READING AND INTERPRETATION OF STATISTICAL GRAPHICS BY 2ND YEAR STUDENTS OF HIGH SCHOOL

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This paper aims to analyze students' understanding about graphs and tables concerning the level of reading that is necessary for them to interpret and communicate information presented through these graphs and tables. A formative assessment attached to a didactic activity was carried out in a class of 29 high school students. The students' production was analyzed according to assumptions of the discursive textual analysis methodology. The results indicated that students recognize that the reading of graphs and tables passes through different levels, which range from literal reading to that which requires the search for implicit information. The students pointed out that certain information was clear in the graph, and they just needed to point them out, whereas other information required students to combine and integrate information so that it could be understood.

INTRODUCTION

In today's society, we live in a context in which people are constantly compelled to interpret information and data that are present in the news, social networks, advertisements, etc. We highlight that, as citizens, we are often encouraged to give opinions on everyday facts that require the understanding of graphs to make estimations, organize thinking, and make conscious decisions. Considering the presence of statistics in our daily lives, Brazil's official curriculum proposal highlights and justifies the relevance of teaching statistical contents, claiming that it is essential for people's lives. However, they emphasize that this learning should be significant and prioritize the meaning of concepts and critical reading of information (Ministério da Educação, 2018).

Campos (2007) and Perin (2019) point out that in the didactic process of statistics, the development of three skills is relevant: statistical literacy, statistical reasoning, and statistical thinking. Such competences are essentially based on the critical interpretation and analysis of information from real data and are aligned with the principles that guide Critical Education and Critical Mathematics Education.

In this line, Perin and Campos (2020) explain that the teaching of statistics at different school levels should prioritize learning experiences relevant to the development of these skills to enable students to become able to face various tasks they will find in different everyday contexts. For the authors, these pedagogical experiences must be centered on students and focused on problems that are relevant to them so that they can reflect on the activity developed.

Therefore, focusing on statistical literacy, we proposed a didactic strategy based on a formative assessment to analyze the understanding of 2nd year high school students about the reading levels that are necessary for them to understand and communicate information presented in graphs and tables. Our goal is to clarify the reading levels that are necessary for students to understand and communicate information presented in graphics and tables.

In the theoretical framework of this study, we emphasize the concept of statistical literacy regarding the reading of graphs and tables, describing its different levels. Additionally, we briefly discuss the formative assessment didactic strategy. The students' output will be analyzed in light of this theoretical framework.

THEORETICAL FRAMEWORK

Campos, Wodewotzki, and Jacobini (2011) define statistical literacy as the study of arguments that use statistics as a reference, that is, the ability to argue correctly using statistical terminology. They also include basic skills for understanding information, which require the ability to organize data, build tables, and understand symbols, vocabulary, and concepts as well as probability as a measure of uncertainty.

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Statistical literacy is related to the skills of reading and interpreting data contained in tables and graphs, verifying whether conclusions can be obtained based on the available data and information, and understanding the concepts involved with drawing inferences and making decisions. This competence involves knowledge about mathematical/computational processes, conceptual analysis of information, and a critical posture facing the statistical demands present in the media (Perin & Campos, 2020).

Gal (2002) explains that statistical literacy is the ability to interpret, critically analyze, and communicate statistical information. Gal considers a statistically literate person to be one who uses a set of skills that comprise elements of disposition and knowledge. Gal (2002) proposes a model in which literacy involves two processes that assume the idea of promoting the ability to understand, interpret, and critically evaluate statistical and probabilistic information found in reading contexts that are developed in adults and school students. The first process represents a combination of cognitive elements responsible for knowledge, which are: (a) literacy skills, (b) statistical knowledge, (c) mathematical knowledge, (d) knowledge of the context, and (e) critical questioning. The second process is responsible for attitudinal issues: (f) critical posture and (g) beliefs and attitudes.

Regarding the objectives of this study, we sought to deepen our study of statistical literacy aimed at reading graphs and tables, on which we found the research by Curcio (1989). According to Curcio, the reading and interpretation of tables and graphs takes place at three levels: at the first level, reading the data, the student identifies data explicitly presented in the graph, just by reading the facts that are represented in it. At the second level, reading between the data, students interpret and organize the information provided by the data, combining and integrating information and identifying mathematical relationships through some prior knowledge about the subject addressed. Finally, at the third level, reading beyond the data, students make inferences using all available information, have an in-depth prior knowledge of the data context, and can answer questions that require use of information implicit in the graph, that is, extrapolating, predicting, or making inferences.

Considering the relevance of this competency so that individuals can consciously exercise their citizenship, we find in the didactic strategy known as formative assessment a way to promote its awareness among students. This is because this strategy is centered on the students' cognitive processes and associated with the processes of feedback, regulation, self-assessment, and self-regulation of learning. It comprises a pedagogical strategy that actively involves the student throughout the process, developing self-assessment techniques, which helps them to perceive their own learning achievements in a way that leads students to learn how to learn (Leonardi et al., 2017).

In this way, we understand that formative assessment is an instrument that allows students to reflect on the results they have achieved, indicating other activities that they can perform to expand the level of their learning. Along the teaching and learning process, students are encouraged to self-evaluate their learning, which serves as an indication to the teacher of what aspects should be reinforced and/or modified in his initial planning to attend to the students' needs.

METHODOLOGY

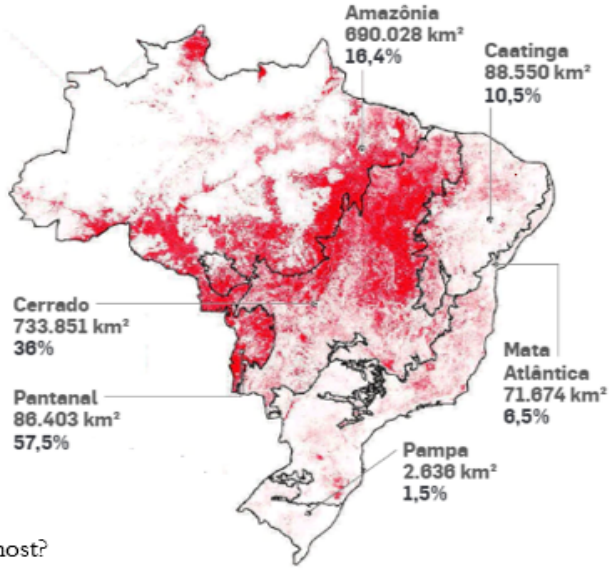
The activity was carried out in a class of 29 high school students in a private school from São Paulo. Student’s prior knowledge in statistics is mostly based on calculating descriptive measures (mean, median, standard deviation) and reading and building simple charts and tables.

The didactic sequence was elaborated based on infographics present in a newspaper that included data about fire in Brazilian territory. Through the exploration of the infographics, the students had the task of identifying the biome (ecosystem) that burned the most in the analyzed period, calculating the percentage of each biome’s area that was burned, and estimating the burned area of the Pampas biome, assuming continuous linear growth until 2030. The students' understanding of the reading level necessary to carry out the didactic sequence was captured in the formative assessment carried out after the didactic sequence. Both the evaluative activity and formative assessment are displayed in Figure 1. The formative assessment data were organized and analyzed according to the assumptions of the discursive textual analysis methodology.

Discursive textual analysis is a process that begins with the separation of texts into meaning units. After this phase, similar meanings are articulated in a process called categorization. In this process, similar units of meaning are brought together, which can generate several levels of analysis categories. In the next section on Results and Discussion we present the categories, bringing clippings of the students' productions in the formative assessment, which are identified by A1 (student 1), A2, etc.

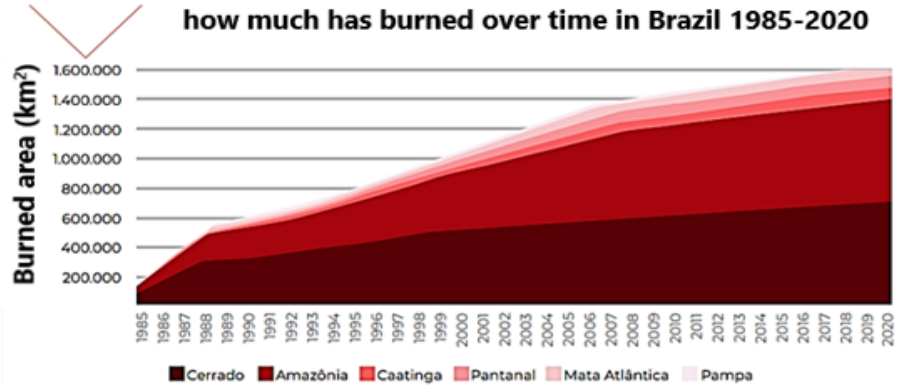
The discursive textual analysis has its foundation in the writing exercise as a mediating tool in the production of meanings. Therefore, in recursive processes, the analysis moves from the empirical to the theoretical abstraction. This whole process generates analytical meta-texts that will compose the interpretive texts (Moraes, 2003).

Evaluative activity



Which biome burned the most?

What percentage of Brazil's area has already been burned?



Consider that fires in the Pampas grew linearly from 1985 to 2020 and follow this trend until 2030. Therefore, what will be its burned area on that date?

Formative assessment

I found it difficult .... because .....

By doing this activity I learned that....

Figure 1. Evaluative and formative assessment

RESULTS AND DISCUSSION

Using the techniques of discursive textual analysis, it was possible to construct three categories of analysis. The data obtained through formative evaluation show that students recognize that reading and understanding tables and graphs requires skills that permeate the three reading levels explained by Curcio (1989).

In the first category of analysis, we show the students' understanding of Curcio's (1989) level 1 of reading the data, which is related to the ability to identify explicit data in the text.

- *A8: There is information that is very clear on the chart, it is just a matter of looking there and identify, there is no need to make any account.*
- *A12: For example, if you asked about the already burned area of the Caatinga, it would be something simple because the information is already on the chart.*

- *A25: For me, the simplest interpretation would be the one that would not require me to do calculations, that is, it would be the one in which I had to look for something that was already there on the chart.*

This category shows that students understand that interpreting graphs and tables involves a task that can be simple, namely when it is only necessary to identify information without need for any kind of calculation. There are interpretations that depend only on the search for information that is explicit in the graph or table, that is, they are tasks that do not require the inference skill.

Through this first category of analysis, we can infer that students' understanding of the first level of reading necessary for understanding graphs and tables is close to that established by Curcio (1989). For the author, the understanding of these statistical resources at a first level occurs through the literal reading of the graphs. In this case, students do not need to interpret the data beyond what is actually placed and perceptible in the representation. It is only necessary to extract the information, without requiring any comparison or analysis.

Considering the definition presented by Campos, Wodewotzki, and Jacobini (2011) and Perin and Campos (2020) for statistical literacy, a citizen capable of reading and interpreting graphs and tables using only resources of this level would not be considered a statistically literate citizen. For these authors, statistical literacy requires the ability to integrate information in order to understand non-explicit data that are exposed in these statistical resources.

In the second category of analysis, we show that students also recognize the existence of what Curcio (1989) classified as level 2, reading between the data, for interpreting graphs and tables and judge the tasks of this level as the most difficult.

- *A10: Perform exercise 2, because we had to carry out several calculations to reach the final result.*
- *A6: To perform exercise 2, because to reach a solution it was necessary a higher reasoning and graphic analysis (...).*
- *A24: I found question 2 more difficult because we had to discover the total area of all biomes.*
- *A17: Answer to question 2 had to take into account the territorial size of each biome, in this case we used the rule of 3.*

Exercise 2 referenced by students in this category of analysis asks about the total area from Brazil that was burned. In this category, students emphasize the need to perform calculations and admit the demand to combine information to draw a conclusion using the data shown in the graph. The need to carry out reasoning, a deeper analysis of the graph, evidences the understanding that performing certain tasks requires the development and use of the ability to infer. To discover the total area, students made use of information that was not explicit, but that could be found based on some data that were evident. It can be seen in the students' speech that they recognize the need to find existing relationships between the data that are presented in the chart in order to respond and draw conclusions.

Curcio (1989) explains that, at level 2, students must combine and integrate information and identify mathematical relationships through some prior knowledge (in this case, mathematical knowledge) about the subject dealt with in the graph. It requires students to have the ability to compare quantities and use mathematical concepts.

Based on Gal's (2002) definition for statistical literacy, we can say that a citizen at this level mobilizes some elements of statistical literacy such as: statistical knowledge, mathematical knowledge, and knowledge of the context.

Students also recognize that they can obtain other data, and/or other information that are not explicit in charts and tables. This fact constitutes our third category of analysis.

- *A9: We learn to infer non-explicit information in the chart.*
- *A23: I saw that from a chart it is possible to get lots of information even if it is not represented in it.*
- *A1: From a chart, it is possible to discover more information than those already represented in them.*

In this category, we observed that students admit the possibility of capturing ideas or data from a graph that are not represented explicitly, that is, there is implicit information that can be revealed. This was possible through the activity that requested a future estimation regarding the variable under study. Curcio (1989) explains that this work is based on some previous knowledge of mathematics and, in

many cases, also on the analyzed context. This statement is consistent with Gal's (2002) definition of statistical literacy.

In this study we were able to see that students could recognize the different levels of reading graphs, as well as the skills inherent to each level. However, students emphasize that they find more difficulty dealing with levels that require the ability to do inferences.

CONCLUSION

Based on the results, we can say that students recognize that reading graphs and tables requires different levels, ranging from literal reading to that which requires the search for implicit information because they pointed out that certain information was clear in the graphs, there was just the need to locate them. Others demanded students to combine and integrate information to draw conclusions. The students also noticed that the third level is the most difficult to achieve.

As for the didactic strategy employed, we understand that it helped students to distinguish the different levels of understanding of a graph because it required them to carry out a self-assessment of their skills regarding the reading of this important statistical resource.

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