

Conciliating statistical and language literacy skills for the development of critical thinking and communication: Students stand up for the Brazilian biomes

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Brazil's National Curriculum determines that statistics be taught from very early education. Some of the skills expected from 12-year-old students are (i) interpreting data from media, (ii) identifying graph elements, and (iii) writing texts based on statistical data. This paper describes a project from the National School of Statistical Sciences (Ence/IBGE) to this public. Students had to use statistical data to make a public claim. They experienced a simulated Conference of the Parties, focusing on the fires that devastated Brazilian biomes in 2024, and had to fight for aid funds. School teachers and students were deeply engaged, and students had an impressive performance as they experienced criticizing disinformation, curating quality sources, organizing data in bar graphs, and finally stood up for their chosen biomes using arguments and statistical data. Articulating both literacies showed that students experiment engagement and pride in presenting compelling arguments based on contextual knowledge and statistical data.

INTRODUCTION

Statistics in Brazil is determined to be taught from the 1st grade of Basic School (corresponding to 6-year-old students) to the last grade of High School (corresponding to 17-year-old students). The National Curriculum (as known as and henceforth BNCC) is founded over the development of competencies, and it purposefully echoes international standards on that matter, such as the international evaluations from OECD (Programme for International Student Assessment - PISA) and UNESCO (Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación - LLECE) (Brazil, 2018). It determines 10 general competencies that are supposed to grant all citizens learning and development rights fully. Competency 7 confers the capacity of “arguing based on facts, data and trustworthy information to formulate, negotiate and defend ideas. (*Ibid.*, 2018) All that is underpinned by the value of behaving with ethics towards oneself, the others and the planet.

“Arguing based on data” naturally articulates two areas of knowledge: language and statistics. This is clear in the document (Brazil, 2018) as both Portuguese and Statistics establish same objects of knowledge: understanding and production of graphs, information curation, interpretation of descriptive statistics in media articles and use of data to establish a position on a given topic. The interface of statistics and language is also noticeable in statistical literacy studies.

Gal's model of statistical literacy (Gal, 2002) considers language literacy skills as one of the five knowledge bases that cooperate with dispositional elements to constitute the process of literacy. Statistical literacy was in part defined as the ability to “interpret and critically evaluate data-related arguments” (Gal, 2002). Arguments are the building blocks of social debates and decision making. Statistical literacy is critical for the elaboration of *informed* arguments, which, in turn, sustain democratic societies (ProCivicStat Project, 2018). Democracies presuppose debates, but ethical ones, which establish a “fair play”, using facts rather than personal opinions or fancy narratives to guide decisions and actions.

The studies of language literacy also advocate for the development of abilities that allow for critical evaluation and ethical production in linguistic expression. For Rojo (2019), a literate person can use Portuguese to act socially under the perspective of “protagonist citizenship”. For Soares (1998), a reference scholar in Portuguese literacy studies, literacy is not to serve a capitalist role in society, rather it is to bring freedom and a critical stance.

In this paper, we advocate for the benefits of provoking the “marriage” of these two disciplines of knowledge that naturally “flirt” with each other in educational contexts. In Brazil, Statistics is supposed to be taught by the teachers of Mathematics since 2018, the year BNCC was launched. However, those teachers feel difficulties to do so beyond the mathematics involved in it. That kind of capacity was not fully internalized by pre-service training programs yet (Pontes & Castro, 2021). In addition, Gal (2002) spouses another key knowledge base in his model of statistical literacy: the

contextual knowledge. In this sense, working with an interdisciplinary approach is necessary for the connection between statistics and contextual factors.

In this case study, we report the experience of the National School of Statistical Sciences (henceforth Ence) with 37 12-year-old-students (7th grade of Middle School in Brazil) from a public school of Rio de Janeiro. Students were invited to use statistical data to make a public claim (argument). They experienced a simulated Conference of the Parties, focusing on the fires that devastated Brazilian biomes in 2024, and had to fight for special aid funds. For that, they argued based on data that included statistics.

THE EXPERIENCE

In 2024, Ence developed an extension project on statistical literacy that included three of Ence's teachers and three undergraduates. They had the mission of planning an intervention in a public school across the street. The teachers had the intention of exploring the interdisciplinarity between statistics and Portuguese. They met the pedagogical coordinator of the public school, an old partner, who enjoyed the idea and suggested the Portuguese teacher of a specific 7th grade class as a possible candidate for the project. She also suggested the theme to be explored: the fires in Brazil that devastated several important biomes, such as Pantanal and the Amazon forest. Students from this class had been working with the theme in the disciplines of biology, geography and mathematics. The biology teacher explored the characteristics of each biome, the geography teacher associated them with the Brazilian regions and the mathematics teacher explored the elaboration of graphs based on statistics involving the area devastated by the fire during the last 5 years.

The undergraduates were then asked to study the objects of knowledge and abilities corresponding to statistics and Portuguese according to BNCC and find possible connections. Advised by the teachers, they found out that Portuguese included abilities such as noticing when information source is manifested or hidden for persuasion purposes; distinguishing between fact and opinion; identifying editorial styles, such as sensationalism. In BNCC, there are several dimensions of discourse use. We focused on the media-journalistic and the public claim dimensions. The first one was used to explore information and understand how information was brought to students' knowledge while the public claim was the dimension in which students would pose a claim regarding the theme. The statistics object of knowledge in BNCC for the 7th grade was graphs and the abilities were interpreting and analyzing data in graphs. Moreover, a general ability for statistics in basic education is to curate sources.

From those conclusions, undergraduates under the advisory of Ence' teachers presented a proposal of school intervention with three encounters to the teachers and pedagogic coordinator of the public school in an online meeting. The meeting ran smoothly with the public school staff approving of the proposal and sending us all the material they had worked with the 7th grade students before. The Portuguese teacher agreed to help the students to work with argumentation skills to prepare them for the planned intervention detailed in the next paragraphs.

The first encounter was designed to explore strategies in the production of disinformation. They were split in groups and created news headings based on random pictures involving pets. They used their imagination, and they were expected to use numbers and play with made up sources. We explored the typical statistics that usually appear in headings, e.g. percentages and averages. We also explored sensational language and the consequences of combining both. Students produced fantastic examples and clearly manifested they were having fun (See Picture 1). At the end of this first encounter they were taken to reflect on the importance of resourcing to trustworthy sources. The undergraduates, who were conducting the class, wrapped up talking about IBGE (the Brazilian NSO) and an official source to be considered about fires in Brazil (INPE – National Institute of Spatial Research). The students took home a flyer alerting about fake news and what should be done to detect them, including the curation of sources (see Picture 2). The abilities from BNCC involved in this day were distinguish fact from opinion (Portuguese) and interpreting data from media (Statistics).

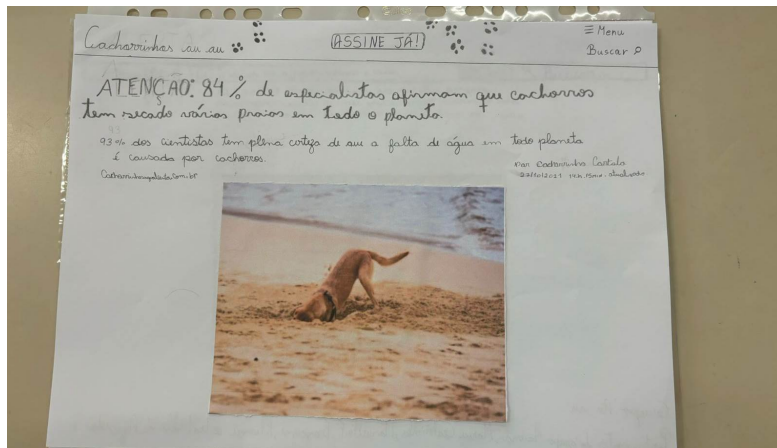


Figure 1. This is one of the results of the first activity 7th grade students produced. From the picture of a dog digging the sand of a beach, students created the heading: Attention: 84% of specialists affirm that dogs have dried out beaches all over the planet.



Figure 2. This is the flier students took home advising how to identify fake news, highlighting the importance of checking the source. The QR codes refer to INPE (official source for fire control in Brazil) and IBGE Educa (an educational portal of Brazilian NSO).

The second encounter was thought to lead students to read and produce graphs for the creation of news. First, they were taught about the elements of graphs, and we discussed the need to normalize the number of fires by the area of the territory each biome occupied. They noticed that a mere comparison of the absolute number of fires led to wrong conclusions. Then, they were divided in 5 groups; each group was responsible for one Brazilian biome. They produced graphs and headings with subheadings departing from data of fires for their specific biome taken from INPE (see Picture 3). This time they created news with good information, opposing to the fake news they created in the first

encounter. At the end of the lesson, all groups presented their productions to the class. The abilities from BNCC involved in this day were reading and producing graphs, raising questions for a public claim (Portuguese) and interpreting data from media, and identifying graph elements (Statistics).



Figure 3. This picture shows the graph produced from the table organizing data for Pantanal. They produced the heading and subheading over the table.

The third encounter (the apex) was to produce a public claim based on data. In a first moment, students prepared to present a public claim in groups. They studied all the information they had about the biomes, the statistical data in the graphs they produced and a script we offered for them to use a more formal diplomatic language. Then they participated in a simulation of a Conference of Parties (taking profit of the fact that the real CoP was going to happen in Brazil in 2025), in which they were to define which biome would get emergency aid funds (see Picture 4). In the Conference, the five groups represented the different biomes and they had to defend their biomes based on the data they had obtained in the second encounter, but also considering the information they studied with the other teachers (biology and geography). In the end of the diplomatic session, the whole class would decide which biome really deserved emergency attention. The abilities from BNCC involved in this day were arguing for a public claim (Portuguese) and producing texts to summarize conclusions of statistical data (Statistics).

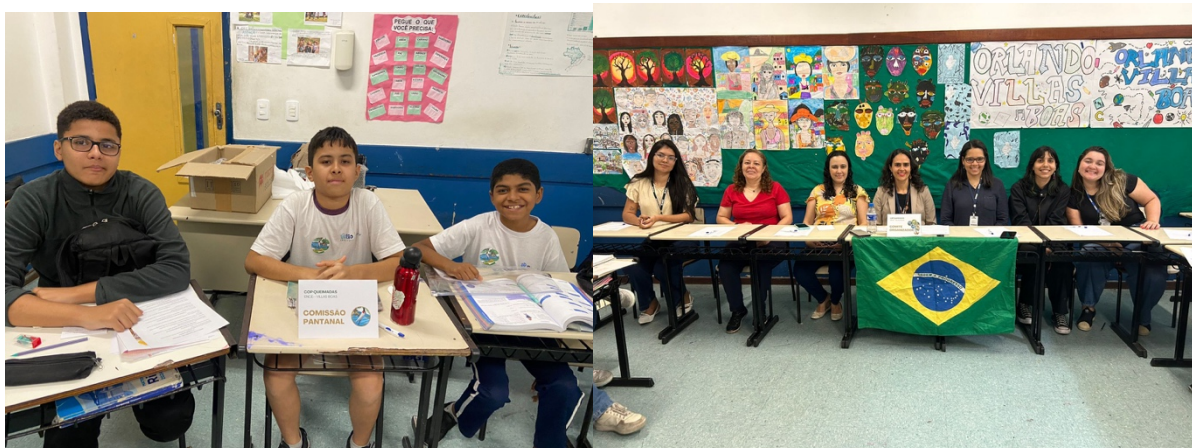


Figure 4. This picture shows a group of students representing Pantanal on the left and Ence's teachers and undergraduates as well as the Portuguese teacher representing the board of the CoP, responsible to conduct and mediate the diplomatic meeting.

IMPLICATIONS

The school intervention ran smoothly with evident engagement and an outstanding performance of the 7th grade class in the apex meeting: the simulated CoP session. The first encounter resulted in very smart headings in which all groups of students used sensational language combined with fake statistics and sources. The headings are reproduced below.

- Attention: 80% of children today do not play with electronic devices.
- Alert: The number of stray cats rise astonishingly.
- Caution: 85% of children that play with soap bubbles develop allergy leading to death.
- Alert: A monkey in an IQ test scores 20% more than Newton.
- Attention: studies show that children are hypnotized by vibrant colors.
- Attention: 84% of specialists affirm that dogs have dried out beaches all over the planet.
- Alert: 98% of children love going to this park because they give magic ballons.

The second encounter posed some challenges. As students never used the graph paper, undergraduates and teachers had to help with the notion of scale, using the squares on the grid, conventionalizing the number of squares used to represent a certain quantity of fires in a certain period. The groups worked with different orders of magnitude as biomes varied from hundreds to hundreds of thousands in number of fires. The 7th grade students, however, showed they understood the elements of the graphs such as title, names of axes, legend and title. They presented the results of this task aligned with the headings they created alerting about the fires in a certain biome. They were able to connect texts with graphs pretty well.

Finally, the third day surprised us with their excellent performance. Undergraduates noted in their reports that the fact of us creating a theater of the CoP, dressing more formally and speaking diplomatic language, took them to a mindset of serious and committed behavior. They did not talk while other groups talked and paid close attention to one another. At the end, they collaborated to decide which biome deserved the emergency aid. They chose arguments resourcing to numbers and their knowledge of the biomes and constructed very good speeches. We helped them with some template sentences such as starting public speech and ending public speech. They used those formulae, but went beyond that in the listing of the different arguments to talk about the biomes.

All the observations above were systematized from the observations of Ence's teachers as well as from the observations and comments registered in the evaluation reports undergraduates had to produce as an assessment criterion of their participation in the Extension project. The school Portuguese teacher also noticed an unusual performance from the 7th grade students, showing more fluency on the use of language on top of the usual commitment the class showed.

From this experience of intervention, some lessons were learned. We systematize those lessons as the following script for interdisciplinary work involving statistics and language.

- Departing from a target context for language use: decide where your students will arrive in terms of production (e.g. a journalistic article, an opinion article, a diplomatic debate, a public speech, a scientific report). In the case of the experience we reported, our target language situation was a diplomatic session, involving a public claim (standing up for a biome in a Conference of Parties turned to the theme fires in Brazil).
- Checking if there are any other contexts of language use: decide what kind of language use the students will depart from or go through (e.g. they can come from technical reports to arrive at opinion articles; they may come from journalistic articles to arrive at public claims before the school community). In this work, they departed from journalistic articles to arrive at a public claim in a diplomatic session, as they studied news about the fires in Brazil.

- Thinking of the abilities involved in that language use: in each communicative situation, certain abilities are necessary. In a diplomatic session, the ability to defend a point, speak and listen to formal language, behave according to strict protocols.
- Exploring the statistics that cooccur with a certain language use: this can be done by studying samples of texts that represent a certain language use. In our case, we found out that descriptive statistics frequently cooccurred with emphatic and/or comparative language. For example, news uses descriptive statistics with emphatic expressions or words (underlined in the following examples): “In 2024, burns destroyed 2.6 million hectares of Pantanal, corresponding to 17% of all the extension of the biome.”; “Burns in Pantanal devasted 17% of the biome in 2024, according to study.” Source: Revista Exame, 26/06/24. In addition to descriptive statistics, news use results of surveys that are not detailed or planned and associate the results with emphatic language, building an impression that numbers are compelling.
- Exploring how statistics can answer questions in the process of decision-making or position-taking: this can be noticed in the process of elaboration of a certain language use. In this work, for students to defend their biomes they asked the following questions minimally: Has my biome suffered with burns for a while? or Is it suffering compared to other biomes in Brazil in 2024? or even Have fires grown along time? To answer the first question, students should consult a time series regarding the number of fires in a certain period. To answer the second question, students should consider comparative statistics amongst the five biomes, preferably represented in the format of a graph.

The script above can be used as a roadmap for Math teachers responsible for teaching statistics. They usually get lost on how to teach statistics beyond calculation forms (Pontes & Castro, 2021).

During all the intervention, we were very careful to sustain awareness in the process of how data was used in the construction of arguments. They were able to notice how data can be used to fool (in the activity of fake, sensational news), as well as to help a decision or to convince of an argument (when they used data from an official source to base their arguments). As a highlight, the acting of a CoP really took them to living a role and experiencing the benefits of considering data to take a position and making a decision fully.

CONCLUSION

Statistics is a discipline that involves more than technical skills; it requires thoughtful engagement with real-world contexts and a critical mindset to ensure meaningful and responsible use of data. It is used in public debates for position-taking or decision-making; thus, it helps sustain democratic social practices. Likewise, language can be used to help those social activities and linguistic resources can be used to convince people – a characteristic that is enhanced when cooccurring with statistics.

The process of statistical literacy includes language skills and the process of language literacy may include the understanding of statistics (e.g. news articles constantly build meaning in the interrelation of texts and descriptive statistics, graphs, and tables). From the experience we reported, one can easily notice how the work with Portuguese language in an experience that simulates real communication facilitates the deep understanding that using data to make decisions is necessary and beneficial for the exercise of citizenship. An awareness work of the interrelation of statistics and language resources framed by a specific language use context is promising to bring meaningful learning experiences to both areas of knowledge.

This intervention is only one example of how statistics can benefit from interdisciplinary work. It amplifies the possible tasks Mathematics teachers are likely to propose, as they may find difficulties to go beyond numbers or calculation. The ubiquity of statistics in our lives justify interdisciplinary partnerships to deal with the complexity of making real sense of data and of negotiating ideas in democratic debates. Thus, interdisciplinary work in those areas facilitate development in both statistical and language literacies.

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*Titles were translated from Portuguese to English as recommended by reviewers.