Statistical literacy in the age of disinformation

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Persuasive speeches aim to influence audiences to adopt specific viewpoints, support causes, or endorse political candidates. In the political arena, media discourse disseminates rhetorical strategies designed to elicit identification, appeal to emotions, and strengthen arguments. This article reports an investigation into how the integration of media, Mathematics, and Statistical Education can foster students' critical analysis of persuasive narratives in the classroom. The study was conducted with seven high school students (aged 17–18) from a public school in Brazil, using participant observation. Data were generated through media news reports and information from the MapBiomas platform addressing deforestation in Brazil, and analyzed based on students' written records and audio recordings. The findings indicate that engaging with news and statistical data promotes critical awareness of deforestation, environmental issues, and social inequality, highlighting the potential of Mathematics and Statistics for educating reflective and critically informed citizens.

FOSTERING CRITICAL STATISTICAL LITERACY ON CLIMATE CHANGE: CITIZEN EDUCATION IN THE DISINFORMATION ERA

We live in an era marked by the intense circulation of digital information, in which the speed and reach of messages directly influence how meaning is constructed around complex and urgent issues, such as the preservation of the Amazon rainforest. Narratives circulating on social media, in news reports, and in political discourse often mobilize statistical data and technical-scientific arguments to lend credibility to their positions. However, these representations are not always based on contextualized interpretations of reality. The manipulation of numbers and the dissemination of data out of context have become recurring strategies in the production of disinformation (Kitchin, 2014; Best, 2012), highlighting the risks posed to a society that consumes information without the necessary preparation to critically question it.

In this context, schools play a crucial role by providing educational spaces that foster the development of statistical literacy capable of promoting the understanding, analysis, and critical examination of circulating data. Mathematics and Statistics—traditionally associated with neutrality and logical rigor—can become tools for critical reading of the world when aligned with an educational perspective committed to social justice (Souza, Araújo & Pinto, 2022). Technical mastery, while necessary, is not sufficient: it is essential to educate individuals who can interpret data, identify biases, recognize the political use of information, and act responsibly in the face of contemporary challenges.

This reflection becomes even more urgent when we consider the context of climate change and deforestation in the Amazon. Data on these phenomena have been used to justify public policies and opposing ideological positions, often generating controversies that are not always supported by reliable evidence. In light of this scenario, Weiland (2017) emphasizes that Critical Statistical Education emerges as a strategic tool for strengthening citizenship, as it enables students to develop analytical and argumentative skills to interpret environmental and social issues based on data.

We therefore propose to investigate the following question: how can Statistical Education and Mathematics contribute to the development of civic competencies and the interpretation of environmental phenomena in a context saturated with (mis)information? To address this question, we developed a pedagogical proposal with seven high school students (aged 17–18), grounded in an inquiry based on political discourse and statistical data related to deforestation in the Amazon. The proposal, situated within a participant research framework, aimed to promote statistical literacy through the analysis of real-world data and the integration of mathematical knowledge with environmental awareness. In the following sections, we outline the methodological path adopted, discuss the results of the pedagogical experience, and reflect on the implications of this approach for education in the face of today's environmental and informational challenges.

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METHODOLOGY

This investigation is grounded in participatory research, an approach recognized for its ability to create connections between practice and social reality, fostering discoveries and insights about this dynamic context (Demo, 1984). The choice of participatory research is justified by its potential to enable the researcher's immersion in the studied context, allowing for a deeper understanding of the participants' experiences and practices.

The study was conducted in a public high school in state of Ceará, Brazil, and involved the voluntary participation of seven third-year high school students (aged 17–18) during out-of-school hours. The students engaged in the pedagogical proposal had already been participating for over a year in the doctoral research of the first author. During this time, they had been investigating the interrelations between different social markers—such as race/ethnicity, social class, and gender—with the aim of understanding, through statistical data analysis, how certain groups are unequally affected by social structures. Thus, this article presents a segment of a broader investigation whose central focus is addressing social inequalities through critical statistical education. A series of pedagogical proposals were developed and discussed within the Research Group on Equity in Mathematics, Statistics, and Science Education (GEMEC), coordinated by the second author of this paper.

In this section, the focus is on the perceptions constructed by students regarding political discourse, news reports, and digital platforms that address deforestation in the Amazon—a complex and urgent issue marked by narrative disputes, economic interests, and profound socio-environmental implications. The activities analyzed were developed over the course of three meetings held in 2024, each lasting approximately three hours, which provided significant time for deepening the proposed content and for the maturation of students' reflections on the environmental issue at hand.

The data production process was based on the students' analysis of different sources: a political speech, journalistic reports, and data verification using the MapBiomas Brazil platform. The speech examined was delivered in 2022 by the then President of the Republic, Jair Messias Bolsonaro, during the 77th United Nations (UN) General Assembly in New York, where he presented information without clarifying the sources used. The journalistic report selected was produced by the Amazon Institute of People and the Environment (Imazon), a Brazilian research organization that promotes conservation and sustainable development in the Amazon. Finally, the data were verified by the students using the MapBiomas Brazil platform, a collaborative network made up of NGOs, universities, and technology companies, organized by data of Brazilian biomes and cross-cutting themes such as urban areas and agriculture.

Records were made through audio recordings and observation notes of students interaction, allowing for the capture of both speech and participants' gestures and expressions. For the analytical treatment, a qualitative approach was adopted to understand the internal logic of the group, aiming to interpret discourses, symbols, and interactions (Minayo, Deslandes & Gomes, 2011). This methodology facilitated the identification of patterns and meanings that express the social relationships and perceptions of students regarding the debated topics, such as environmental conservation and the critical use of mathematical and statistical concepts.

The implementation of the pedagogical proposal was under the responsibility of the first author, identified in the dialogues as Ana. For the purpose of analysis, excerpts from the transcribed conversations were selected based on their alignment with the investigative objectives of this study, prioritizing those that highlighted significant reflections from the participants. Pseudonyms were used in place of the students' real names to ensure confidentiality and uphold the ethical principles established by Brazilian regulations.

RESULTS

We started with a problematization of students' perceptions regarding social issues in Brazil, aiming to stimulate an analysis based on data and discourse. To foster the debate, an excerpt from the speech delivered by then-President Jair Messias Bolsonaro at the opening of the 77th General Assembly of the UN in 2022 was presented, in which he highlighted the issue of the Amazon. In this activity, we strategically chose not to reveal the identity of the speaker to the students, a methodological decision aimed at minimizing potential biases and preventing prior political positions from influencing their interpretation.

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Initially, students were given an explanation about the UN, highlighting its structure, main objectives, and relevance in the global context. Next, the context of the 77th General Assembly was introduced, with the central theme being "Solutions through solidarity, sustainability, and science." This theme reflected the need to address global challenges in an integrated and collaborative manner, emphasizing the importance of cooperation among nations to promote sustainable development and use science to solve complex problems. After this contextualization, students were exposed to the following statement by the then-President of Brazil: "Two-thirds of all Brazilian territory remains covered with native vegetation, exactly as it was when Brazil was discovered in 1500. In the Brazilian Amazon, an area the size of Western Europe, over 80% of the forest remains untouched, contrary to what is reported by the national and international mainstream media." After reading this, students were asked about their perceptions regarding the veracity and intent of the statement. The majority expressed skepticism about the data presented and raised the possibility that the speech could contain inconsistencies or even disinformation. The students labeled it as fake news and considered the UN context as a highly significant geopolitical space.

To continue, they analyzed a news article published by the Imazon (Lima, 2023) with the headline: "Deforestation in the Amazon is the lowest in the last 5 years, but it is equals 1,300 soccer fields per day." This statement was used as a stimulus to engage students in a reflection on the relationship between statistical data, media communication, and socio-environmental issues. With this headline, it was possible to foster dialogues that explored not only the numbers presented but also the narratives that these data construct, the impacts of their dissemination, and the importance of developing a critical reading of information. This first moment served as a foundation to connect statistical and mathematical content with concrete social issues, promoting interdisciplinary and reflective analysis. Below is an excerpt from the dialogues:

> **Ana:** How can we understand this headline?
> **Thy:** They're saying that deforestation has decreased, but 1,300 soccer fields a day still seems like a lot!
> **Lucena:** Even with the reduction, the impact is still big.
> **Ana:** Exactly. Comparing it to soccer fields helps make information more visual and concrete. Now, let's think: why did they choose to use soccer fields instead of square kilometers, for example?
> **Dávila:** I think it's because many people can't picture what a square kilometer means, but a soccer field is something we know. So it helps people better understand the size of the deforested area.
> **Cauã:** The article says deforestation was 3,891 km² between August 2022 and July 2023. If we calculate that, it's over a million soccer fields per year!
> **Thy:** Whoa, that's a lot!
> **Ana:** And what do these numbers tell us about the situation in the Amazon? Why is a drop in deforestation rates still concerning?
> **Cauã:** I think the problem is that any deforestation is already harmful. Even with the reduction, deforestation continues, and that can impact the climate and biodiversity in the region.
> **Belly:** An 11% drop in deforestation is positive, but as the article highlights, we're still talking about a huge deforested area.
> **Dávila:** Comparing those numbers to previous data—if it dropped by 11%, then the previous year it was about 4,373 km² of deforestation. It seems like a lot, but 11% less means we're starting to get the problem under control, even if we're still far from ideal.
> **Ana:** How can we use this data in debates about public policy and environmental conservation?
> **Cauã:** I think we can argue that, even with the reduction, stricter policies are still needed. The data shows we're still losing large areas of forest, and that needs to be controlled more quickly.

The dialogue demonstrates a pedagogical interaction in which students reflected on a news report published on the Imazon website. The choice to compare deforested areas with soccer fields

instead of square kilometers was quickly understood by the students as a communication strategy that helps visualize the problem. The students also showed an awareness of the complexity of the issue by pointing out that, although there had been a percentage decrease in deforestation, the environmental impacts remained alarming.

This perception goes beyond a mere interpretation of numbers, revealing a critical and contextualized understanding. Another noteworthy aspect was the use of quantitative reasoning by the students, who calculated the annual deforestation in terms of soccer fields, thereby connecting abstract data to a more comprehensible scale. This practice demonstrated the applicability of mathematics in interpreting environmental problems while fostering interdisciplinarity, integrating geographic, environmental, and statistical knowledge. Finally, the dialogue culminated in a discussion about public policies, during which the students reflected on how the presented data could be used in debates on environmental conservation.

This initiative aligns with the suggestions of Souza, Araújo, and Pinto (2022), who highlight the relevance of statistical data and numerical information for understanding political, social, economic, educational, and public health issues, among other socially significant topics. Therefore, for information to be useful and reliable, it is crucial that numbers are used appropriately and that language is written and expressed clearly. A lack of clarity—whether accidental or intentional—can lead to biased interpretations that favor specific groups, especially those who omit or distort reality to serve political interests. Thus, this debate reinforces the importance of connecting statistical learning to real-world issues, promoting a critical and transformative education.

Subsequently, the students were guided to explore the MapBiomas platform (2025) to understand how deforestation mapping is carried out in Brazil. The platform provides an advanced monitoring system that integrates data on deforestation and land-use changes across the country. Through MapBiomas, users can access recent alerts related to environmental management, as well as detailed information on forest cover loss and transformations in different biomes. The tool offers multiple features that allow for in-depth and visual analyses, supporting the understanding of environmental dynamics and conservation challenges in Brazil.

MapBiomas' interface also provides a variety of tools for analyzing and visualizing data related to land cover and land use in Brazil. Users can view interactive maps that show land cover changes from 1985 to 2023. These maps allow users to select various layers of information—such as biomes, states, and municipalities—enabling region-specific analyses. In addition, the platform provides detailed statistics on land use and cover classes, making it easier to understand environmental transformations and aiding research and decision-making in territorial management and environmental conservation.

Thus, by manipulating the platform, it became evident in the dialogues that integrating interactive digital tools like MapBiomas can enrich pedagogical practice by encouraging students to explore real data and apply it to social and environmental contexts. Souza and Araújo (2022, p.18) states that the "scenario of technological innovations, social networks, and online communication brings new experiences to human beings, and therefore new problems emerge that must be regulated by moral and ethical components."

In this light, after exploring the platform to understand how monitoring and data analysis related to deforestation are conducted, students were prompted to reflect on the role of mathematics and statistical education in the construction and interpretation of the information presented in the news report. The discussion focused on investigating how these analytical tools are used in news production and how they influence public perceptions of environmental impacts. This approach enabled students to identify the presence of mathematics and statistics in data communication and to critically analyze how these tools can reinforce or challenge narratives about socio-environmental issues.

One standout moment was a comment from student Dávila, who revealed a keen awareness of the temporal dimension in statistical analyses: "I'm going to look for information on the total area of the Amazon to make a final projection about the forest's resistance. This data helps us understand the long-term impact." Her statement reflects an important understanding: data are not just snapshots of the present but instruments that, when well-contextualized, allow us to project future scenarios and support informed decision-making. In doing so, Dávila highlights critical statistical literacy as a tool for understanding complex phenomena (Weiland, 2017), such as Amazon deforestation, in its multiple

dimensions. Furthermore, this stance demonstrated a significant level of critical maturity among students in addressing the social and environmental issues affecting the Amazon.

While performing mathematical calculations and statistical analyses, the students showed growing interest in applying this knowledge to explore future scenarios for the Amazon. A striking example was the projection of the time required for the forest to be completely deforested, assuming the current rate of 1,300 soccer fields per day reported in the news. The estimate suggested that, without considering reforestation, this process would take approximately 1,315 years. After concluding the calculations, a follow-up question was posed: "Does that time seem long or short to you?" Most students initially considered the projection to be lengthy, revealing an immature perception of the severity of deforestation. However, as the discussion progressed, deeper reflections emerged on the negative impacts of forest destruction—not only for biodiversity but also for climate balance and for the populations who depend on the forest for their livelihoods, as the following dialogue illustrate.

Thy: It seems a really long time. More than a thousand years?
Kay: Yeah, I thought that was a long time too.
Dávila: So there's no need to worry.
Belly: Then it's not a priority right now, Miss.
Thy: Like I said, more than a thousand years feels like forever.
Ana: Interesting! Do you think that the long timeline reduces the urgency of the problem?
Dávila: Thinking about it like that… maybe we think it's far away, but the impact doesn't just happen at the end. People are already suffering, right? Like Indigenous communities, and animals.
Lucena: And there's the climate too. My grandfather always says that it used to rain at the right time for planting, and now everything is messed up.
Belly: What really shocked me was the number of soccer fields per day. We don't see it on TV like it really is. When we put it into numbers, it becomes more real.
Cauã: What do we do with this information? Because knowing is one thing, but it seems like no one listens to the data.

The dialogue reveals an initial perception among students marked by a temporal understanding that distances the environmental issue from its immediate consequences. The claim that "more than a thousand years is a long time" and therefore "there's no need to worry" illustrates how the notion of a distant future can act as a demobilizing mechanism in the face of urgent issues like Amazon deforestation. This seemingly simplistic initial reading highlights the importance of pedagogical mediation in breaking with naturalized or minimized views of socio-environmental problems. Working with social demands such as deforestation is urgent, as it allows for the challenging of ingrained ideas, promotes awareness, and most importantly, forms individuals capable of understanding that the effects of environmental injustices are not only projected into the future, but are already present — and demand immediate action.

The dialogic process allowed students to reframe their views on the urgency of the environmental issue and the need for concrete actions to mitigate it. By confronting data with lived and perceived realities — as seen in the reports of climate changes affecting farming or the lack of media visibility on the issue — students deepened their understanding of the systemic impact of deforestation, going beyond isolated numbers to interpret its social, environmental, and political implications. Additionally, the pedagogical approach demonstrated the potential of mathematics and statistics as tools for critically reading the world. By applying concepts such as averages, projections, and graph interpretation in real contexts, students not only consolidated curricular knowledge but also developed argumentative, ethical, and civic competencies. The concern expressed in Cauã's statement — "knowing is one thing, but it feels like no one listens to the data" — reflects an emerging awareness that information alone does not change reality; it must be critically mobilized in public debate.

After analyzing news articles, consulting the MapBiomas platform, and applying mathematical and statistical concepts to examine political discourse on deforestation, students were encouraged to reassess a statement made by the then-President of Brazil. They were invited to critically reformulate this discourse to reflect a more realistic view of deforestation. To support this reformulation, students

collected information over several sessions, analyzing statistical data, environmental studies, and news reports on the topic. Through this investigative and collaborative process, they brought at the following reformulation:

> "About two-thirds of Brazilian territory still maintains some form of native vegetation cover, although many of these ecosystems have undergone alterations since the beginning of colonization in 1500. The Brazilian Amazon, which encompasses an area equivalent to Western Europe, still preserves approximately 80% of its original forest. However, much of this area is not entirely untouched, as many regions have been affected by selective deforestation, wildfires, and forest degradation. Satellite monitoring data, such as those provided by INPE, show that deforestation in the Amazon has been increasing, reflecting ongoing threats faced by the world's largest tropical forest." (Students participating in the research)

The students' reformulated version of the political statement demonstrates a critical approach grounded in scientific reality concerning Brazil's and the Amazon's vegetation cover. While the original statement emphasized the presence of native vegetation and suggested a lack of significant environmental impact, the students' version introduced a broader perspective, recognizing that despite the remaining forest cover, many ecosystems have been altered since colonization. This shift in narrative avoids fostering a misleading notion of untouched or fully preserved forests. One of the key corrections made by the students relates to the claim that "more than 80% of the forest remains untouched." Although the Brazilian Amazon still retains significant forest cover, this does not mean it is immune to degradation. The reformulation highlights that the forest has been affected by factors such as selective logging, fires, and degradation — as well as extreme droughts and floods — phenomena that are well-documented by environmental research. In doing so, the revised version avoids oversimplification and offers a more complex view of the Amazonian reality.

Beyond factual corrections, the students' version adopts a more informative tone. The original speech included the phrase "contrary to what is reported by the national and international media," introducing a judgmental tone that could compromise the objectivity of the analysis. By removing that expression and focusing on presenting evidence-based data and arguments, the students ensured greater academic rigor and strengthened the rewritten statement. Finally, the reformulated statement underscores the continuous threats faced by the Amazon rainforest — a point minimized in the original speech. By acknowledging that deforestation is increasing and that the forest faces constant risks, students construct a more realistic argument aligned with scientific knowledge about the region. This rewriting exercise not only corrects inconsistencies and misinformation but also exemplifies the importance of media literacy, mathematics, and critical statistical education, enabling students to identify misleading discourses and reconstruct them based on reliable data.

FINAL MARKS

This paper presents a fragment of a doctoral research project that aimed to investigate how the media influence the construction of social perceptions, with an emphasis on the role of Statistics and Mathematics in this process. The analysis highlighted the relevance of statistical literacy as a tool to combat misinformation and to foster the development of critical and analytical thinking grounded in data. The findings indicate that Statistics and Mathematics Education, when anchored in real and relevant social contexts—such as the issue of Amazon deforestation—play an essential political and formative role in building critical citizenship. The activities carried out enabled the students not only to deepen their understanding of the use of statistical data in public debate and decision-making, but also to develop skills to interpret information with a critical stance — both in relation to the sources used and the results obtained. Furthermore, the students began to question prevailing narratives and identify patterns of disinformation frequently disseminated by the media.

We conclude that pedagogical practices grounded in data analysis and the critical examination of realities promote more meaningful, critical, and transformative teaching. Beyond learning specific content, this approach fosters the development of environmental and civic awareness, which is essential in the face of the challenges of the 21st century. As a practical implication, this study highlights the urgent need to rethink the methodologies used in teaching Statistics, proposing that it be approached in

a contextualized, interdisciplinary, and critical way. This means preparing students to navigate a world increasingly shaped by data and information. For future research, we propose expanding the scope of investigations by exploring other socio-environmental and sociocultural themes and systematically incorporating these discussions into the school Mathematics curriculum.

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