase in school dropout rates in Brazil. We focus on descriptive data analytics to understand the combination of factors that amplify this problem. Our findings serve as a foundation for future studies, highlighting, for instance, the locations of schools with the most alarming situations. We used data provided by INEP, a federal agency linked to the Brazilian Ministry of Education. The data analysis focused on the Basic Education Microdata (INEP, 2020a), which included the School Census with Statistical Data on Basic Education and Basic Education Indicators by School, as well as School Performance Rates (INEP, 2020b).

This study focuses on key variables related to dropout to identify the most valuable information for determining the schools of interest. These include the type of school zone, type of school network, municipality location, school performance measures (e.g., approval and failure rates), and the level of education. Additionally, we consider variables with potential national-scale impact on dropout rates, such as the geographical region and the federal unit where the school is located. We also assess the impact of external factors, specifically government changes, financial crises, hydrological events, and the COVID-19 pandemic. While numerous factors could influence this problem in a specific region or city, addressing all of them would be overly complex (Piscitello et al., 2022). Therefore, the focus is primarily on geographical characteristics and a selected set of external factors. After preprocessing millions of data from INEP, we provide a descriptive and exploratory analysis of 200 thousand school dropout rate records in Brazil between 1996 and 2022, covering primary and secondary education to:

- identify which school and regional characteristics are most strongly associated with high dropout rates;
- assess the role of external factors—such as government transitions, economic crises, hydrological events, and the COVID-19 pandemic—on the phenomenon;
- conduct a detailed case study in the state of Alagoas, given its critical scenario and significant contrasts across educational networks; and
- investigate the relationship between school dropout and other performance indicators, such as repetition rates.

The rest of this paper is organized as follows. Section 2 discusses related works. Section 3 presents our data analysis methodology. Section 4 presents results and discussions. Finally, Section 5 concludes the paper and points out our future research directions.

## 2 Related Works

Silva, 2016 presented a broader approach by discussing studies on dropouts in other countries and their social contexts, drawing comparisons to Brazil. The study also explores prevention

strategies, highlighting that one of the main factors contributing to this problem is the lack of a sense of integration within the school environment experienced by students. Institutions have been established to mediate relationships between parents, students, and schools, providing support to students in vulnerable situations.

S. G. Ferreira et al., 2022 state that school dropout and absenteeism rates have been declining over the past 20 years, expressing optimism that this trend will continue and intensify. However, they also highlight concerns about a potential reversal of this progress in the post-pandemic era, which could lead to an increase in these rates. The authors reflect on education as a tool for social mobility, analyze the factors that encourage students to remain in or leave the school environment, discuss the consequences of dropout/absenteeism for individuals and society, and propose potential solutions to address or mitigate the issue.

Rosa et al., 2023 studied the factors influencing school dropout rates in the Southeast and Northeast regions of Brazil. The authors discussed negative impacts, emphasizing the resulting social exclusion and the reduced employment opportunities for affected individuals. They evaluated academic variables that may influence dropout rates in basic education, experimenting with multiple linear regression analysis to identify which combinations of factors are most significant in increasing the problem in Brazil's most populous regions: the Southeast and Northeast.

Barbosa, 2023 analyzed school dropout rates in Brazil and the impact of public policies aimed at addressing this issue. The study highlights the negative consequences for individual well-being, society, and public finances. The authors argue that tax money invested in education is not recovered, job opportunities for individuals become more limited, and societal violence increases. Regarding the causes of dropout, the study points out that while the financial return of completing high school exceeds the real interest rate of the economy, families often do not seek financial resources from the national banking system to support education. This is possibly due to misinformation or individual circumstances. As a potential strategy for change, the study explores financial incentives to encourage students to return to and stay in school. This approach was tested through a comparative experiment conducted in Alagoas and Goiás, yielding promising results that require a more extended period of analysis to fully evaluate their effectiveness in combating high rates.

S. C. Ferreira e Teixeira, 2024 conducted a multilevel analysis of the determinants of dropout in Alagoas municipalities. The study considered various factors, including family context (parental education level and household income), regional economic development, the state's organizational and political structures along with its historical interests, as well as individual student characteristics (age, race, and school schedule) and school-related factors (type of school and location). The findings revealed that the discrepancy between a student's age and the average age of their classmates serves as a key indicator of academic failure, primarily driven by grade repetition. Combined with the individual's economic situation, such characteristics and information make dropout rates more pronounced in high school compared to elementary education. However, the authors only considered data collected from a specific year (i.e., 2019).

Among the leading causes of school dropout is the need to supplement the family income (Pong e Ju, 2000), as work schedules often conflict with school hours. Even when students manage to balance both by attending evening classes, they frequently end up dropping out due to the overwhelming burden of daily responsibilities (Bridgeland et al., 2010).

Another significant factor driving school dropout is the age-grade mismatch caused by successive grade repetitions (Giano et al., 2022). This mismatch often leads to a lack of interest in studies among students. However, there are other reasons, such as a poorly designed school curriculum and an uninspiring environment also contribute to disengagement. Negative aspects of the school environment include teacher behaviors, classes perceived as uninteresting or irrelevant by students, harmful administrative management practices, and an overwhelming amount of academic content.

Among the external factors influencing education are regional economic development and social inequality (Peng et al., 2020). For many families, limited financial resources make it challenging to support their children's education, often resulting in a lack of encouragement for students to remain and progress in school, which is a situation closely tied to parental education levels. This highlights the need for inclusive and effective public policies aimed at fostering equity in Brazil's basic education system. Currently, the majority of students who choose to drop out of school share several common characteristics, including skin color, gender, and the type of school they attend.

### **3 Materials and Methods**

This section presents the procedures adopted for data collection, processing, and analysis in this study. Initially, Section 3.1 describes the data sources used, highlighting the School Census and the challenges faced due to the lack of standardization in formatting over the years. Section 3.2 details the preprocessing steps, discussing the tools employed and the strategies used to handle inconsistencies and the large volume of information. Finally, Section 3.3 outlines the exploratory data analysis approach, presenting the variables considered, the hypotheses tested, and the methods used to examine the factors influencing school dropout rates, with a specific focus on the state of Alagoas and the impact of external factors.

#### **3.1 Datasets**

The datasets included the School Census with Statistical Data on Basic Education and Basic Education Indicators by School and School Performance Rates (INEP, 2020a, 2020b). Given the relatively long timeframe, the data from 1996 to 2006 exhibited various formatting issues. There were different columns or names across the years, and some data was incomplete, requiring multiple datasets for the same year. In 2007, INEP adopted a single standard for data organization.

For each data file, the number of school records was approximately 200,000 instances, while the number of columns was inconsistent, ranging from 367 to 3,808 fields until the 2007 standardization (370 fields). The large volume of data, the lack of standardization, and the dispersion of information across multiple columns made preprocessing an essential step.

#### **3.2 Data Pre-processing**

We conducted an initial exploratory analysis using the 1996 school census data using the Jupyter Notebook and Google Colab. This analysis identified which columns did not add value and

which were significant and served as the target for data extraction in subsequent years. However, due to the cloud-based nature of the tool, we observed that loading the files took a considerable amount of time, as they contain hundreds of thousands of rows and hundreds of columns, making preprocessing unfeasible in this environment.

As an alternative, we used the Jupyter Notebook provided by the data science software Anaconda. This approach allowed the files to load more quickly compared to Colab, as the entire environment was running on a local machine. However, the developed script involved extensive operations for grouping information (columns), which made the execution significantly slower due to the large volume of data. Consequently, any script errors (logic errors) or processing/memory issues had a substantial impact on the time required to complete all pre-processing tasks for the selected period. Thus, we used the KNIME Analytics Platform, achieving significantly improved performance and efficiency in data processing.

There are two sets of fields extracted from the school census files or school performance rates. We collected one of them set with minimal alterations, with only simple data standardization adjustments made across the years. The other set included grouping multiple interrelated columns.

Thus, the collected set consisted of fields taken almost unchanged from the school census files. These fields included the unique school identification code, state abbreviation, state name, municipality name, census year, administrative dependency (private, state, municipal, or federal), location (urban or rural), and operational status of the school (active, closed, or suspended). Table 1 describes the main variables and components.

Table 1: Main variables and components.

Regions	Federative Unit	Administrative Dependency	Location	Academic Performance
North	Amazonas, Roraima, Amapá, Pará, Tocantins, Rondônia, Acre	Federal	Urban	Number of Approved Elementary Students, Number of Approved High School Students
Northeast	Maranhão, Piauí, Ceará, Rio Grande do Norte, Pernambuco, Paraíba, Sergipe, Alagoas, Bahia	State	Rural	Number of Elementary School Failed Students, Number of High School Failed Students
South	Paraná, Rio Grande do Sul, Santa Catarina	Municipal	–	Number of Elementary School Dropouts, Number of High School Dropouts
Southeast	São Paulo, Rio de Janeiro, Espírito Santo, Minas Gerais	Private	–	–
Midwest	Mato Grosso, Mato Grosso do Sul, Goiás, Distrito Federal	–	–	–

The constructed dataset combined various related variables to create meaningful aggregated fields. These included a category that logically combined binary variables to indicate whether a school offered the initial or final stages of elementary or secondary education. Another category grouped states into geographic regions. Additionally, the dataset contained a field representing

the total number of schools in specific groupings. For elementary education, the dataset included aggregated data such as enrollment numbers (broken down by gender and time of day until 2006 and as total figures from 2007 onward), the total number of classes, teaching staff, and the number of students who were approved, failed, or dropped out—data either directly collected or derived from percentages, depending on the year. A similar structure was used for secondary education data, focusing on the same types of information but for high school. This combination of collected and constructed data provided a comprehensive view to analyze trends and patterns in both elementary and secondary education over the years, ensuring consistency despite changes in the original data structure over time.

### 3.3 Data Analysis

Figure 1 presents a high-level view of experimental steps. This study used exploratory data analysis through Google Colab. We examined the relationship between student dropout rates and various other factors, including categorical variables such as school location, type of administrative management, geographical region, and year, as well as numerical variables like the number of classes, teachers, approved students, and failed students. The objective was to identify the combination of characteristics that contributed most significantly to increasing this problem.

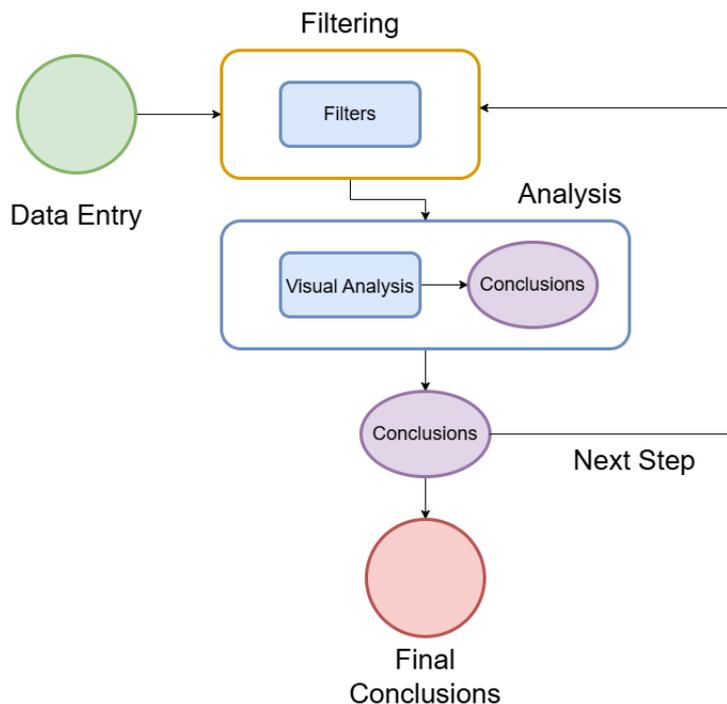


Figure 1: Summary of the experimental steps.

The central hypothesis was that grade repetition in elementary and secondary education leads to student dropout. Other considered hypotheses included external factors, such as financial crises and the COVID-19 pandemic. The experiment consists of two parts. The first part uses the combined school data collected for Brazil from 1996 to 2022. The second part relies on the conclusions drawn from the analyses conducted in the first part.

The analysis of an aggregation table data considered three main stages. The first stage involved an initial filtering process using the Situation-Functioning field to focus exclusively on data representing schools that were active at the time of each school census. This filtering ensured that we only included relevant and operational data for further analysis.

The second stage consisted of extensive visual analyses. We developed a range of graphical visualizations and intermediate conclusions to explore the relationship between school dropout rates, both for elementary and secondary education, and various categorical variables and their combinations. These variables included Location, Administrative Dependency, Region, and Year. We synthesized the insights gained during this stage to create a foundational understanding that informed the direction of subsequent analyses.

In the third stage, we conducted more in-depth analyses, which were divided into four sub-stages. First, we performed additional filtering based on the conclusions from the earlier stages, with a focus on the Location and Administrative Dependency fields. Next, we carried out further visual analyses using the state field to support our conclusions and identify a region for more detailed exploration. The subsequent sub-stage involved further refinement of the data using the Region field. Finally, we conducted another round of graphical analyses to examine the relationship between dropout rates and primarily numerical variables, including the number of approved and failed students in both elementary and secondary education.

We synthesized the conclusions from these analyses into a comprehensive summary of the findings from an aggregation table. This final synthesis provided insights and guided the experiment toward a more focused discussion of dropout in the state of Alagoas as a specific case study.

The analysis of the Alagoas data followed a structure similar to that of the aggregation table, consisting of several sequential stages. The process began with an initial filtering step using the Operational Status field to isolate data representing schools that were active during each census period. This ensured that we only included relevant and functional schools in the analysis.

The next stage involved comprehensive analyses. We performed extensive graphical explorations, generating intermediate conclusions for each analytical block. These analyses examined the relationship between school dropout rates, both in elementary and secondary education, and categorical variables, such as Location and Administrative Dependency. We synthesized these intermediate conclusions to create a foundational understanding that guided subsequent stages.

Afterward, the analysis progressed to a more detailed examination. This stage included further filtering of data based on conclusions from the previous steps and additional visual analyses. The filtering process focused on the Location and Administrative Dependency fields, while the graphical analyses explored the relationship between dropouts and primarily numerical variables. Statistical analyses examined distribution trends and comparative analyses across various geographic areas, including year-by-year dropout, comparisons between Alagoas and national rates, Alagoas versus the Northeast region, and Alagoas against states with the highest rates in the Northeast. These efforts culminated in a synthesized summary outlining the key findings from the Alagoas analysis and setting the stage for an exploration of external factors influencing this problem in Alagoas.

The final stage of the analysis focused on external factors, following a structure similar to

the prior stage. Data filtering targeted the Municipality field, while the visual analyses examined how external factors influenced dropout rates over time. The chosen external factors included government transitions, financial crises, hydrological events, and the COVID-19 pandemic.

## 4 Results and Discussion

Section 4.1 examines school dropout rates nationwide from 1996 to 2022, identifying patterns and characteristics that maximize the problem, such as school location and administrative network type. Section 4.2 delves deeper into the state of Alagoas, identifying the most affected municipalities and the differences between municipal and state school networks in elementary and high school education. Finally, Section 4.3 explores the relationship between school failure and dropout, demonstrating that this correlation is stronger in elementary school than in high school, highlighting contributing factors, and suggesting possible interventions.

### 4.1 Student Dropout at the National Level

The location analysis aims to identify which school zone, rural or urban, exhibits the highest student dropout rates in Brazil. Figure 2 presents student dropout quantity by region in Brazil and school zone. Figure 3 presents student dropout quantity by year and school zone.

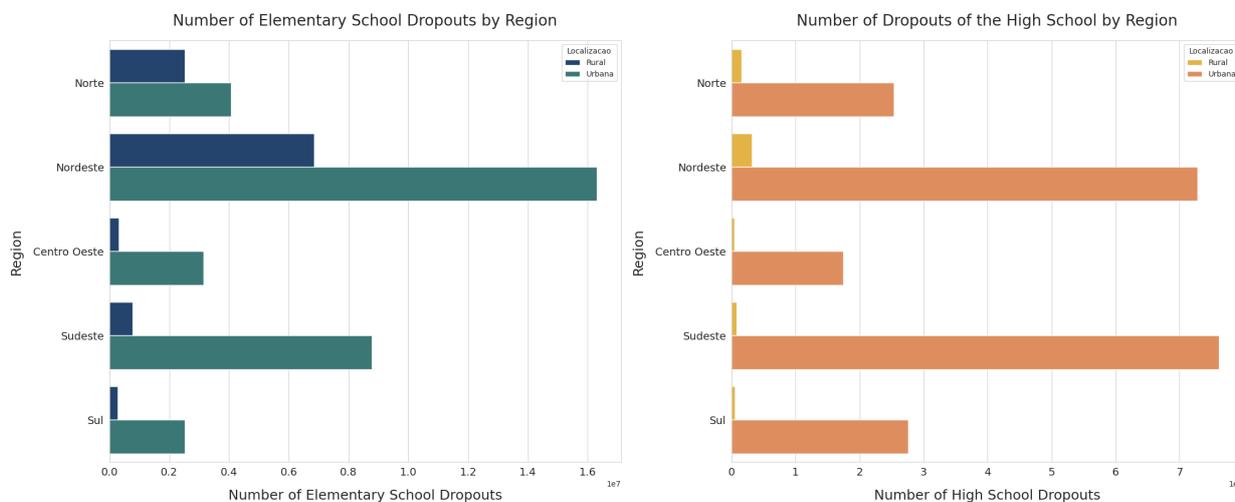


Figure 2: Student dropout quantity by region in Brazil and school zone.

The analysis revealed that student dropout rates have steadily declined, with significant decreases after 2006, particularly in urban areas. Urban zones consistently exhibit higher dropout numbers than rural zones across both elementary and high school levels, highlighting systemic challenges in urban education environments. The Northeast and Southeast regions are disproportionately affected, recording the highest dropout rates, while the Central-West and South regions have the lowest.

The decline in dropouts after 2006 may reflect the positive impact of educational reforms or policies implemented during that period. However, the recent slight increase in dropouts calls for

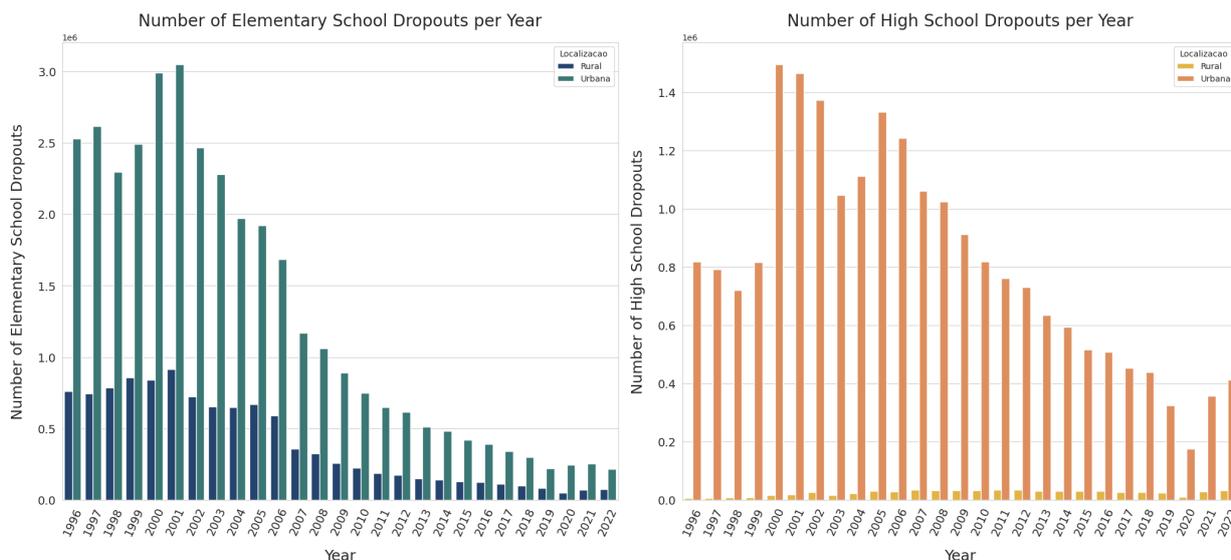


Figure 3: Student dropout quantity by year and school zone.

continued monitoring and targeted interventions, particularly in urban areas and regions like the Northeast and Southeast, to address persistent disparities and challenges.

The analyses of administrative dependency aim to identify which school network (state, municipal, federal, or private) exhibits the highest rates. Figure 4 presents the number of student dropouts by school network. Figure 5 presents the number of student dropouts by region in Brazil and school network.

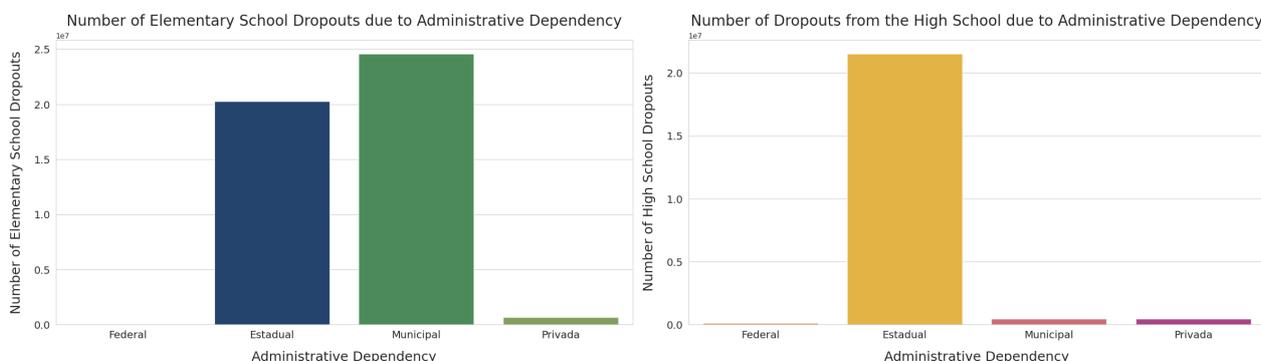


Figure 4: Number of student dropouts by school network.

Dropout rates in elementary education are higher in municipal schools than in other networks for most groupings. However, in some groupings, state schools record the highest numbers.

The North and Northeast regions have the highest dropout rates in elementary education for municipal schools, while in the other areas, state schools lead in this category. The Northeast consistently shows the highest rates in both cases. For high schools, the Southeast region has the highest rate in state schools, followed closely by the Northeast, with a slight difference between them.

The regional analyses aim to identify which Brazilian region has the highest student dropout

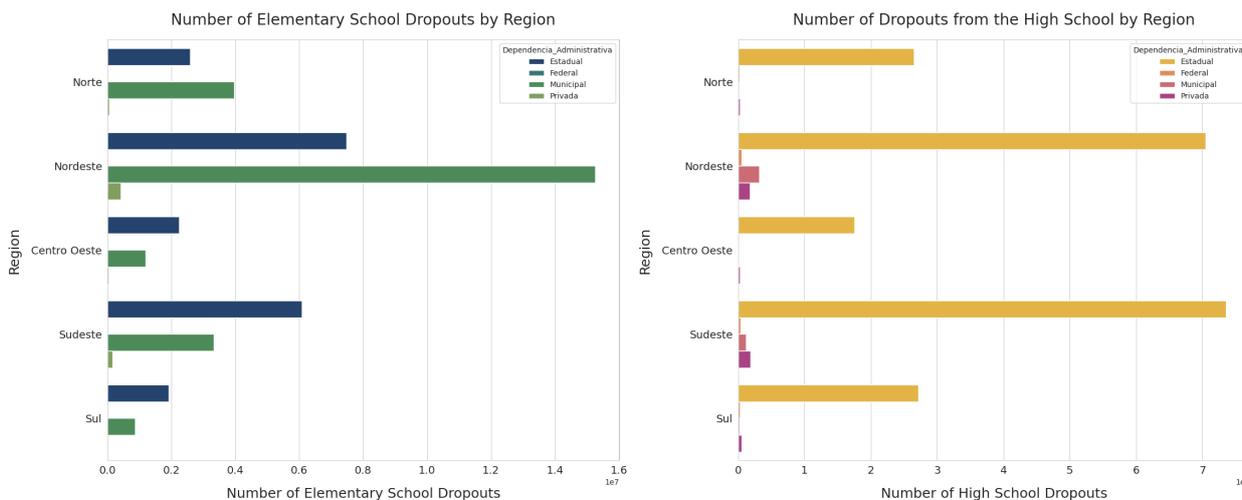


Figure 5: Number of student dropouts by region in Brazil and school network.

rates. Figure 6 presents the number of student dropouts by region in Brazil. Figure 7 presents the number of student dropouts by year and region in Brazil.

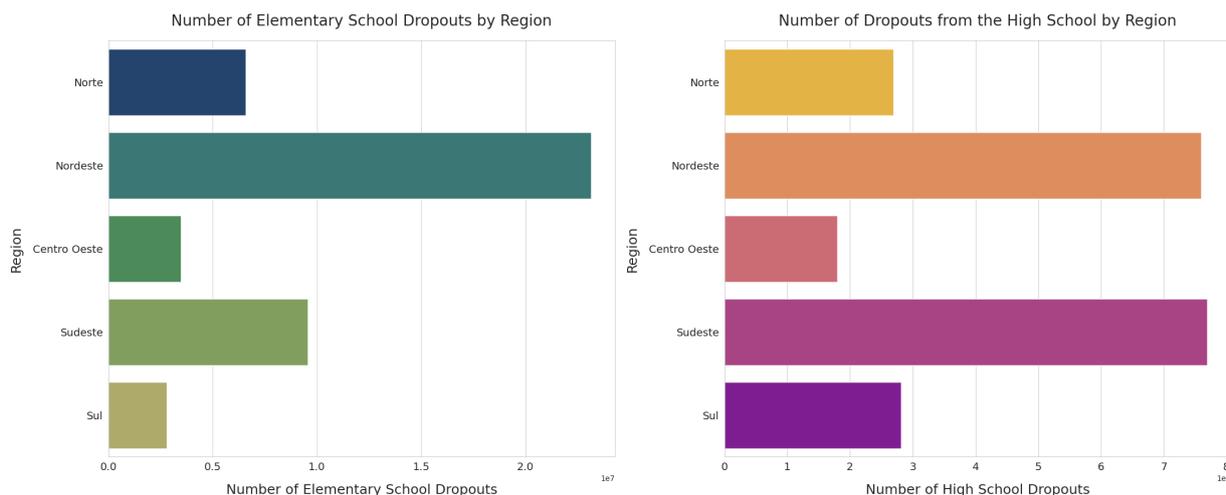


Figure 6: Number of student dropouts by region in Brazil.

Dropout rates in elementary education are higher in schools in the Northeast than in other regions across all groupings. In contrast, for high schools, the rates are highest in schools in the Southeast, with the Northeast following closely behind with only a slight difference. The year 2001 marked the peak of dropouts for elementary schools in the Northeast. For high schools, 2000 was the year with the highest rates in the Southeast, while 2005 represented the peak for the Northeast.

The analyses of federal units aim to assist in selecting the Brazilian region to be the focus of the research, as well as identifying which states have the highest quantitative and percentage values of school dropouts. Figure 8 presents the quantity and percentage of elementary school dropouts by federal unit. Figure 9 presents the quantity and percentage of high school dropouts by federal unit.

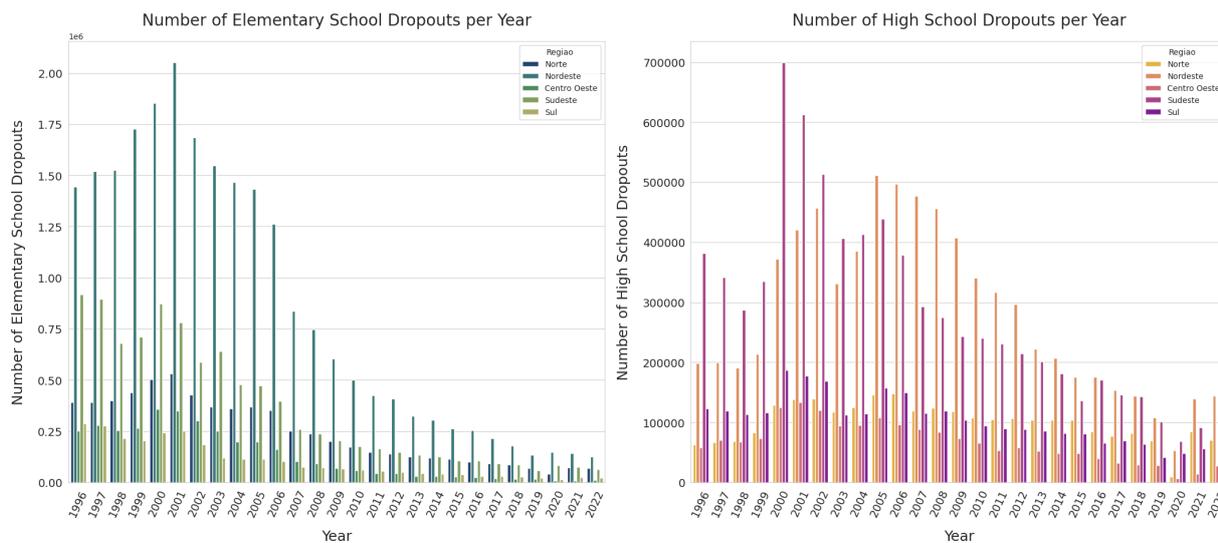


Figure 7: Number of student dropouts by year and region in Brazil.

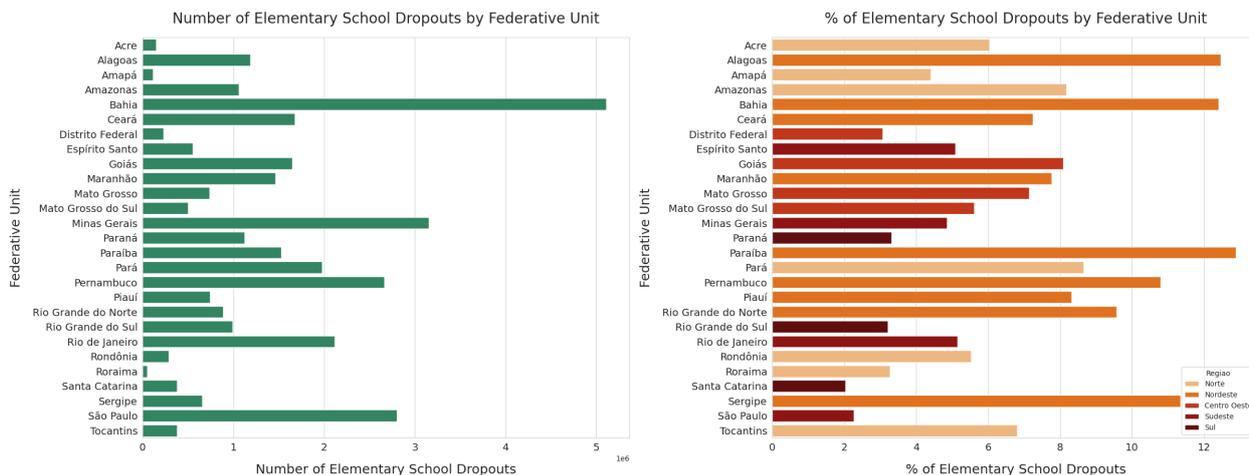


Figure 8: Quantity and percentage of elementary school dropouts by federal unit.

The Northeast region exhibited higher percentage dropout rates compared to other areas. While some states from other regions also have elevated percentage rates, all states in the Northeast rank high when classifying states with the highest rates, whether for elementary or high school education. Table 2 describes the leading states in student dropouts.

Table 2: Leading states in student dropouts.

Elementary Education (Absolute Value)	High School (Absolute Value)	Elementary Education (Percentage)	High School (Percentage)
Bahia	São Paulo	Paraíba	Rio Grande do Norte
Minas Gerais	Minas Gerais	Alagoas	Pará
São Paulo	Bahia	Bahia	Alagoas
Pernambuco	Rio de Janeiro	Sergipe	Piauí

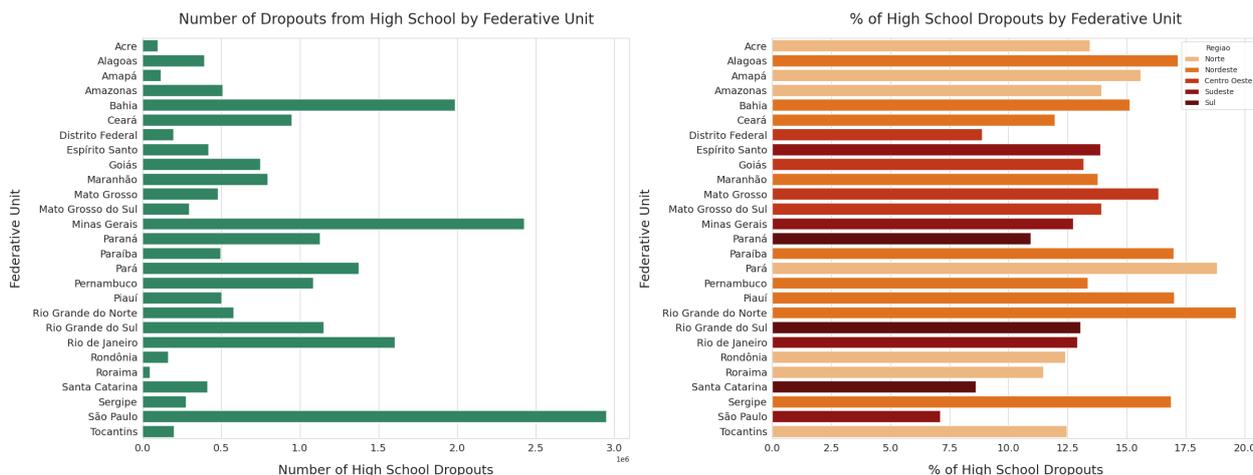


Figure 9: Quantity and percentage of high school dropouts by federal unit.

Other analyses of administrative dependency aim to provide insights into the distribution of student dropout rates across the states of the Northeast region, as well as an analysis of their trends over time. Figure 10 presents the distribution of quantitative data on dropouts by the state in the northeast and school network. Figure 11 presents the monitoring of student dropouts over time and by school network.

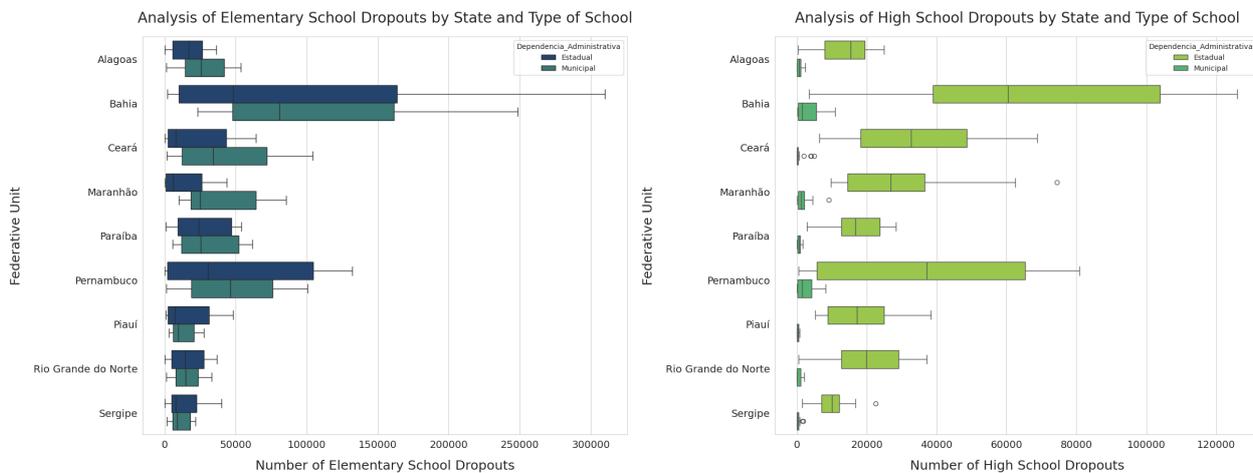


Figure 10: Distribution of quantitative data on student dropouts by state in the northeast and school network.

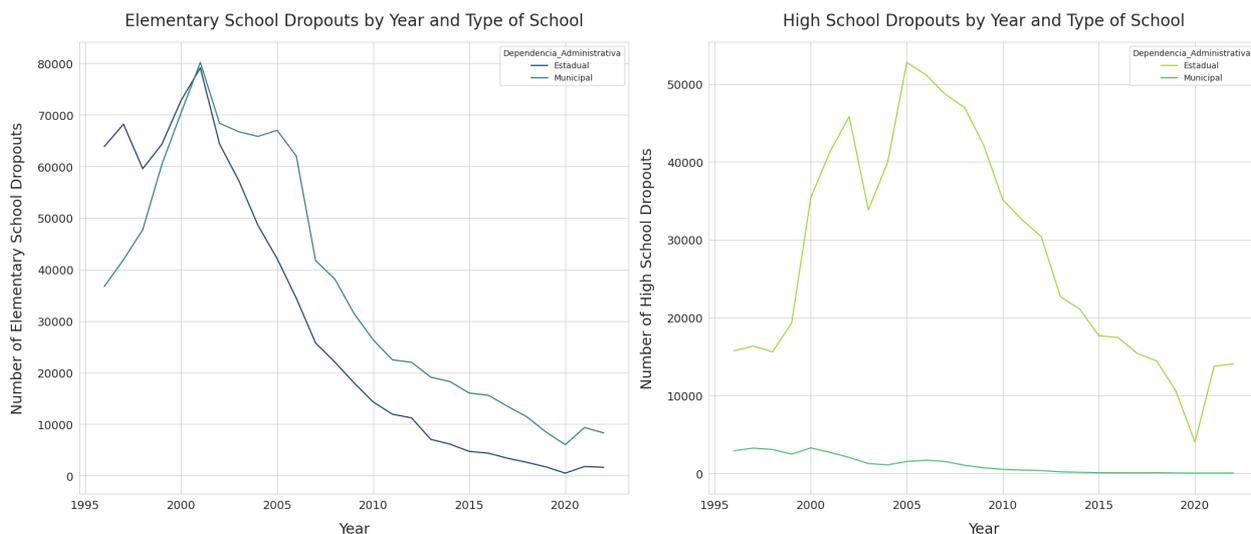


Figure 11: Monitoring of student dropouts over time and by school network.

Dropout rates in both elementary and high schools show the most significant data dispersion in Bahia, regardless of whether the schools belong to the state or municipal networks. For elementary schools, up until around 2001, state schools recorded higher absolute rates compared to municipal schools. However, a reversal occurred between the networks, with municipal schools surpassing state schools, a trend that has persisted to the present day. Both networks demonstrate a downward trend in dropout rates. In contrast, for high schools, the state network consistently recorded higher rates throughout the analyzed period compared to the municipal network. The state network reached its peak dropout rates in 2005 and has shown a downward trend since then, while the municipal network appears to have stabilized at zero.

The analyses of school performance sought evidence of potential correlations between school performance variables while also enabling temporal monitoring of the behavior of the curves. Figure 12 presents quantitative monitoring of school performance metrics over time. Figure 13 presents the percentage monitoring of school performance metrics over time.

Both in terms of quantity and percentage, the curves for elementary school student dropout and failure rates frequently alternate and exhibit similar values and patterns, suggesting a possible correlation between failure and dropout. Similarly, when examining the curves for high school dropouts and failure rates, a comparable proximity is observed, further indicating a potential correlation between the two metrics.

In addition, the comparison between dropouts, the number of teachers, and the number of classes aims to identify indications of possible correlations between dropout rates and the quantitative values of teachers and classes in schools. It also allows for temporal monitoring of the behavior of these curves. Figure 14 presents a temporal analysis of the influence of teacher and class quantities on rates.

Neither the quantitative curve of elementary school teachers nor the curve of elementary school classes appears to have any relationship with the curve of elementary school student dropouts. The same conclusion is reached for the set of curves related to high school.

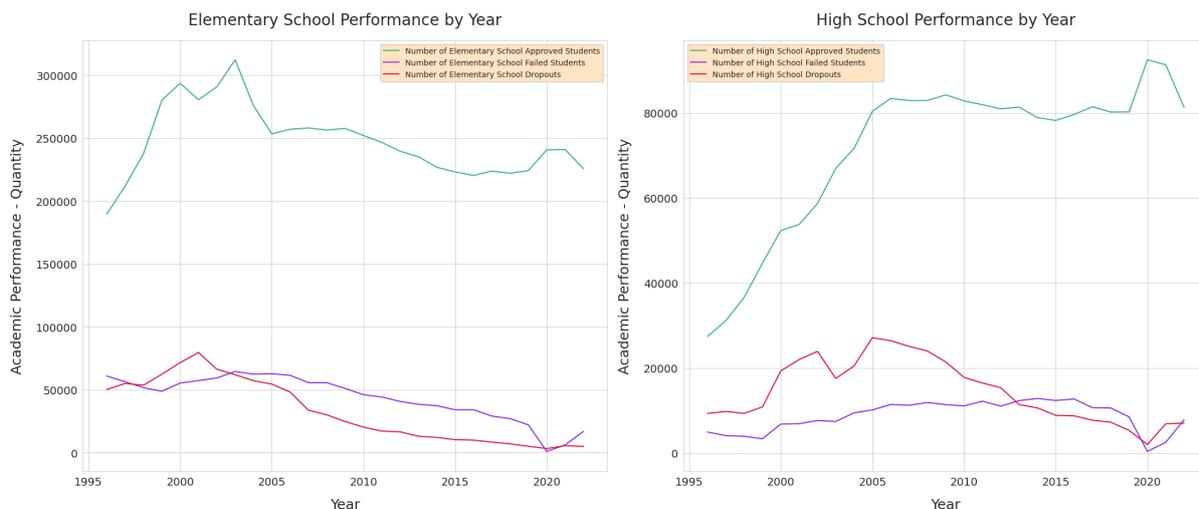


Figure 12: Quantitative monitoring of school performance metrics over time.

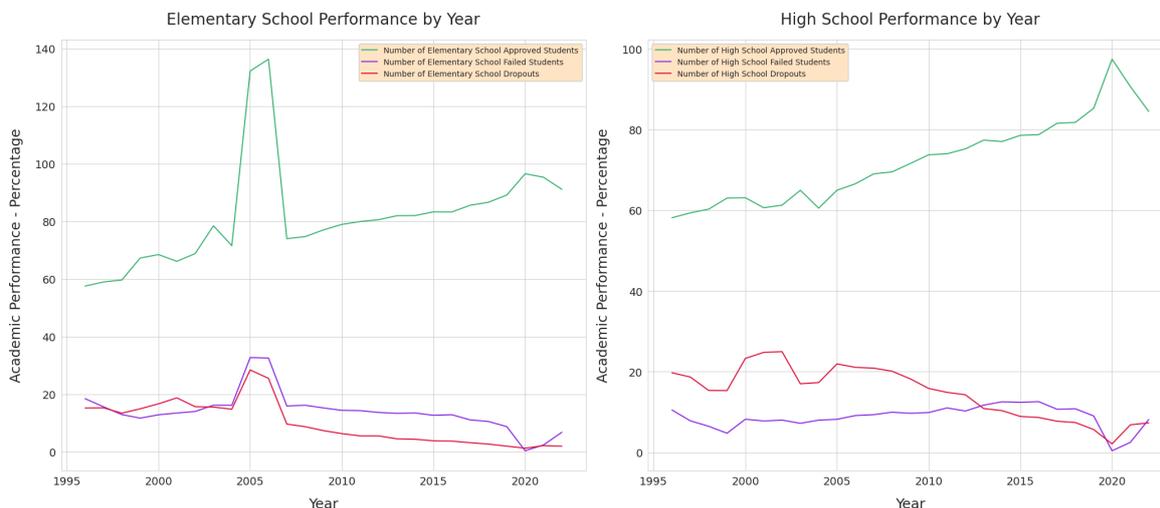


Figure 13: Percentage monitoring of school performance metrics over time.

Therefore, we identified several characteristics that maximize student dropout rates. For elementary schools, we observed the highest rates in urban schools within the municipal or state networks, primarily located in the Northeast region, with smaller concentrations in the Southeast. For high schools, the highest rates occur in urban schools within the state network, predominantly in the Southeast and Northeast regions.

Additionally, we observed that 2000 and 2001 were the years with the highest student dropout rates. Based on these observations, we filtered the Aggregation Table database to include only urban municipal or state schools. We identified the percentage value of dropouts as the relevant metric to determine that the focus region would be the Northeast. With the filtered database, subsequent analyses could proceed, focusing on the temporal monitoring of dropouts in relation to numerical variables.

Figure 15 presents a temporal analysis of student dropouts in elementary and high school

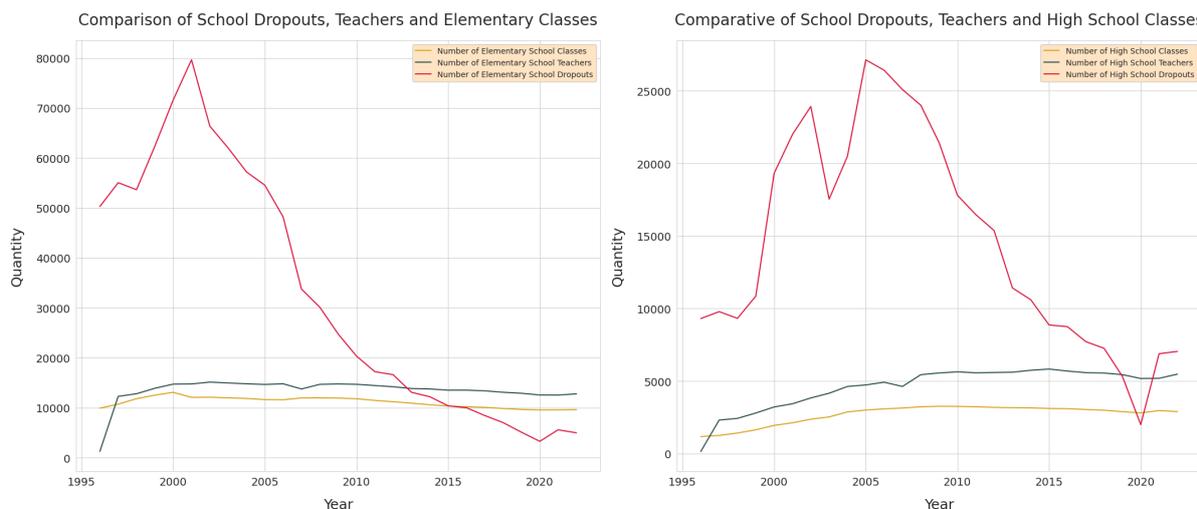


Figure 14: Temporal analysis of the influence of teacher and class quantities on student dropout rates.

education. Overall, dropout rates have decreased over the years, both in state and municipal school networks. Among the possible reasons for this decline, it is estimated that the primary factor is increased government investment in public policies aimed at strengthening education in Brazil. Our analyses suggest a possible correlation between the curves of failure and student dropout rates in both elementary and high school education. However, the quantitative curves of teachers and classes do not show any relationships with this problem.

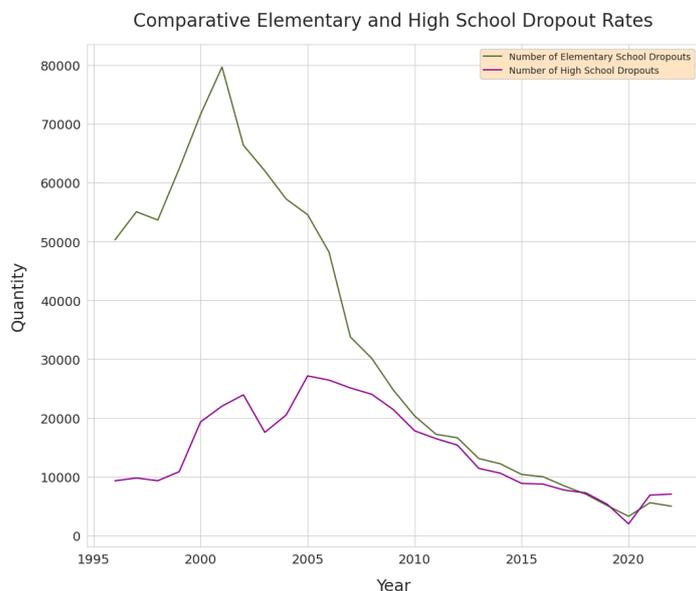


Figure 15: Temporal analysis of student dropouts in elementary and high school education.

Among the states in the Northeast, the three states with the highest percentages, considering both elementary and high school education, are Alagoas (14.88% absolute and 16.46% average), Paraíba (14.96% absolute and 15.48% average) and Rio Grande do Norte (14.62% absolute and

15.17% average). Sergipe and Bahia follow closely behind.

The difference in the Absolute Dropout Percentage between Alagoas and Paraíba is very small. At the same time, the Average Dropout Percentage shows a larger gap. We used the Human Development Index (HDI) as a criterion to choose the focus state. As of 2021, Alagoas has an HDI of 0.684 (ranked 26th), while Paraíba has an HDI of 0.698 (ranked 21st)<sup>1</sup>

We considered Alagoas as a specific case study due to having a lower HDI, which indicates that, overall, the state is in a worse condition compared to Paraíba. In addition to analyzing the data from Alagoas’ schools, we considered the education database with external factors to gain a better understanding of the student dropout situation and identify which external factors have a significant impact on it.

### 4.2 Student Dropout in Alagoas

By better understanding the school-related factors that contribute to dropout rates in basic education, as well as some of the potential external causes, solutions can be designed to reduce or eliminate dropouts in Alagoas. However, other states in Brazil could also reuse such solutions.

The location analyses aim to identify which school zone, rural or urban, exhibits the highest student dropout rates in Alagoas. Figure 16 presents the number of dropouts by school network and school zone. Figure 17 presents the number of dropouts by year and school zone.

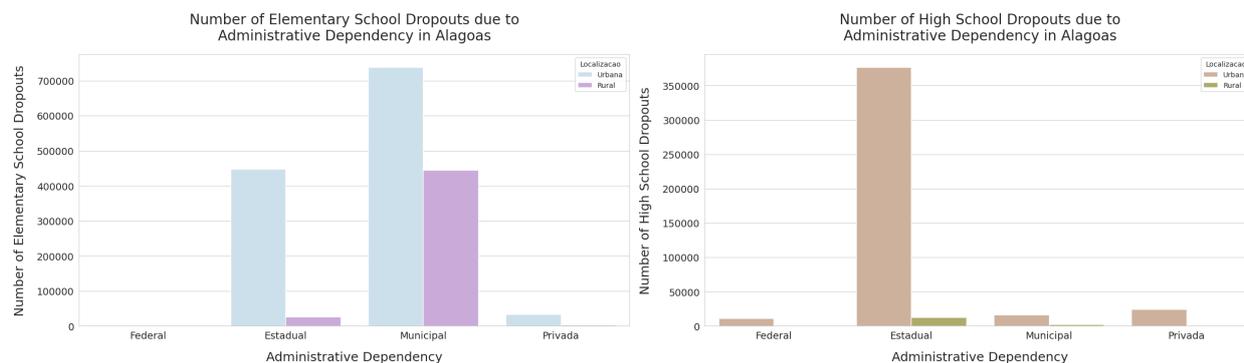


Figure 16: Number of student dropouts in Alagoas by school network and school zone.

Dropout rates in elementary and high schools in Alagoas are higher in urban schools than in rural schools across all groupings. Urban municipal schools have the highest rates in elementary education, while urban state schools show the highest rates in high school education. The year 2000 marked the peak of dropouts for elementary schools in urban areas, whereas 2005 was the year with the highest rates for high schools.

The administrative dependency analyses aim to identify which school network—state, municipal, federal, or private—has the highest student dropout rates in Alagoas. Figure 18 presents the number of dropouts by school network. Figure 19 presents the number of dropouts by year and school network.

<sup>1</sup>HDI for 2021: Alagoas: 0.684 (26th), Paraíba: 0.698 (21st). Information was obtained from the website atlas-brasil.org.br/ranking.

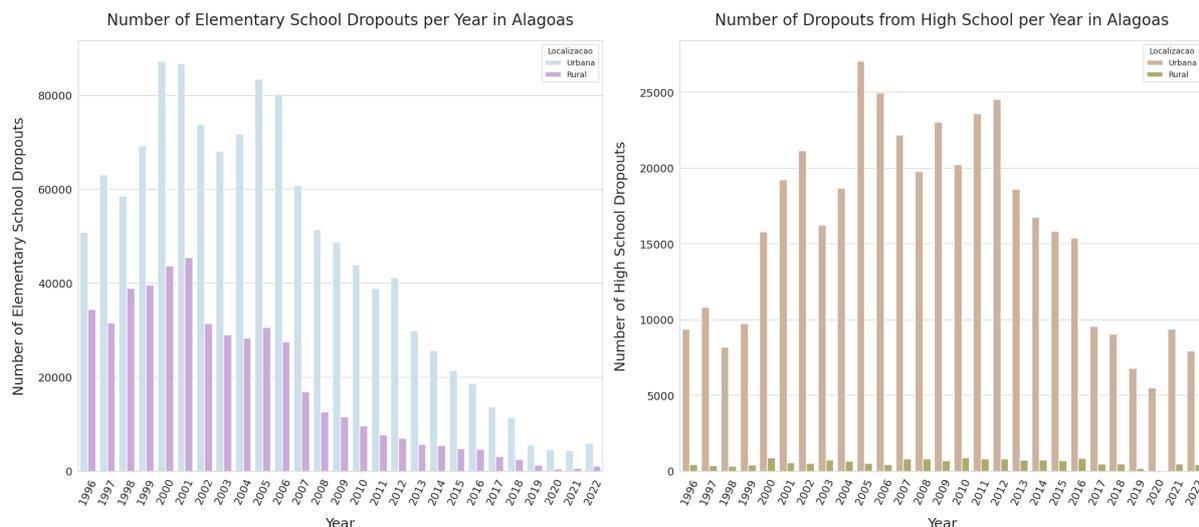


Figure 17: Number of student dropouts in Alagoas by year and school zone.

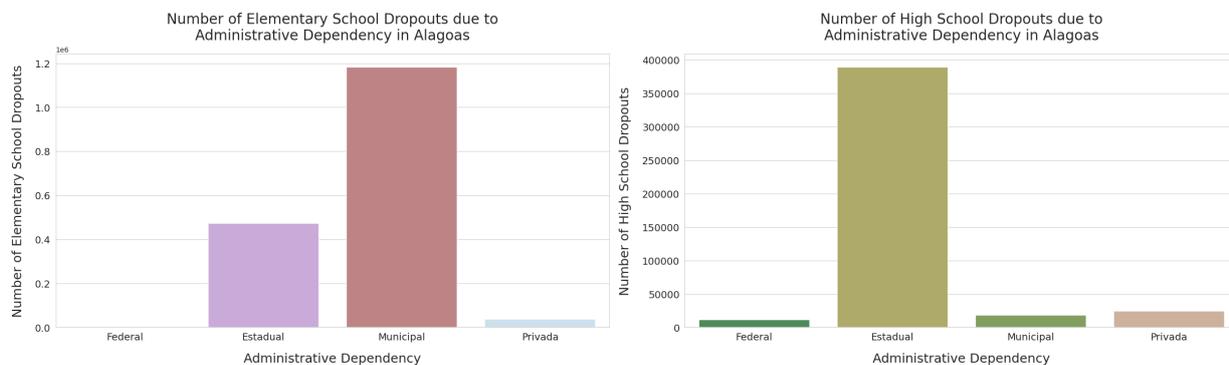


Figure 18: Number of student dropouts in Alagoas by school network.

Dropout rates in elementary education are higher in municipal schools compared to other school networks, whereas in high school education, rates are higher in state schools. Regarding the peak years, 2001 marked the highest rates for municipal elementary schools, while 2005 was the year with the highest rates for state high schools in the state.

The analyses of Alagoas municipalities aimed to identify which ones would be the focus of future research. Figure 20 presents the most relevant municipalities in student dropout rates.

We provide evidence of potential correlations between the school performance variables in Alagoas while also enabling temporal monitoring of the behavior of the curves. Figures 21 and 22 present quantitative monitoring and percentage of school performance metrics over time.

Although the analyses have focused on a much smaller region than the national scope, both in terms of quantity and percentage, the two pairs of curves—the dropout and failure curve for elementary school students in Alagoas, as well as for high school students—show a certain degree of proximity and similarity. This suggests a possible correlation between failure and dropout rates.

The comparison between dropouts, the number of teachers, and the number of classes aims to evidence the potential correlations between dropout variables and the quantitative values of

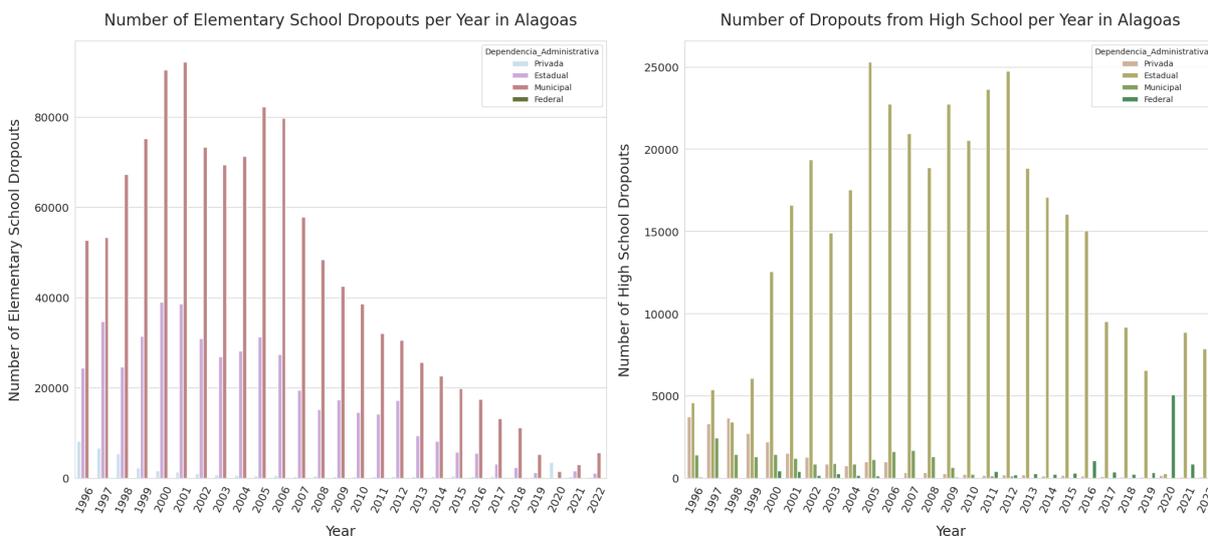


Figure 19: Number of student dropouts in Alagoas by year and school network

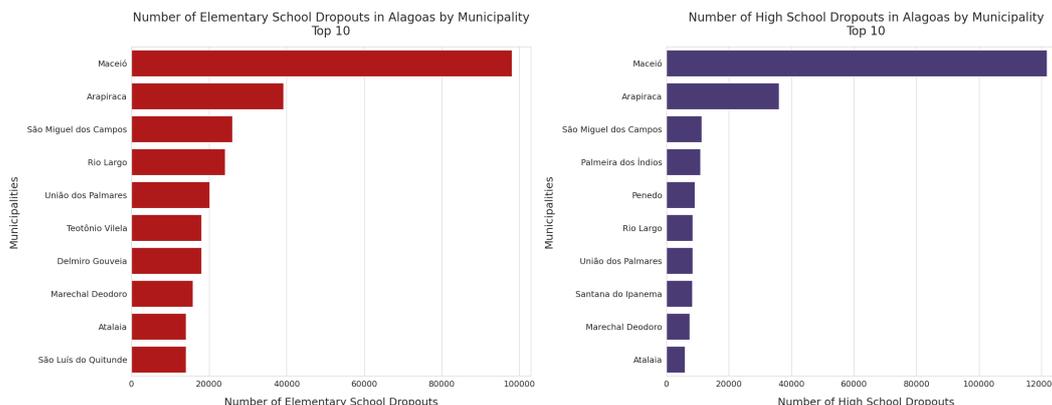


Figure 20: Top 10: most relevant Alagoas municipalities in student dropout rates.

teachers and classes in Alagoas schools. It also allows for temporal monitoring of the behavior of these curves. Figure 23 presents a temporal analysis of the influence of teacher and class quantities on dropout rates.

Although the analyses focused on a much smaller region than the national scope, no relationship can be observed between teachers, classes, and dropout. This occurs regardless of the education level, whether elementary or high school.

A comparison between dropout rates in Brazil and Alagoas aims to determine whether the trends for Alagoas align with those of Brazil. Figures 24 and 25 present a temporal analysis comparing elementary and high school dropouts. Both the dropout curves for students, whether in elementary or high school, in Brazil and Alagoas show a downward trend. However, the curves for Brazil appear to be smoother.

A comparison between dropout rates in the Northeast and Alagoas aims to determine whether the trends the curves for Alagoas align with those representing the other states in the Northeast region of Brazil. Figure 26 and 27 present a temporal analysis comparing elementary and high

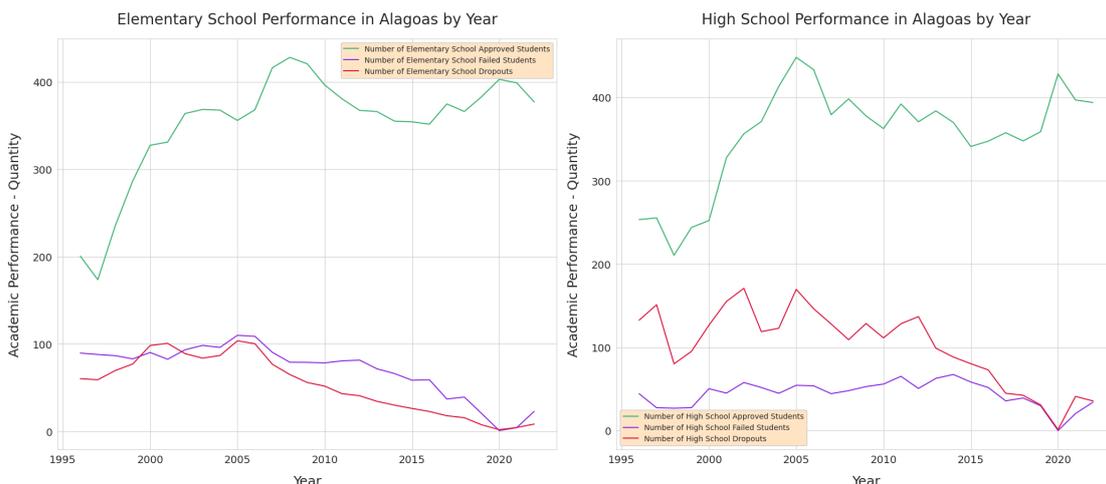


Figure 21: Quantitative monitoring of school performance metrics in Alagoas over time.

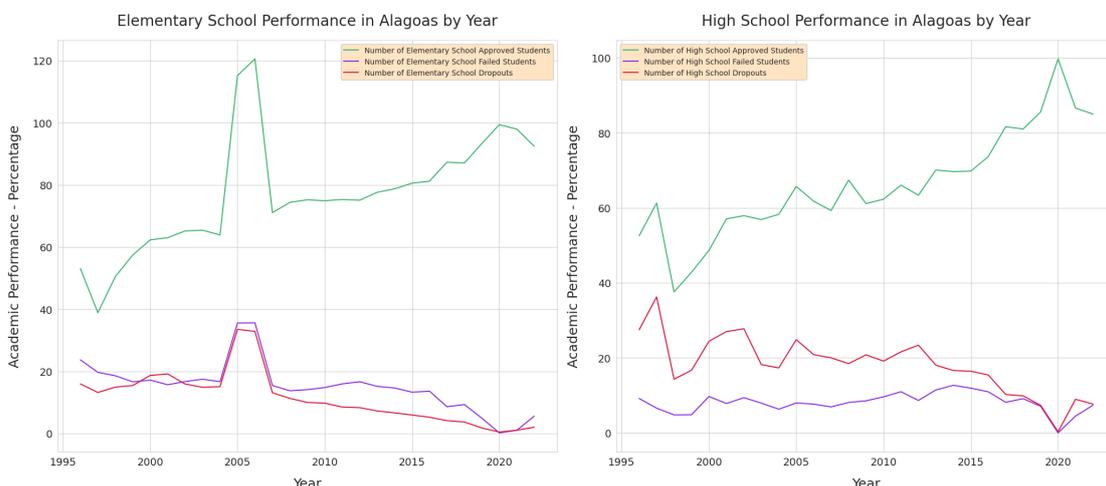


Figure 22: Percentage monitoring of school performance metrics in Alagoas over time.

school dropout in the northeast with Alagoas. Both the dropout curves for students, whether in elementary or high school, in the Northeast and Alagoas show a downward trend. However, the curves for the Northeast appear to be smoother.

A comparison between the three leading states in terms of student dropout rates in the Northeast aims to show the evolution in the three states of the region that have the most critical dropout indices. Figures 28 and 29 present a temporal analysis comparing the leading states in elementary and high school dropout in the northeast.

The state of Paraíba experienced the highest peaks in elementary school student dropouts, leading from 1996 to 2006. After this period, the state of Alagoas took the lead until 2017. The state of Rio Grande do Norte had the highest peaks in dropouts, leading from 1999 to 2013. After this period, the state of Paraíba took over, leading from 2016 to 2018. All three states show a downward trend.

The following characteristics of elementary and high schools are maximizing student dro-

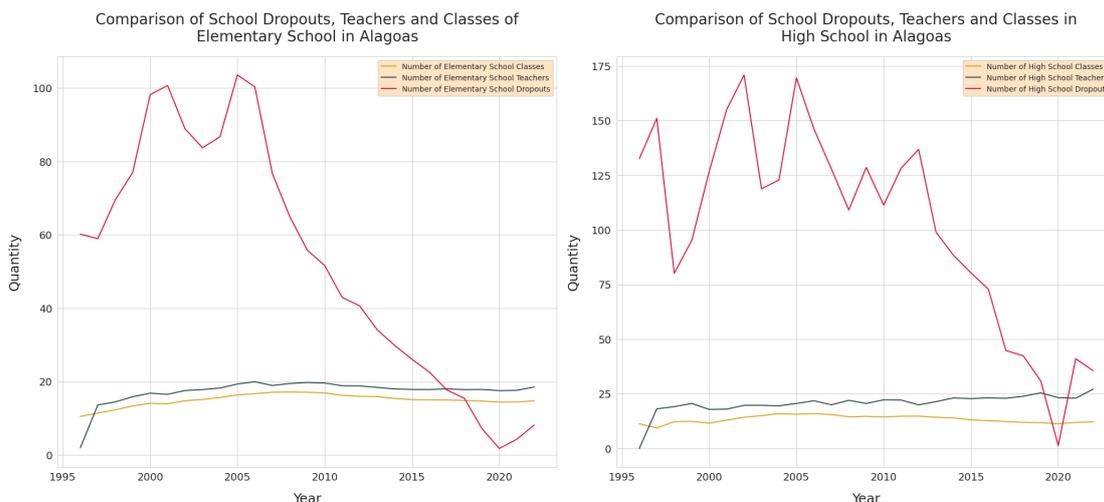


Figure 23: Temporal analysis of the influence of teacher and class quantities on student dropout rates in Alagoas.

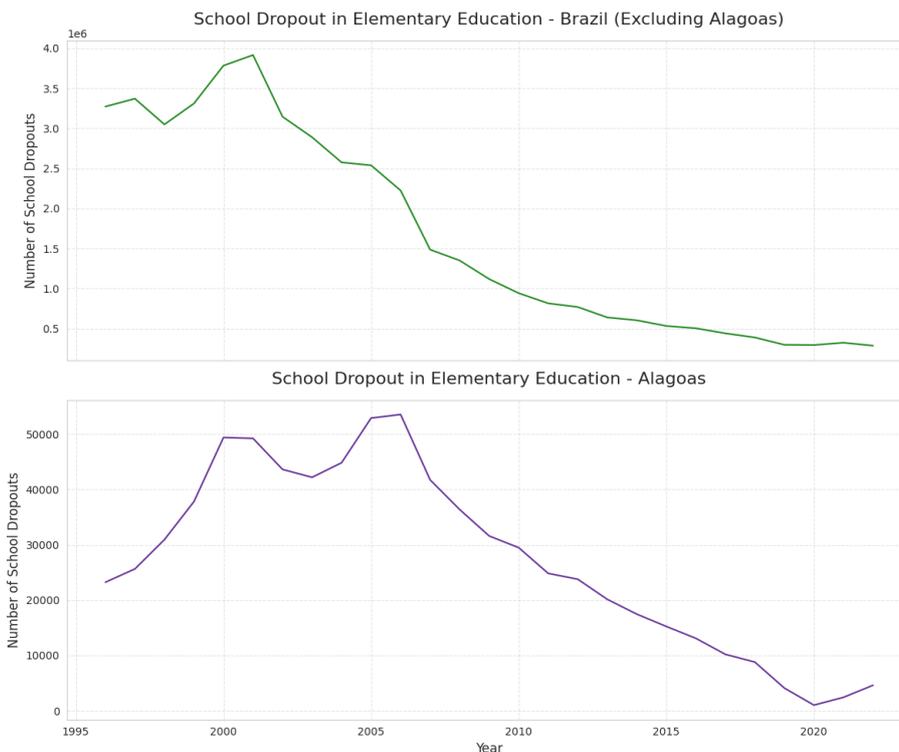


Figure 24: Temporal analysis comparing elementary school dropout in Brazil with Alagoas.

pout rates and, therefore, serve as a starting point for more in-depth analyses. For elementary schools, municipal schools are a key factor contributing to higher rates. In high schools, state schools play a significant role in the higher dropouts observed.

The years of high rates include 2000, 2001, 2005, and 2006 for elementary education and 2005, 2006, 2011, and 2012 for high school education. Since the data for elementary and high

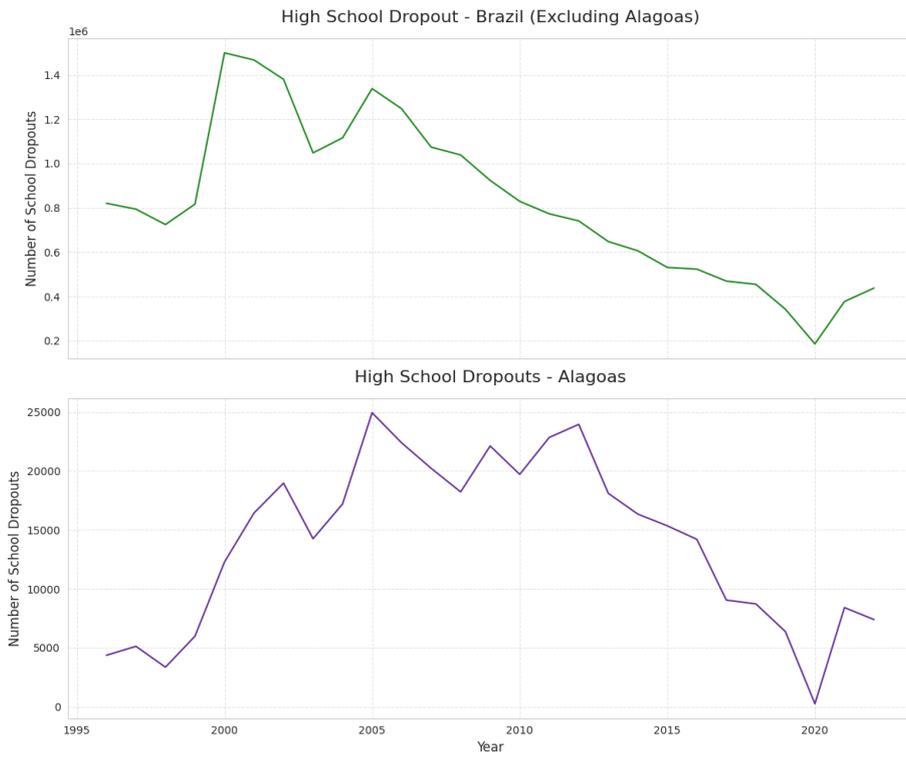


Figure 25: Temporal analysis comparing high school dropout in Brazil with Alagoas.

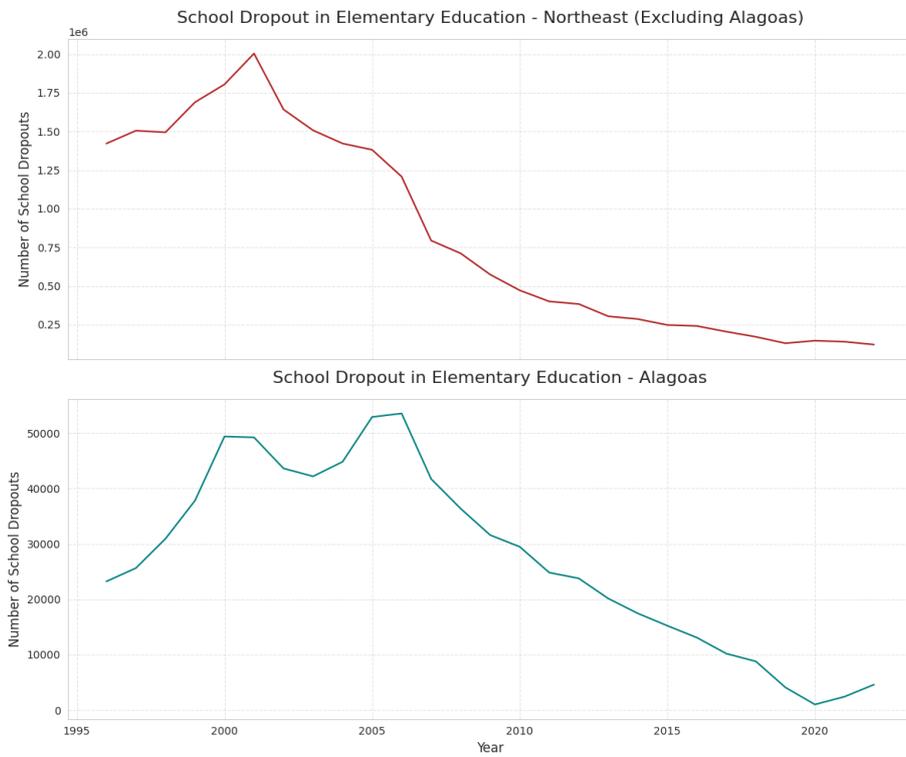


Figure 26: Temporal analysis comparing elementary school dropout in the northeast with Alagoas.

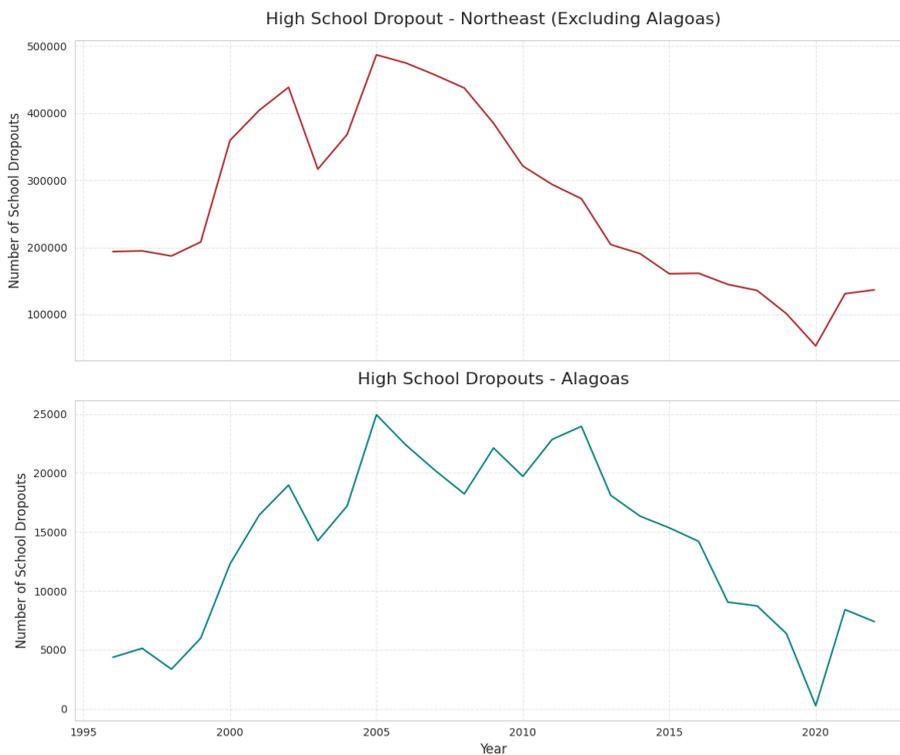


Figure 27: Temporal analysis comparing high school dropout in the northeast with Alagoas.

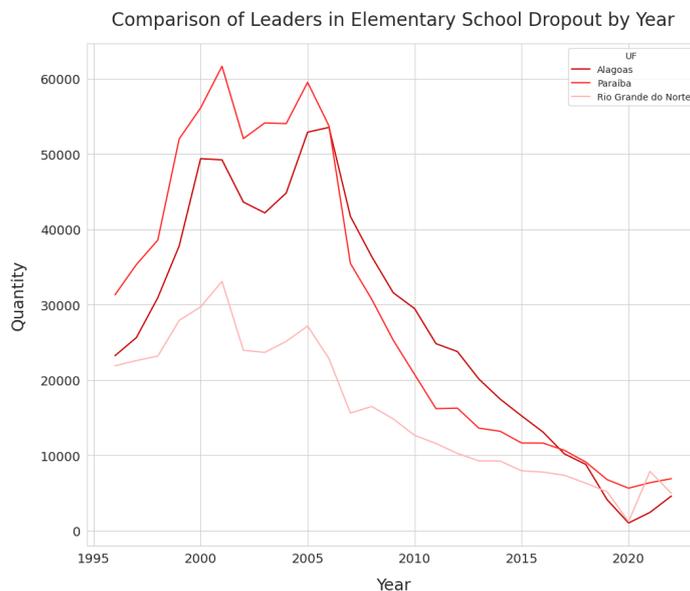


Figure 28: Temporal analysis comparing the leading states in elementary school dropout in the northeast.

school education are well separated, more data were extracted from the Alagoas dataset: one set for elementary education, containing only urban municipal schools, and one for high school education, containing only urban state schools. These two sets serve as the datasets for the subsequent

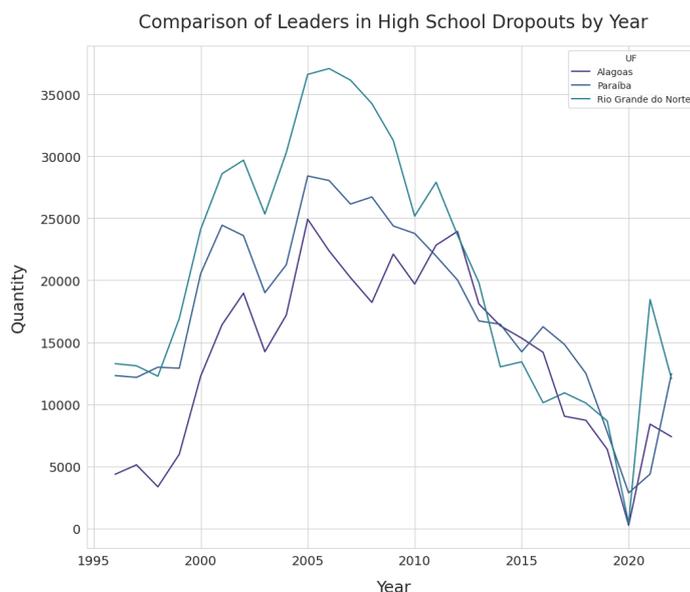


Figure 29: Temporal analysis comparing the leading states in high school dropout in the northeast.

analyses.

Among the 102 municipalities in Alagoas, the most relevant ones with the highest student dropout rates are as follows. For urban municipal elementary schools, the municipalities include Maceió, Arapiraca, São Miguel dos Campos, Rio Largo, União dos Palmares, Teotônio Vilela, Delmiro Gouveia, Marechal Deodoro, Atalaia, and São Luís do Quitunde. For Urban State High Schools, the municipalities are Maceió, Arapiraca, São Miguel dos Campos, Palmeira dos Índios, Penedo, Rio Largo, União dos Palmares, Santana do Ipanema, Marechal Deodoro, and Atalaia. The most relevant municipalities for both education levels are Maceió, Arapiraca, São Miguel dos Campos, Rio Largo, União dos Palmares, Marechal Deodoro, and Atalaia.

In general, dropout rates have decreased over the years. Among the possible reasons, we can estimate that the main factor is increased government investment in public policies aimed at strengthening education in Alagoas. From the comparison between the instances of Brazil, the Northeast, and Alagoas, we can conclude that the decline in student dropout rates is not just a trend in Alagoas but a commitment that encompasses all political and regional spheres of Brazil.

There is a possible correlation between the failure and dropout curves for both elementary and high school students in Alagoas, which will be further studied in relation to external factors and through a correlation analysis. Meanwhile, the curves of teachers and classes show no relationship with student dropout rates in Alagoas.

Among the various external conditions that are beyond the control of schools and can affect student learning in different ways, the following external variables are analyzed: government transitions, financial crises, hydrological events, and the COVID-19 pandemic.

To conduct the analysis of student dropout rates in Alagoas in relation to external factors, we used the datasets of urban municipal elementary schools and urban state high schools, filtered to include only the most relevant municipalities.

Additionally, we consider government election years to be even-numbered years. Although each term lasts four years and elections alternate between national and local elections, we considered them together because, in theory, every two years, new political groups come into power, potentially interacting differently from the previous group and impacting various sectors of society. Figures 30 and 31 present a temporal analysis of the influence of government transitions on the quantitative/percentage dropout and failure curves in Alagoas over time.

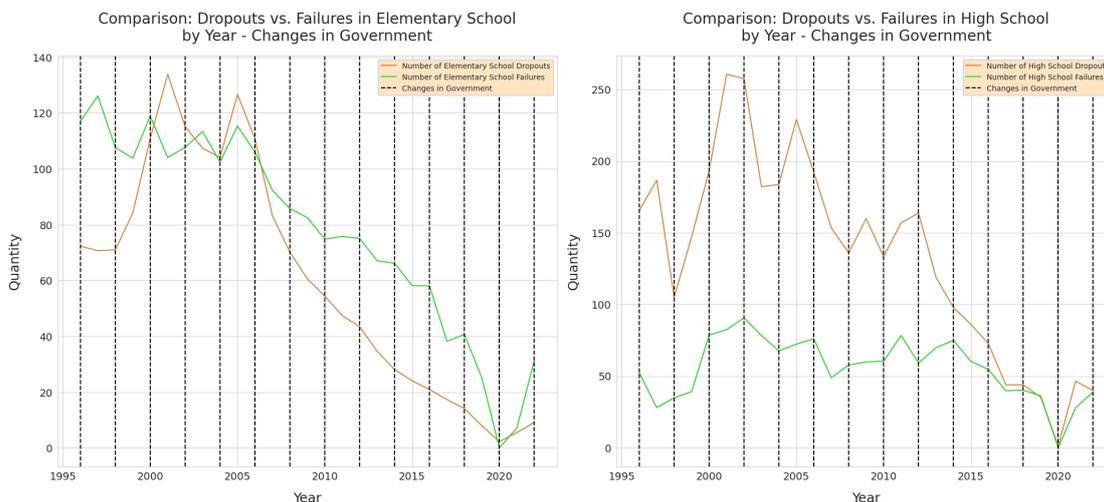


Figure 30: Temporal analysis of the influence of government transitions on the quantitative dropout and failure curves in Alagoas over time.

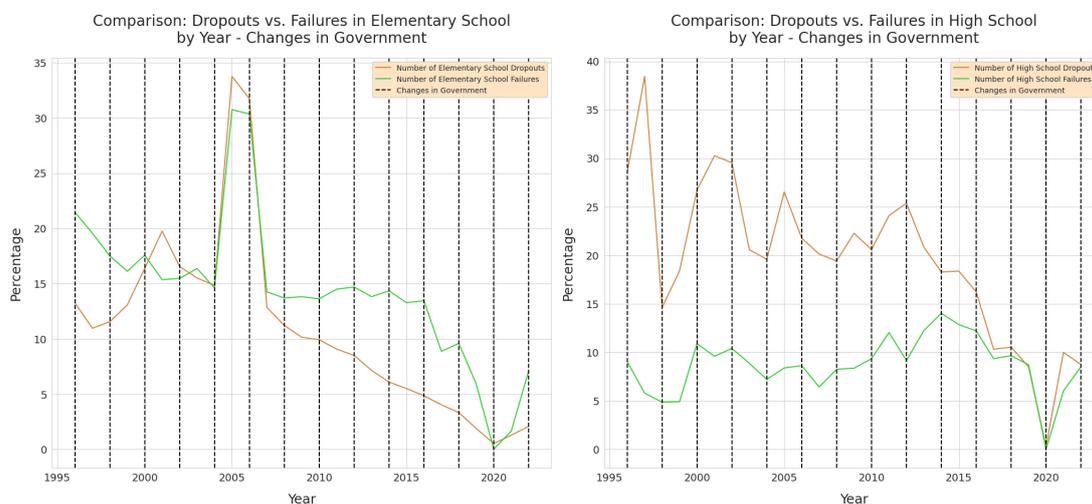


Figure 31: Temporal analysis of the influence of government transitions on the percentage dropout and failure curves in Alagoas over time.

We observed that the number of failed students in elementary education curve appears to be significantly impacted by government transitions, given its large fluctuations from one term to another. The number of dropouts in elementary education curve shows the most significant fluctuations during the terms of 1998, 2000, 2002, 2004, and 2006.

The high school curves seem to be considerably affected by government transitions, as evidenced by their significant fluctuations from one term to another. When examining the number of high school dropouts, the most significant fluctuations are observed during the terms of 1996, 1998, 2000, 2002, 2004, 2006, and 2012.

The major financial crises that impacted Brazil between 1996 and 2022 include several significant events (Holland, 2019). The 2008 financial crisis affected Brazil with a drop in stock values, a rise in the dollar, a reduction in credit, and a decline in international investments. The 2014-2017 crisis was caused by supply and demand shocks, primarily due to public policy mistakes, which contributed to an economic downturn (da Cunha Resende e Terra, 2020). The 2020 crisis, triggered by the COVID-19 pandemic, exacerbated the effects of the previous 2014 crisis.

The Asian financial crisis of 1997-1998 caused global financial instability, impacting several Southeast and East Asian countries<sup>2</sup>. This crisis was marked by capital flight and asset devaluation, creating panic in global markets. In 2014, Brazil also experienced a water crisis, primarily affecting the Southeast region, due to extreme droughts that led to the unprecedented drop in water levels of the Cantareira system in São Paulo. This water shortage severely impacted water supply, energy production, and food production.

Additionally, the country faced other significant events, such as President Dilma Rousseff's impeachment in 2016, the JBS whistleblower testimony in 2017, the truck drivers' strike in 2018, and the unemployment crisis in 2019, which further contributed to the socio-economic challenges Brazil faced during this period.

Among the 14 government transitions from 1996 to 2022, the most relevant terms for student dropout rates due to significant increases or decreases were as follows: for urban municipal elementary schools, the most impactful terms were in 1996, 1998, 2000, 2002, 2004, 2006, and 2020. For urban state high schools, the notable terms were in 1996, 1998, 2000, 2002, 2004, 2006, 2012, 2016, 2018, and 2020.

The most relevant government transitions for both education levels are 1998, 2000, 2002, 2004, 2006, and 2020. Although 2020 was an election year, the impact on student dropout rates was largely due to the COVID-19 pandemic rather than the government transition itself.

Regarding the quantitative and percentage dropout and failure curves in Alagoas in relation to financial crises, we observed a significant impact of the 2008 financial crisis. The number of elementary school dropouts fluctuates with each new economic crisis.

After the 1997-1998 financial crisis, the number of elementary school dropouts exhibited an upward trend, with considerable fluctuations in both graphs until the 2008 crisis. The 2014-2017 financial crisis significantly affected high schools. During the 1997-1998 financial crisis, the number of high school dropouts showed a sharp decline, followed by a significant increase and considerable fluctuations until the 2014 crisis.

Among the 9 years (or periods) of financial crises between 1996 and 2022, the most relevant crises for student dropout rates are due to significant increases or decreases. For urban municipal elementary schools, after the 2008 crisis, there was a strong downward trend, while following the Asian financial crisis (1997-1998), a growth trend was observed along with considerable fluctuations. For urban state high schools, the 2014-2017 crisis caused a noticeable downward trend in

<sup>2</sup><https://www.imf.org/external/pubs/ft/fandd/1998/06/imfstaff.htm?>

dropout rates. During the Asian financial crisis (1997-1998), there was a sharp decline, followed by a growth trend and considerable fluctuations in the years after the crisis.

Moreover, we considered hydrological events, including floods, inundations, and any other natural disasters involving heavy rainfall in Alagoas. However, we only used the most affected cities due to the large number of municipalities: Maceió, União dos Palmares, Murici, Coruripe, Marechal Deodoro, Penedo, Quebrangulo, Atalaia, São Miguel dos Campos, Santana do Mundaú, Pilar, Viçosa, Palmeira dos Índios, São José da Laje, São Sebastião, Rio Largo, Jacuípe, Cajueiro, Branquinha, and Matriz de Camaragibe.

Regarding the quantitative and percentage dropout for elementary and high school education in Alagoas in relation to hydrological events, not many conclusions can be drawn, as river floods, inundations, and heavy rainfall occur almost every year, affecting some municipalities more than others in different years. Therefore, we cannot state that the municipalities most impacted by hydrological events among the most relevant ones for student dropout in Alagoas are higher or lower. This is due to the frequent occurrence of hydrological events, the relevance/number of the municipalities, or possibly some other unknown factor.

Regarding the quantitative and percentage dropout and failure for elementary and high school education in Alagoas in relation to COVID-19, we observed that both appear to have been significantly impacted, as evidenced by a sharp decline in the first year of the pandemic when containment measures were more stringent. As the restrictions were gradually relaxed, the dropout and failure rates in Alagoas returned to levels close to those seen before the pandemic.

### **4.3 Correlation between Failure and Dropout Rates in Alagoas**

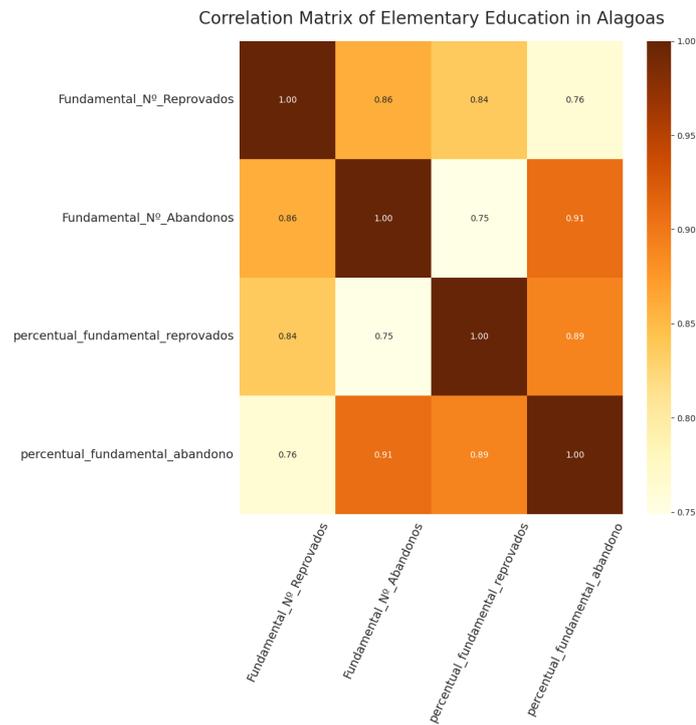
We also studied the correlation between the quantitative fields of elementary and high school education based on the indicators obtained from the school performance curve graphs. Figures 32a and 32b present correlation matrices for elementary and high school education in Alagoas.

The number of elementary school dropouts and failures are highly correlated, with a value of 0.86. Similarly, the percentage of dropouts and failures in elementary education show a high correlation of 0.89. For high school education, the numbers of dropouts and failures are moderately correlated, with a value of 0.71. However, the percentage of dropouts and the failures in high school are only weakly correlated, with a value of 0.31.

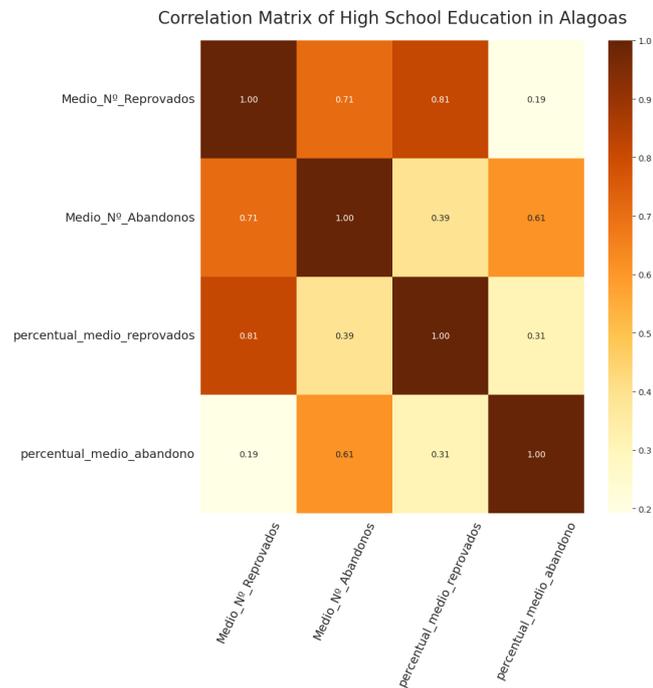
Therefore, we can conclude that there is a correlation between dropouts and failures in both elementary and high school education, with the correlation being much more substantial in elementary education. However, we cannot assert that there is a causal relationship between dropouts and failures for either level of education.

## **5 Threats to Validity**

Multiple elements (i.e., social, economic, pedagogical, and individual) can influence dropout at the regional or municipal level, but addressing all of them in a single study would create excessive complexity (Piscitello et al., 2022). Therefore, our study restricts its scope to geographical characteristics and a selected set of external factors, such as government transitions, financial crises,



(a) Elementary education in Alagoas.



(b) High school education in Alagoas.

Figure 32: Correlation matrices for elementary and high school education in Alagoas.

and the COVID-19 pandemic.

Data reliability also requires attention. The analysis uses INEP microdata, which schools provide through self-reported entries. Although INEP applies verification and standardization mechanisms, inconsistencies or underreporting may still occur and partially compromise the accuracy of the results.

Finally, the exploratory and descriptive design of this research prevents it from testing hypotheses with more rigorous statistical techniques, such as predictive modeling or multivariate regression. Instead, this study identifies overarching patterns and long-term trends, providing an initial foundation for more in-depth investigations in future work.

## 6 Conclusions

While our findings reveal correlations between grade repetition and dropout rates (e.g.,  $r = 0.86$  and  $r = 0.89$  in elementary education), correlation does not establish causation. Although repeated failure may contribute to age-grade distortion, which in turn can demotivate students and lead to dropout, such mechanisms are hypotheses rather than confirmed causal links. Future research using longitudinal or experimental designs is necessary to validate whether and how these dynamics operate over time.

Moreover, through the exploratory analysis conducted in this research, it can be determined that schools in urban areas of the Northeast region, whether municipal or state-run, have the highest student dropout rates in basic education in Brazil. As a result, the Northeast emerges as the region of greatest interest for studies aiming to understand the circumstances negatively impacting education and the potential for conducting experiments that aim for the most remarkable improvements in education quality.

The educational and socio-economic situation in the Northeast is below ideal standards despite being the second-most populous region in the country. This is due to the region's history of natural resource exploitation and insufficient financial investments. However, as most of the region's indicators are deficient, any state in the Northeast is an excellent candidate for studies aimed at identifying causes and testing potential solutions to social issues. The region has a large enough population for testing.

Among the states in the Northeast, one of the leaders in student dropout rates is the state of Alagoas. As in the general analysis from Brazil, schools in urban areas have a higher occurrence of dropouts. Alagoas also shows a more pronounced duality in its education networks than the rest of Brazil, as the highest rates in elementary education occur in municipal schools. In contrast, state schools are the major contributors to dropouts.

Unlike the situation in Brazil and the Northeast, Alagoas faces the most concerning dropout rates in high school education. One of the main factors analyzed in this study as a possible explanation for this problem was its correlation with failure rates. While failure cannot be pinpointed as the sole cause, the majority of studies on the topic consider successive failures a determining factor in students' decision to leave school.

One of the key motivations for this research was to explore how factors outside the control of schools might influence student dropout rates. To address this, the study analyzed aspects related

to public funding, such as government transitions, where some administrations may focus more on educational issues than others, and financial crises that limit available financial resources. Another point of interest was the impact of significant social events, whether caused by the destruction of public or private property or those resulting in substantial loss of life. In this context, natural disasters triggered by heavy rainfall and the COVID-19 pandemic were considered. The results showed periods of both growth and decline in student dropout rates in Alagoas, aligning with government transitions and specific financial crises. As for the COVID-19 pandemic, its sharp decline, followed by growth, is likely due to quarantine measures and their subsequent relaxation, leading rates to return to pre-pandemic levels.

Dropout rates have decreased over the years, largely due to increased government investment in public policies aimed at strengthening education. However, Brazil's educational problems are far from being resolved. What exists in practice is a slow, gradual, and continuous process of improvement.

Student dropout is a problem with multiple causes, including conflicts with work due to the need to supplement family income and the age-grade gap caused by constant failures. Therefore, there is no single solution that can address this issue, and because it is a highly complex problem, no solution will fully cover all of its underlying causes. Often, dropout may be interpreted as a solitary and individual act. However, while there is no complete solution, several measures can be taken to mitigate student dropout rates. Among these measures, we can mention a reformulation of the school environment and its curriculum, creating a more welcoming space for both students and teachers, as well as updating the subjects offered to make them more contextualized, engaging for students, and aligned with the contemporary job market needs. Another important retention strategy is providing financial incentives for students to stay in school and progress in their studies, thus supporting students in vulnerable economic situations so that they do not need to abandon their education for work. Both proposed solutions are the responsibility of the school management and, to a more significant extent, the government, whether municipal, state, or federal.

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