# DIDACTIC ALTERNATIVES FOR PROMOTING STATISTICAL LITERACY WITH PRIMARY AND SECONDARY DATA

## *ALTERNATIVAS DIDÁTICAS PARA PROMOVER A ALFABETIZAÇÃO ESTATÍSTICA COM DADOS PRIMÁRIOS E SECUNDÁRIOS*

## *ALTERNATIVAS DIDÁCTICAS PARA PROMOVER LA ALFABETIZACIÓN ESTADÍSTICA CON DATOS PRIMARIOS Y SECUNDARIOS*


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**ABSTRACT**: In this article, we present two perspectives for promoting statistical literacy in Brazilian Basic Education: the development of the investigative research cycle, with data collection conducted directly by the students, and the discussion of problems of social, political, economic, historical, cultural and cultural relevance for them, based on news published in the media, in the light of secondary data analysis. Our objective is to discuss how these two approaches, prescribed in the National Common Curricular Base (NCCB), can contribute in a complementary way to the improvement of this literacy, based on Civic Statistics. We bring to the discussion, by way of example, two teaching experiences lived by high school students from a public school in São Paulo. In the end, we concluded that both proposals are relevant for students' statistical learning, both in terms of understanding the objects of knowledge of Descriptive Statistics, provided for in the NCCB, and for the promotion of criticality and citizenship, in the context of infodemia and fake news.

**KEYWORDS**: Civic Statistics. Common National Curriculum Base. Primary and secondary data. Research investigative cycle. Statistical Literacy.

***RESUMO:*** *Nesse artigo, apresentamos duas perspectivas de promoção do letramento estatístico na Educação Básica brasileira: o desenvolvimento do ciclo investigativo de pesquisa, com coleta de dados realizada diretamente pelos estudantes, e a discussão de problemas de relevância social, política, econômica, histórica, cultural e ambiental para eles, a partir de notícias veiculadas na mídia, à luz da análise de dados secundários. Nosso objetivo é discutir como essas duas abordagens, prescritas na Base Nacional Comum Curricular (BNCC), podem contribuir complementarmente, para o aprimoramento desse letramento, embasado na Estatística Cívica. Apresentamos aqui duas experiências de ensino vividas por estudantes de ensino médio de uma escola pública paulista. Ao final, concluímos que ambas propostas são relevantes para a aprendizagem estatística dos estudantes, tanto naquilo que diz respeito à compreensão dos objetos de conhecimento da estatística descritiva, previstos na BNCC, quanto para a promoção da criticidade e cidadania, no contexto da infodemia e das fake news.*

***PALAVRAS-CHAVE****: Base Nacional Comum Curricular. Ciclo investigativo de pesquisa. Dados primários e secundários. Estatística Cívica. Letramento Estatístico.*

***RESUMEN****: En este artículo, presentamos dos perspectivas para promover la alfabetización estadística en la Educación Básica brasileña: el desarrollo del ciclo de investigación investigativa, con recolección de datos realizada directamente por los estudiantes y la discusión de problemas de orden social, político, económico, histórico, cultural y ambiental para ellos, a partir de noticias publicadas en los medios de comunicación, por medio del análisis de datos secundarios. Nuestro objetivo es discutir cómo estos dos enfoques, prescritos en la Base Curricular Común Nacional (BNCC), pueden contribuir a la mejora de esta alfabetización, a partir de la Estadística Cívica. Traemos a la discusión, a modo de ejemplo, dos experiencias de enseñanza vividas por estudiantes de secundaria de una escuela pública de São Paulo. Al final, concluimos que ambas propuestas son relevantes para el aprendizaje estadístico de los estudiantes, tanto para la comprensión de los objetos de conocimiento de la estadística descriptiva, previstos en la BNCC, como para la promoción de la criticidad y la ciudadanía, en el contexto de infodemia y fake news.*

***PALABRAS CLAVE****: Base Nacional Común Curricular. Ciclo investigativo. Datos primarios y secundarios. Estadísticas Cívicas. Alfabetización Estadística.*

## Introduction

The current Brazilian educational policy is based on the Federal Constitution (Brasil, 1988) and the Law of Guidelines and Bases of National Education (Brasil, 1996), fundamental for the creation of the National Curricular Parameters (PCN) for Elementary and Secondary Education (Brasil, 1997, 1998, 2000), as well as for the creation of the National Curricular Guidelines for Secondary Education. These guiding documents for Brazilian Education highlight the importance of basic education students developing statistical, probabilistic and combinatorial thinking from the initial grades. To meet these objectives, the Information Processing Block for Elementary Education and Data Analysis for High School was created, seeking to integrate basic notions of Descriptive Statistics with Combinatorial Analysis and Probability, so that students can build their knowledge through everyday situations, according to Souza (2019).

The National Common Curricular Base (BNCC) expanded the Probability and Statistics curricular space (Giordano, Araújo, Coutinho, 2019). In 1997, the National Curricular Parameters (PCN), which introduced Statistics in Basic Education (Cordani, 2015), the BNCC (Brasil, 2018) presented the proposal to develop Learning Projects in all school years, from elementary to high school. This proposal places the student as a central figure in the production of scientific knowledge, as stated by Giordano (2020) and Santana and Cazorla (2020), but it also establishes new challenges for teachers. As presented by BNCC (Brasil, 2018), student participation is present in choosing the topic and research design, in disseminating its final results, through the collection and organization of primary data.

The BNCC (Brasil, 2018) reinforces trends already present in the PCN (Brasil, 1997, 1998, 2000), to promote statistical literacy more broadly and, through its most diverse aspects, expand students' worldview, which included statistical literacy in reading the world and understanding its immediate reality, allowing them to interpret with greater assertiveness the news present in the most diverse media, thus forming an opinion based on scientific evidence, making conscious decisions and arguing in defending their positions. It recognizes the importance of Mathematics and Statistics for understanding information transmitted by the media, emphasizing the need to base opinions on scientific evidence, through reliable sources.

Giordano, Araújo and Coutinho (2019, p. 13, our translation) note that students must be able to "critically analyze the information present in the media, such as newspapers, magazines,

internet, television or radio, sometimes biased, the result of generalizations, result of erroneous research due to bad faith or methodological flaws".

It should be noted that the reliability of information, amid the proliferation of fake news, did not go unnoticed by BNCC (Brasil, 2018, p. 136, our translation), when discussing the "issue of reliability of information, the proliferation of fake news, manipulation of facts and opinions", which raises the need to "compare and analyze news from different sources and media". How could we use the resources of statistics to solve these problems? While Lopes (1998, p. 117), when analyzing the curricular proposal of the PCN, raises the question "how the teaching of Stochastic could be developed through a curricular organization through interdisciplinary work projects?", Giordano, Araújo and Coutinho (2019, p. 17, our translation) observed in BNCC a tendency to "aim for a transdisciplinary approach" and, at the same time, in this document, the "possibility of approaching this through projects that can promote statistical education" is identified.

These curricular proposals in Brazil help to build a statistical culture for society, which should provide the ability to interpret and critically evaluate statistical information, according to Gal (2002). Coutinho and Souza (2015, p. 121, our translation) highlight "the importance of reflecting on the process of teaching and learning statistical content that enables the development of this type of culture, important both for professional practice and for the full exercise of citizenship".

It is necessary to evaluate educational proposals that suggest a statistical approach based on primary data, collected and processed by students, and a critical reading of reality based on the information that reaches them through secondary data media transmitted by the media.

We are interested in considering the potential of these two proposals to carry out the necessary social transformations in the 21st century (Harari, 2018). Our objective is to discuss how research approaches with primary and secondary data, prescribed in the BNCC (Brasil, 2018), can contribute to improving statistical literacy in basic education. In the next section, we will describe our methodological procedures.

## Methodological procedures

With the aim of identifying the contributions of teaching approaches that can promote statistical literacy based on primary and secondary data, and comparing the results achieved by them, we carried out qualitative research, through a literature study. Here we use primary data to support an intervention proposal, based on learning projects. The approach is qualitative, from the perspective of Prodanov and Freitas (2013).

The data collected in this research are essentially descriptive, characterizing as many elements as possible present in the reality studied. According to these authors, research of this nature favors the process to the detriment of the final product. The focus of analyzing the collected data is not strictly on confirming previously elaborated hypotheses, although they respect the epistemological limits of a consistent theoretical framework, guiding the research stages, such as collection, analysis, organization/representation and interpretation of data.

The procedures adopted here, in this case the bibliographic study (Gil, 2017), make use of previously published material, basically composed of books, articles and curricular documents. In this context, this article is based on the statistical literacy perspective assumed by Gal (2002, 2021) and expanded by Gould (2017), in learning projects, through the statistics research cycle (Wild; Pfannkuch, 1999, Batanero; Díaz, 2011) and Civic Statistics (Nicholson; Garota; Ridgway, 2018; Engel, 2019; Engel; Ridgway; Stein, 2021).

Next, we will present our theoretical contributions.

## Theoretical Frameworks

Although the expression "statistical literacy" is not even mentioned in the BNCC (Brasil, 2018), literacy (and multiliteracy), more broadly, is mentioned forty-five times, associated with different curricular components. In Mathematics, the BNCC adopts the definition adopted by the Organization for Economic Cooperation and Development [4](OECD), responsible for implementing the International Student Assessment Program [5](PISA):

> According to the Pisa Matrix 2012, mathematical literacy is the individual ability to formulate, employ and interpret mathematics in a variety of contexts. This includes mathematical reasoning and the use of mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. This helps individuals recognize the role that mathematics plays in the world and enables constructive, engaged, and caring citizens to make informed

[4]Available at: https://www.oecd.org/latin-america/paises/brasil-portugues/ . Accessed on: 03 Jun. 2023.
[5]Available at: https://www.oecd.org/pisa/ . Accessed on: 03 Jun. 2023.

> judgments and make necessary decisions (Brasil, 2018, p. 266, our translation).

Some authors, such as Costa and Afonso (2009), state that knowledge, immersed in the globalization process, is configured as a policy instrument, regulating subjects and legitimizing political decisions. Thus, they question the OECD's attempts to standardize mathematical literacy processes.

Liao, Mota and Fernandes (2021) recognize the inseparability of the relationship between knowledge and politics, and its consequent implications on the BNCC, admitting that it has underlying implications that directly affect society, as well as that political factors will affect within the education departments and, consequently, in the classroom. Furthermore, they recognize that it is fair to assume that this knowledge produced will serve as fuel for future political actions.

Despite this, given the importance of BNCC in Brazilian Education, as well as PISA in World Education, they argue that the issue of developing and establishing minimum curricula that promote mathematical literacy as a public policy action should be discussed at a minimum curricular level by the various Education departments, seeking to develop the cognitive potential of students.

Among the theoretical references of Statistical Literacy to be highlighted, the speech of the president of the American Statistical Association, Katherine K. Wallman (1993) stands out about her conception of this term as being the ability to understand and critically evaluate the statistical results that permeate our daily lives, along with the ability to appreciate the contributions that statistical thinking can make in public and private decisions.

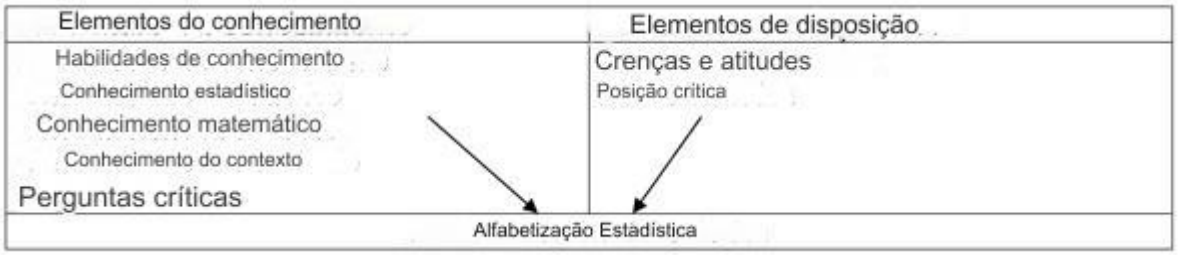
This perspective allowed Gal (2002) to incorporate two components in Statistical Literacy in adults. The first deals with people's ability to interpret and critically evaluate statistical information, data-related arguments, or stochastic data phenomena that they may encounter in various contexts and when relevant. This last component deals with your ability to discuss or communicate your reactions to such statistical information, such as your understanding of the meaning of the information, your opinions about the implications of that information, or your concerns about the acceptability of certain conclusions.

The conceptions of statistical literacy assumed in our article have in common with this definition of statistical literacy the emphasis on reading, understanding and coherent argumentation, seeking social commitment and the critical and responsible exercise of citizenship. For Gal (2021, p. 45, our translation), statistical literacy consists of "motivation and

ability to access, understand, interpret, critically evaluate and, when appropriate, express opinions about statistical messages related to data, arguments or issues involving uncertainty and risk".

According to Gal (2021), statistical literacy is built through a critical and investigative stance, basic knowledge of statistics and mathematics, reading and analysis skills, beliefs, attitudes and knowledge about man and the world around him. It is a necessary skill for the full exercise of citizenship in a world immersed in the infodemic. The WHO (World Health Organization) recognized and classified the infodemic in 2020: an excess of information, some accurate and some not, which makes it difficult to find adequate sources and reliable guidance when necessary. This literacy involves cognitive and dispositional elements, presented below, in Figure 1:

**Figure 1** – Statistical Literacy Model.




Source: Gal (2021, p. 42).

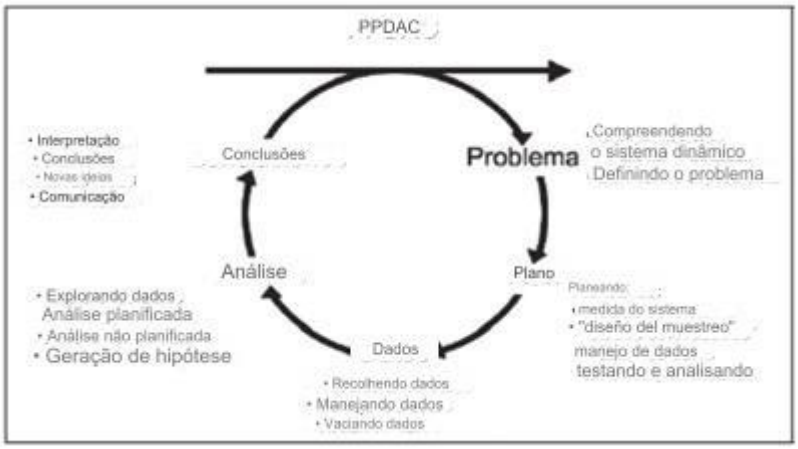
Gould (2017) updates and expands this definition, considering that the development of this statistical literacy requires citizens to: understand who collects data about us, why and how they collect it; know how to analyze and interpret data from random and non-random samples; understand privacy and data ownership issues; know how to create basic descriptive representations of data to answer questions about common real-life situations; understand the importance of the origin of the data; understand how, by whom and for what purposes data is stored; understand how computational representations can vary; Understand the basics of predictive modeling.

This author brings to the discussion emerging issues at BNCC (Brasil, 2018), which reflect many of our concerns regarding the dissemination of information on the Internet, accentuated by the accelerated development of digital technologies, such as invasion of privacy, data ownership, the storage, organization and manipulation of data, with consequences for issues such as fake news (false information that is transmitted or published as news, politically motivated or fraudulent) and fact checking, amid the infodemic.

Researchers such as Giordano, Araújo, Coutinho (2019), Santana and Cazorla (2020), Giordano (2020), Cazorla and Giordano (2021), Porciúncula (2022), see the proposal for developing learning projects as a great opportunity to contemplate the student demands for statistical research, present at BNCC, exploring the research cycle. Batanero and Díaz (2011) defend the proposal of project-based statistical learning, as it reinforces students' interest, especially if they are the ones who choose the topic, according to their universe of interests. According to these authors, students learn best when they work collaboratively with the primary data they collect.

From this perspective, Giordano (2020) states that learning projects, guided by the assumptions of exploratory data analysis (Tukey, 1962; 1970), transform the relationships between teacher, student and knowledge, promoting greater student autonomy in the development of their research. Their results revealed that this approach favors the development of statistical literacy, by fully experiencing an experience that involves the development of the Research Cycle, based on the Statistical Thinking Research Cycle, by Wild and Pfannkuch (1999), as shown in Figure 2.

**Figure 2** – Investigative cycle.




Source: Wild and Pfannkuch (1999, p. 226).

Wild and Pfannkuch's (1999) research thinking cycle, based on the PPDAC cycle: questioning, planning, data (collection, organization and presentation), analysis and conclusions, is in line with the learning project proposal presented at BNCC (Brasil, 2018, p. 319, our translation): "Plan and carry out a sample survey that involves the topic of social reality and communicate the results through a report".

This guidance on carrying out authorial research with primary data collected by the students themselves is present from the first year of Elementary School until the end of High

School. However, in this second segment of teaching, the focus is broadened, including secondary data from reliable sources, through the EM13MAT202 capability:

> Plan and carry out sample research on relevant topics, using data collected directly or from different sources, and communicate the results through a report containing graphs and interpretation of measures of central tendency and measures of dispersion (amplitude and standard deviation), using or not resources technological (Brasil, 2018, p. 546, emphasis added, our translation).

For Nicholson, Gal and Ridgway (2018), statistical knowledge depends on a set of skills that need to be improved in the school environment. These skills, essential for exercising citizenship in the 21st century, are linked to the willingness to engage in civic statistics.

Dispositional elements define the willingness to engage and dedicate time and energy to better understand the information that is continually presented in the most diverse media. This implies, in Gal's (2021) model of statistical literacy: beliefs, attitudes and critical stance. With a view to achieving such knowledge, these researchers propose a didactic approach supported by civic statistics.

Civic Statistics is a branch of statistical education research that was born at the interface between political science, educational sciences and statistics itself. It aims to help citizens to be better informed about issues relevant to society, through scientific evidence based on data from reliable sources, to make more assertive decisions and build awareness of injustice and social inequalities.

According to Nicholson, Gal and Ridgway (2018), in addition to the concepts of "traditional" statistics, Civic Statistics requires a level of understanding that involves specific skills and techniques, encompassing multivariate phenomena; aggregated data; dynamic data; use of enriched texts and diverse visualizations.

**Figure 3** – Civic statistics at the intersection of statistics, political science and educational science.


Source: Engel (2019, p. 3).

The multivariate phenomena mentioned here refer to the way in which data on social phenomena involve different intrinsically correlated variables. According to Engel (2019), a phenomenon is almost always influenced or even caused by other factors, which thus interact with each other, influencing other phenomena in turn. In isolation, we cannot understand what depends on what, as greater understanding presupposes a holistic character. This author states that statistics about society almost always include data grouped in different ways, based on correlated variables or categories. By disaggregating or reassembling them, conclusions about them can reveal new meanings.

According to Engel (2019), this data can be dynamic, collected periodically or on a comparative basis. Through them, trends are identified, allowing comparisons between old and recent data. As texts published in the media that contain statistical information about social phenomena, involving graphs, tables, infographics, diagrams, among other resources. Such a diversity of materials are rich texts that allow for a deeper understanding of civic statistics.

These materials can contribute to the development of statistical literacy, as they provide details of the data collected, in order to provide analysis and evaluation by the reader. With appropriate processing, this data can be visualized in innovative ways using virtual manipulations and dynamic representations that may require specific literacy skills from the reader for understanding (Nicholson; Garota; Ridgway, 2018; Engel, 2019).

Nicholson, Gal, & Ridgway, 2018 argue that the ability necessary to deal with civic statistics involves, in addition to statistical literacy, ten other distinct facets, which are organized into three groups or dimensions:

**Figure 4** – Conceptual model of Civic Statistics.


Source: Nicholson; Gal; Ridgway (2018, p. 6).

Tauber (2021) recognizes a lot in the Civic Statistics approach:

> The potential of a teaching, learning and assessment proposal that connects elements of statistical knowledge associated with deep contextual knowledge, in which statistical concepts are derived from the study of social problems of interest to students [...] in this sense, the contributions of production learning in different instances of exchanges (forums) and evaluation can serve as feedback for students' individual and collective learning. Also, for teacher learning, showing that even with students who have no prior training, it is possible to advance to steps beyond basic statistical literacy, which little by little enrich and expand the statistical thinking that is increasingly necessary for a professional and citizen in era of Big Data (Tauber, 2021, p. 113, our translation).

In the next section, we will present two examples of didactic approaches for promoting statistical literacy based on primary data, collected by the students themselves, and secondary data, from different governmental and non-governmental databases.

## Results and discussion

This section is divided into two subsections. The first deals with the approach through projects, with primary data collected, organized, represented and analyzed by high school students from a public school in the state of São Paulo. In the second section, we present research carried out by students from the same school, based on secondary data obtained from governmental and non-governmental databases.

## I. The Primary and Statistical Data Learning Project

The proposal to develop learning projects in statistics education, in addition to being defended by several Brazilian researchers (Giordano, 2020), includes requirements of the current curriculum base in our country (Brasil, 2018).

For Gal (2021), statistical literacy associates reading and writing practices with social practices. It is not limited to strictly mathematical and statistical knowledge, but also other elements of the arrangement, such as literacy knowledge in the mother tongue, the ability to ask critical questions and knowledge of the context.

Thus, the project-based approach can generate greater motivation and participation among students, especially when choosing topics within their universe of interest, as suggested by Batanero and Díaz (2011). A case study by Giordano (2016) showed the great importance of the role of contextual knowledge for the effectiveness of the statistical approach by projects, in the same line proposed by Batanero and Díaz (2011).

To analyze the development of statistical literacy in a project approach, a case study was carried out with 43 students aged 17 to 20, from two high school classes at a public school in São Paulo, divided into nine groups of four or five members. They participated, over a period of two months, in the entire process of preparing the statistical learning project (Porciúncula, 2022), from choosing the topic and developing the research question to analyzing and disseminating the results.

This research was born out of his concern with the difficulties encountered by elementary school students, more specifically those in high school, in producing, reading and interpreting statistical texts, tables and graphs, as well as in mobilizing statistical knowledge to face their current problems. Its theoretical references were Exploratory Data Analysis (DEA) and Didactic Situation Theory (TSD).

Students were instructed to organize themselves into small groups (four to six members), as recommended by Garfield (1993) to choose a topic of interest, as recommended by Batanero and Diaz (2011). The data collected for the analysis were extracted from the students' productions, results of their research. During the development of the projects, they were able to use the paper-pencil environment, scientific calculators, smartphones, tablets, laptops.

For guidance, the professor had at his disposal a computer and a *data show* installed in a projection room. Students carried out statistical research by choosing a topic, defining the question and objectives of the research, developing a data collection instrument, applying it,

proposing and testing hypotheses, presenting the data through summary measures, statistical tables and graphs, analyzing data and publishing the results of your research through a dashboard.

The changes in the teaching contract, triggered by the development of students' research, contributed to the promotion of their autonomy, so important for the teaching of statistics, as defended by Batanero and Díaz (2011), in addition to being fundamental for the development of statistical literacy, especially with regard to dispositional elements (beliefs, attitudes and critical questioning), as defined by Gal (2021). These works illustrate step by step the research cycle of statistical research, from justifying the choice of topic to data analysis, discussion and dissemination of results.

The learning project approach requires flexibility in time, space and resources, requiring a didactic-pedagogical restructuring in the management and exploration of the classroom beyond the school walls. Furthermore, it is important for literacy that students have technological resources that optimize time and save effort in recording, organizing and presenting data, as proposed by Batanero and Díaz (2011). Above all, it is essential to publicize the research carried out by students, involving, as far as possible, the school community, since the experience of publicizing one's own scientific research work empowers students (Porciúncula, 2022). The socialization of their research findings allows them to experience other aspects of literacy, in the field of orality, with the enrichment of vocabulary and improvement of evidence-based argumentation.

Dozens of Brazilian theses and dissertations have demonstrated advantages in promoting statistical literacy through projects, with primary data collection, but with increasingly easier access to computational resources, we ask ourselves how this demand could be met involving secondary data, in governmental or non-governmental sources, as proposed by Civic Statistics.

This discussion is the objective of the next subsection.

## II. Secondary Data and the Civic Statistics Approach

Among the facets of the conceptual model of Civic Statistics (Figure 4), we find elements of Gal's model (2021), such as dispositions, the valorization of knowledge of the context and literacy in the mother tongue, elements of Gal's (2005) probabilistic literacy, such as statistics and risks, but also new elements, such as the empowerment of information and communication technologies (ICT) in the exploration of new graphic representations or, what

interests us most in this section is the expansion of official statistics, as defined by Tauber (2021):

> Extensions in the area of official statistics. Official statistics (INDEC, EuroStat, United Nations, etc.) are sources of data on issues of social relevance. Many of the key ideas used receive little attention in traditional statistics courses, such as: survey design (non-response or response bias), measurement problems (reliability and validity, definition of metadata), definition and meaning of indices, operationalization of variables and their relationship with the theoretical construct on which they are based and the models that allow them to be analyzed (Tauber, 2021, p. 95, our translation).

Considering the richness of the work with these databases, in a high school class made up of twenty-seven high school students from a public school in São Paulo, we asked the students to look for news in the media on topics of interest to them and suspected the reliability of the source, the quality of the data, the intentionality of the information vehicle that disseminated it, compared with other sources, governmental and non-governmental, in search of possible errors, resulting from technical-procedural failures or even bad faith attempts and unethical manipulation.

One of the groups chose the theme of poverty and discrimination in our society. They found a piece of news, from ten years ago, titled more than 1/4 of favela residents have already felt discriminated against, says an investigation, on the Terra news portal [6]. The information base for this news was the Radiographies of Brazilian Favelas survey, recently launched in November 2013, the first by the Data Favela Institute, presented at the 1st Forum of New Brazilian Favelas.

However, when searching for more data on this research (Meirelles; Athayde, 2014), it was found that 59% of favela residents agree that those who live in peripheral communities are discriminated against, a number very different from that presented on the Terra portal. According to Data Favela, Brazil then had 11.7 million people living in favelas and, if it were a state, it would only lose in numbers to São Paulo, Minas Gerais, Rio de Janeiro and Bahia. The discussion that followed was about the lack of specific public policies for this population, understood as the authorities' disregard for these people's quality of life, often only remembered at election time.

[6]Available at: http://noticias.terra.com.br/amp/brasil/cidades/mais-de-14-dos-moradores-de-favelas-ja-se-sentiram-discriminados-diz-pesquisa,d98f56c7d4b12410VgnCLD2000000dc6eb0aRCRD.html. Accessed on: 03 June 2023.

Interested in the topic, the students searched for more recent data and found the Atlas of Peripheries in Brazil: Racial Aspects of Infrastructure in Subnormal Agglomerations (Goes *et al*., 2021), organized by the Institute of Applied Economic Research (Ipea), [7]a public foundation linked to the Federal Government, more specifically to the Ministry of Economy.

These students were impressed with the complexity of the work, with the organization of the data, with the richness of the representations, very different from those found in the media and even in their textbooks, and were encouraged to compare the data represented there with other bases.

A second group started a discussion about drug use and the situation in Cracolândia, in the city of São Paulo. The discussion extended to the situation of the homeless population and the recent eviction of homeless people and the removal of tents in the city of São Paulo.

Mayor Ricardo Nunes informed, on February 24th, that he is making 3500 places available for homeless people in São Paulo which, by the end of 2024, aims to offer decent housing alternatives for more than 31 thousand citizens in this condition[8]. According to a survey carried out in January 2022 by the Municipal Secretariat for Social Assistance and Development (SMADS[9]), in the last two years there has been a growth of 31%, reaching the number of around 31,884 people who sleep on the streets of São Paulo every day [10].

However, according to the State Movement for the Homeless Population (MEPSR-SP[11]), this number would be close to 66 thousand people. A third source of information, the Brazilian Observatory of Public Policies with the Homeless Population (POLOS-UFMG) points out that in 2022 the city of São Paulo had 42,240 people living on the streets, almost a quarter of the total number of homeless people in the country (around 180 thousand people living on the streets).

When looking for more reliable data, the students found the IBGE Automatic Recovery System, linked to the Brazilian Institute of Geography and Statistics (SIDRA-IBGE), [12]but they consider that access to the information is difficult and much of the data is out of date. Next, the difficulties encountered in carrying out the last IBGE 2022/2023 Demographic Census were

[7]Available at: https://www.ipea.gov.br/portal/ . Accessed on: 03 June 2023.
[8]Available at: https://www.brasil247.com/entrevistas/rua-nao-e-moradia-barraca-nao-e-lar-diz-ricardo-nunes-prefeito-de-sao-paulo . Accessed on: 03 Apr. 2023.
[9]Available at: https://www.prefeitura.sp.gov.br/cidade/secretarias/assistencia_social/ . Accessed on: 03 June 2023.
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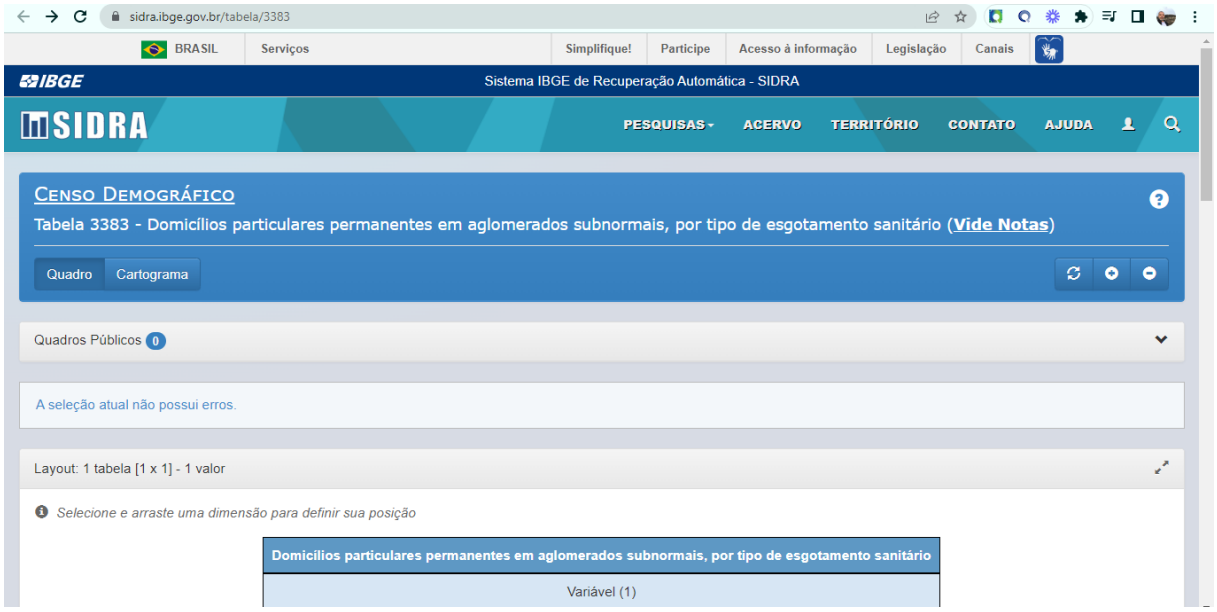
[11]Available at: https://oglobo.globo.com/brasil/cidade-dos-sem-teto-sao-paulo-ja-tem-66-mil-pessoas-nas-ruas-aponta-ong-25231546 . Accessed on: 03 June 2023.
[12]Available at: https://sidra.ibge.gov.br/home/pms/brasil. Accessed on: 03 June 2023.

discussed, from financing to the collaboration of interviewees. They discussed the previous government's possible motivations for boycotting this research, the need for greater investment in this area, the importance of accurate information for implementing public policies and the role of open data for the full exercise of citizenship.

**Figure 5** – IBGE Automatic Recovery System Interface.




Source: Brazilian Institute of Geography and Statistics.

We highlight that, in the other groups, with other equally relevant topics, such as feminicide, violence in schools, the future of social networks, internet privacy, climate change and the devastation of the Amazon, the debate among students evolves with the change in the focus of interest of more specific, superficial questions to deeper problems as new data is obtained. The fine-tuning of the research question, as well as the research hypotheses, reflects, in our view, the improvement of the student's statistical competence.

In the next section, we will present our conclusions.

## Final remarks

The promotion of literacy is widely defended by the BNCC (Brasil, 2018), in different aspects, although not all of them are directly mentioned in this document. With statistical literacy (Gould, 2017; Gal, 2021) it is no different. This concern is evidenced in the description of the objects of study, skills and competencies throughout the base, with regard to the curricular component and, transversally (Brasil, 2019), also in other components.

The exploration of statistical skills through authorial research, following the course of the research cycle (Batanero; Díaz, 2011), is present at BNCC (Brasil, 2018), in all years of elementary and secondary education, in the component mathematics curriculum.

On the other hand, the need to develop skills to read, interpret and communicate ideas, argue critically and coherently, based on scientific evidence and, finally, make responsible decisions on relevant issues regarding social, political, economic, cultural and environmental, goes beyond the field of mathematics, appearing in different components such as the Portuguese language, geography and natural sciences.

In Languages and Mathematics, emphasis is placed on purifying, in the media, reliable information from reliable sources, understanding how the data that underpins the information works, not only in terms of its acquisition and processing, but also in terms of its presentation, articulation, as well as the intentionality of those who reveal them in this way. It is necessary to know how to read the data, read between the data, read beyond the data and read behind the data (Friel; Curcio; Brilhante, 2001).

The potential for exploring the research cycle (Santana; Cazorla, 2020) to promote statistical literacy is broad (Porciúncula, 2022), allowing teaching partnerships and interdisciplinary and transdisciplinary explorations (Cazorla; Giordano, 2021), implying greater motivation and student commitment, development of socio-emotional skills, cooperative and collaborative work.

However, the statistical learning project approach also presents many challenges for teachers, both in cognitive aspects, in terms of mastering the topics proposed by students in their research, and in dispositional aspects, involving personal beliefs, values and attitudes towards production of scientific knowledge.

They involve teacher knowledge not only specific to Mathematics and Statistics, but also pedagogical, on topics such as knowledge of the curriculum and classroom management (Porciúncula; Schreiber; Giordano, 2022). Among the obstacles to be overcome, we can mention the time needed to develop the projects (taking into account that, with the reform of secondary education and the implementation of training itineraries, the mathematics workload in this segment was reduced), the need to extrapolate the school walls, at different moments, from data collection to the dissemination of research, the difficulties faced in mobilizing the group of teachers, the collaboration of the management team and the lack of material resources. This does not mean that these difficulties should not be faced and cannot be overcome (Giordano, 2020).

The secondary data approach, in different dynamic multivariate databases, governmental or not, also prescribed in the BNCC (Brasil, 2018) offers advantages such as the development of computational thinking and digital literacy, the development of the ability to sift, debug and verify information (Gould, 2017), fundamental in the management of *fake news* amid the infodemic, improving graphic reading (Friel; Curcio; Bright, 2001), with access to updated information and new data visualizations, (Nicholson; Garota; Ridgway, 2018), critical analysis of information sources (Engel; Ridgway; Stein, 2021) and citizen decision-making that contributes to the empowerment of citizens and the strengthening of democracies (Engel, 2019).

Within the scope of limitations, carrying out classes involving civic statistics, we can highlight, considering the reality of Brazilian public schools, the lack of computing resources, poor quality or even the absence of internet connectivity, evidenced during the COVID-19 pandemic (Borba, 2021), the low level of digital literacy of both teachers and students (Freitas; Cunha; Manfredo, 2022), the difficulty in accessing updated databases in Portuguese, associated with difficulty in understanding, despite the offering translation tools on the internet, resources from international databases such as Eurostat, the proliferation of fake news, at a time of national political polarization (Giordano; Pereira; Souza, 2022).

Finally, we consider that the two proposals complement each other and the diversity of statistical explorations with primary and secondary data can significantly contribute to the promotion of statistical literacy, proposed by Gal (2021).

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