Statistical literacy in Mathematics teacher education: an ideological perspective encompassing citizenship education[1]

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ABSTRACT

The difficulties related to the statistical literacy of Brazilians are well known, that is, the unpreparedness of a large part of the population to interpret data referring to the social environment in which they live. Likewise, we are aware of teachers' unpreparedness and the scarcity of discussions involving this topic in initial training. Therefore, the investigation presented in this paper aimed to analyze the knowledge that emerged from undergraduate students in Mathematics during a pedagogical workshop on statistical literacy, from an ideological perspective, which considers race and citizenship education. To meet the demands of the study, the theoretical framework adopted is based on the ideas of Bell Hooks, Iddo Gal and Ubiratan D'Ambrósio. The methodology developed was action research and the evidence found revealed that the workshop participants built a more accurate look at statistical concepts and racial issues, admitting the possibility of addressing social issues in Mathematics classes in basic education.

KEYWORDS: Statistical Literacy; Degree in Mathematics; Basic education.

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Letramento estatístico na licenciatura em matemática: uma perspectiva ideológica abrangendo a formação cidadã

RESUMO

São conhecidas as dificuldades referentes ao letramento estatístico dos brasileiros, ou seja, o despreparo de boa parte da população para interpretar dados referentes ao meio social em que vive. Do mesmo modo, sabemos do despreparo docente e da escassez das discussões envolvendo esse tema na formação inicial. Sendo assim, a investigação apresentada neste artigo teve como objetivo analisar os saberes emergidos dos licenciandos em Matemática durante uma oficina pedagógica sobre letramento estatístico, sob uma perspectiva ideológica, que considera raça e a formação cidadã. Para atender às demandas do estudo, o quadro teórico adotado se fundamenta nas ideias de Bell Hooks, Iddo Gal e Ubiratan D'Ambrósio. A metodologia desenvolvida foi a pesquisa-ação e as evidências encontradas revelaram que os participantes da oficina construíram um olhar mais apurado sobre os conceitos estatísticos e sobre as questões raciais, admitindo a possibilidade de se abordarem questões sociais nas aulas de Matemática da educação básica.

PALAVRAS-CHAVE: Letramento Estatístico; Licenciatura em Matemática; Educação Básica.

La alfabetización estadística en la carrera de Matemáticas: una perspectiva ideológica que abarca la educación racial y ciudadana

RESUMEN

Son bien conocidas las dificultades relacionadas con la alfabetización estadística de los brasileños, o sea, la falta de preparación de gran parte de la población para interpretar datos referentes al entorno social en que vive. Asimismo, somos conscientes de la falta de preparación de los docentes y de la escasez de discusiones que involucren este tema en la formación inicial. Por lo tanto, la investigación presentada en este artículo tuvo como objetivo analizar los conocimientos que emergieron de los estudiantes de licenciatura en Matemáticas durante un taller pedagógico sobre alfabetización estadística, desde una perspectiva ideológica, que considera la formación racial y ciudadana. Para atender las exigencias del estudio, el marco teórico adoptado se basa en las ideas

de Bell Hooks, Iddo Gal y Ubiratan D'Ambrósio. La metodología desarrollada fue la investigación-acción y las evidencias encontradas revelaron que los participantes del taller construyeron una mirada más certera sobre los conceptos estadísticos y las cuestiones raciales, admitiendo la posibilidad de abordar las cuestiones sociales en las clases de Matemática en la educación básica.

PALABRAS CLAVE: Alfabetización Estadística; Licenciado en Matemáticas; Educación básica.

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Introduction

The main objective of the research described in this article is to analyze the knowledge that emerged from the participating bachelor's degree students in a pedagogical workshop on statistical literacy from an ideological perspective that considers race and citizenship education.

This is a segment of a master's research (Pereira, 2022) that discusses the training of Mathematics teachers at the Faculty of Education of Baixada Fluminense (FEBF), starting from the issues related to the challenges and difficulties of statistical literacy in the mathematics teacher education program and pedagogical thinking for citizenship education. In this sense, we view statistical education as an opportunity to promote social transformation and develop approaches to facilitate discussions and reflections on citizenship education.

Pereira (2022) emphasizes the need for the use of statistical knowledge in everyday situations and the difficulties related to statistical literacy among Brazilians, i.e., the unpreparedness of a significant portion of the population to interpret data related to the social environment in which they live. The author, along with Costa Junior (2019) and Conti (2015), also identifies the unpreparedness of educators and the scarcity of discussions surrounding the teaching and promotion of statistical literacy in initial teacher education. Therefore, the contribution of the results

presented here directly pertains to teacher education. The analysis of the knowledge regarding statistical literacy emerging from the bachelor's degree students can provide insights for a reevaluation of the structure of Brazilian Mathematics Teacher Education programs and the treatment of statistical literacy within them.

To address the demands of the study, the ideas of Gal (2020), Hooks[4] (2017), and D'Ambrósio (2012, 2016) are crucial. The first contributes to the concept of statistical literacy, while the latter two discuss an education focused on the formation of citizens and the use of social context issues in this process. The methodology developed, of a qualitative nature, was categorized as action research and led us to the design and implementation of a pedagogical workshop with incoming students of the Mathematics Teacher Education program at UERJ/FEBF. In this workshop, proposals for interpreting statistical messages that promote exchange, mutual learning, discussions, and the construction of statistical literacy were emphasized.

To better explain the research stages, the next section articulates the ideas of Gal (2020), Hooks (2017), and D'Ambrósio (2012, 2016). Continuing in the subsequent sections, we present the method, the analysis of the results, and the final considerations.

Statistical Literacy and the Approach to Social Issues

The National Common Core Curriculum (BNCC in Portuguese), which guides curriculum development in Brazil, describes Statistics as the study of data handling and aims to develop skills in data collection, organization, representation, interpretation, and analysis in various contexts to assist in decision-making. Thus, it "involves reasoning and using statistical concepts, representations, and indices to describe, explain, and predict phenomena" (Brasil, 2017, p. 276). The document also recommends

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[4] The writer's name is spelled in lowercase as a political stance of intellectual egoic refusal advocated by the author. Bell hooks asserted that her works deserved more attention than her person.

websites of research institutes, such as the Brazilian Institute of Geography and Statistics (IBGE), to use Statistics education to understand reality (Brasil, 2017).

In this sense, Statistics education must be based on the perspective of statistical literacy, which, according to Gal (2002), consists of the ability to interpret, critically evaluate, and communicate statistical information and messages. The author emphasizes that the development of statistical literacy is essential for understanding the world. Therefore, it can be inferred that statistical literacy holds great importance in society, being necessary both for social use and scientific use.

However, despite this recommendation, studies show that Statistics education is almost always associated with the analysis of graphs and tables that do not encompass the social reality of the students and focus on topics such as the number of items owned, and favorite ice cream flavors, among others. In this regard, Coutinho, Santos, and Giordano (2019) assert that the graphs in textbooks are very simple and do not seek to represent the social reality of the students.

The selection of graphs, tables, and statistical data that composed the workshop described in this article was made to reverse this situation. D'Ambrósio (2012, 2016) asserts that Mathematics Education can take on two distinct positions. The first, advocated by conservatives, involves using education as a means to enforce the teaching of Mathematics, and in this position, students revolve around rigid mathematics. The second, advocated by the author, uses the act of teaching Mathematics as a means to provide good education, as in this position, subjects revolve around the students, so they are in constant change, reflecting social and cultural contexts, as well as the issues, desires, and needs of the learners. In agreement with D'Ambrósio (2012, 2016) in support of the second position and considering the approach to statistical concepts in mathematics classes from basic education, the activities proposed in the workshop break away from formality, which emphasizes rigorous methods, definitions, axioms, and

theorems, while aiming to create a statistics that is focused on social reality with an emphasis on issues related to race, gender, and social class.

For Hooks (2017), when addressing issues related to politics, race, gender, and social class, "neutrality" in teaching is disrupted. Hooks (2017, p.31) also emphasizes that "it is possible to teach without reinforcing existing systems of domination." Therefore, it is crucial to recognize that it is not possible to promote entirely politically neutral education, as highlighted by Hooks (2017). This reality applies to the teaching of Mathematics, as every act within the educational sphere is political, including the decision not to address social issues in pedagogical practice. And, considering Statistics, when the educator chooses to use only fictitious data and does not use data that pertains to reality, such as inequalities (social, racial, economic, cultural, educational, and gender), they are making a political choice.

Methodology

The research conducted was action research. Action research, according to Thiolent (1986, p.14), is "a type of empirical-based social research that is conceived and carried out in close association with an action." In this method, researchers and participants are involved in the situation in a cooperative or participatory manner. Thus, an investigation is characterized as action research when an action occurs in a field that is relevant enough to deserve its development and investigation. In this context, "researchers play an active role in formulating the problems encountered, monitoring and evaluating the actions triggered in response to the problems" (p.15).

Following the principles of action research, a workshop was developed and conducted with six incoming students of the Mathematics Teacher Education program at the Faculty of Education of Baixada Fluminense (FEBF), located on the Duque de Caxias campus of the State University of

Rio de Janeiro (UERJ) in the city of Duque de Caxias, in the metropolitan region of Rio de Janeiro.

Initially, the plan was to conduct the workshop in person. However, due to the global impact of the COVID-19 pandemic, which resulted in significant losses, this approach was not feasible. Additionally, in response to the pandemic situation, in-person activities at UERJ were suspended from March 2020 to February 2022.

The workshop was conducted through a virtual, synchronous meeting, lasting for two hours, due to the isolation period resulting from the Covid-19 pandemic at the time. The description of the activities within the workshop and the analysis of the students' participation are detailed in the next section. It is worth noting that, with the students' consent, the entire session was recorded and subsequently transcribed. The names of the students mentioned in the analysis are fictitious to protect their identities.

Data Analysis

The workshop can be divided into three moments. In the first moment, a problem scenario in a salary context was discussed, involving concepts related to measures of central tendency and the notion of standard deviation. In the second moment, statistical data regarding the homicide of black women are analyzed, and in the third moment, reflections are proposed on certain statistical messages disseminated in the media. To facilitate a better understanding of the engagement of the bachelor's degree students in the workshop, each moment is analyzed separately.

Moment 1

Before the workshop, the students were asked to respond to a questionnaire with 8 questions. Among them was the question from Figure 1:

FIGURE 1: Question 6 from the pre-workshop questionnaire

Em qual escola você aceitaria trabalhar?

Escola A: Moda salarial: R$ 9.500

Escola B: Média salarial: R$ 3733,14

Escola C: Mediana salarial: R$ 1600,00

Source: Pereira (2022).

And the students' responses were as follows:

> **João** - I would choose school B. In this school, it would be <u>a good initial opportunity for someone who has just graduated</u>. (emphasis ours)
>
> **Paulo** - School B, because the salary is given as the average of salaries. <u>With the average, you can get an idea of the value of all salaries</u>. (emphasis ours)
>
> **Guilherme** - School A, because it has the <u>highest</u> salary. (emphasis ours)
>
> **Evandro** - School A, because <u>according to the salary mode</u>, many teachers earn well. (emphasis ours)
>
> **Gabriela** - School A for sure, because <u>the salary is higher</u>. (emphasis ours)
>
> **Marcela** - I would choose school B because in school A, <u>the salary is way too high for beginner teachers</u>, and in school C, it's too low. (emphasis ours).

The first moment of the workshop began with a review of this question. Everyone maintained their questionnaire choice, except for Marcela, who revealed that she had chosen school A because it had the highest absolute value, but only during the workshop did she realize that the values were related to measures of central tendency and did not

represent the actual salary value. This scenario highlights the importance of the cognitive component of literacy, as found in Gal's (2002) statistical literacy model, as it is essential for individuals to be able to read and interpret messages in different situations (Soares, 1999). Therefore, it can be argued that she did not understand the proposed question due to inattention while reading the data, which does not indicate a lack of statistical knowledge.

Next, it was suggested that, if they considered it necessary, they should formulate questions for the supposed author of the statistical message. Only Evandro mentioned that he would inquire whether, in school A, which had the highest value among the three, they would hire teachers with only an undergraduate degree. Evandro's question can be considered a critical question that emerged from contextual knowledge (Gal, 2002) because it is known that, in many institutions, a teacher's salary increases with their level of education. However, the passage "the salary of school A," shows that he did not consider the value as the mode.

Afterwards, it was revealed that schools A, B, and C represented the same institution, and they were asked what could have caused such divergent measures of central tendency. On this point, it's worth noting the dialogue below:

> **Guilherme:** I think it must be due to positions: teacher, assistant, director. I believe this salary of nine thousand must be for a director. It must be by department or job, something like that. Because the mode is the one that stands out the most. So, a director is the most prominent one, everyone asks, "Where is the director? Who is the director?" so he will earn more because he's in style. The average is the guy below him, in this case, the teacher, so he'll earn a little less. And the median is the overall salary, the lower class, like the janitor. (emphasis ours)
>
> **Paulo:** I disagree. The part that Guilherme mentioned about different roles may be right, but I disagree with the ending. To

me, <u>the difference is in the method of calculating the values</u>. In the salary mode, it's as if we have a set of 10 teachers, and within that set, the one that repeats the most is 9500, so the salary mode ends up being 9500. The average salary is as if in the same set I mentioned earlier, the sum of the salaries is divided by the same number of teachers, which will be 3700. <u>I don't remember the median well; it wasn't used much in school.</u> (emphasis ours)

Marcela: Professor Érika said that the median is the value that lies in the middle of the organized data set. <u>I know how to calculate it, but I don't know what it means. And the mode isn't about who stands out, it's about who repeats the most</u>, do you understand, Guilherme? (emphasis ours)

Guilherme: I understand, I know how to do the calculations too, but now I'm feeling stupid because I think I've always confused the mode and the median. (emphasis ours)

In the above-transcribed dialogue, it was evident that they were familiar with and knew how to calculate measures of central tendency, but they had difficulties interpreting them within a context and grasping the indicators that could be extracted from each of them. It is worth noting that this suspicion had already been raised in Questionnaire A, as the participants tended to treat statistical measures as absolute values. Therefore, in this meeting, the definitions of statistical concepts such as mean, mode, median, and range were presented (Iezzi, Hazzan, and Degenszajn, 2013). Subsequently, the salary range of the institution was exposed and related to statistical measures to clarify their doubts, as shown in Figure 2.

**FIGURE 2:** Slide with the salary range from the example

Source: Pereira (2022).

From the slide presented in Figure 2, an explanation was provided about the difference between measures of central tendency and absolute values. In the same slide, the meaning of each measure in the context of the data was addressed. For example, the median represents the value in the center of the range, in this case, the value of R$1,600. From this, it is feasible to infer that half of the data is less than or equal to - R$1,600. Thus, by having an understanding of the meaning of the median in the analyzed situation, it is possible to have suspicions about the composition of the range.

It's worth recalling that three of them had chosen school B in the questionnaire based on the average value. For this reason, they were asked if there was any reason beyond being an intermediate value. Thus, Paulo and Marcela justified that the average was the statistical measure that seemed to be the most reliable because it used all the data. The rest of the group agreed, but João indicated that this example was an exception because the average was not so reliable. Following this, they were asked if there was a way to know if the average value was close to the reality of the data without having access to the range. The students said they were unaware of any method for that. Then, the workshop moved on to the presentation of the concept of standard deviation (Iezzi,

Hazzan, and Degenszajn, 2013), as the expression of the degree of variation in a dataset, in which the closer it is to zero, the more homogeneous the dataset will be, as shown in Figure 3.

FIGURE 3: Slide about Standard Deviation
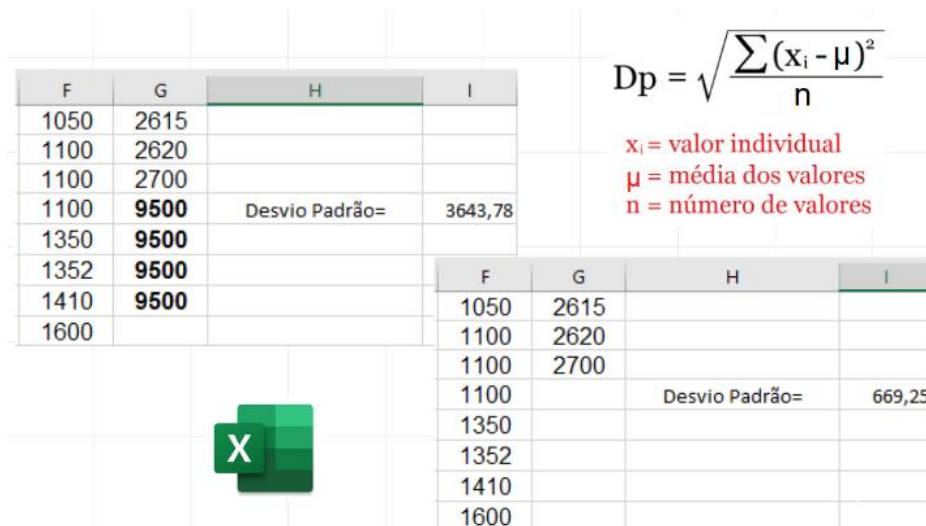
Source: Pereira (2022).

The presented slide contains the formula for calculating the standard deviation and the calculation of the standard deviation done in Excel with all the data from the range. Next to it, the standard deviation was recalculated by removing the salary values related to the mode. At this moment, Evandro made the following comment in the chat: "I remember calculating standard deviation in the preparatory, but I didn't learn to see it this way." This comment supports what Santana (2016), Lopes (2013), and Kataoka et al (2011) claim about Statistics being traditionally taught through ready-made formulas, without any reflection on the interpretation of the taught statistical measure.

After the explanation, the following questions were raised: "If you were the school owner and had to present some statistical measure about the payroll to the teachers' union to show that you pay good salaries, which measure would you choose?" and "What if it was to present to

someone interested in buying the school?" They replied that they would choose the mean or the mode for the teachers' union and the median for a potential buyer.

Next, Marcela pointed out that choosing according to the situation would be the same as spreading Fake News, which was promptly countered by Guilherme, who emphasized that presenting any of this data is not the same as lying. Letícia indicated that if it is dishonestly presented, it amounts to producing Fake News, unlike Pedro, who said that the school owner would not be to blame for people not knowing statistics. Finally, Paulo argued that in this case, it would be a way to take advantage of the other person's lack of knowledge, and the others reflected on his statement and agreed. This discussion among the teacher trainees brought out the attitudinal component (Gal, 2002) since the participants, based on their particular way of seeing the situation – beliefs and attitudes – took a critical stance on the issue.

Moment 2

Continuing with the proposal to revisit statistical messages that were interpreted in questionnaire A, an image of the graph displaying the number of homicides of Black women by state was presented. Participants were asked what could be concluded specifically about the states of Espírito Santo (ES) and São Paulo (SP) from the graph provided. It's worth noting that the graph shows a trendline by state with absolute values.

Regarding this example, Guilherme mentioned that in ES, the cases were increasing, while they were decreasing in SP. Evandro indicated that even though the number of cases had increased in ES, it would still be a more violent state than SP. The others agreed with both statements. The researcher concurred with Guilherme but drew attention to the comparison that Evandro's statement brought up and presented the graph with the same data but in relative values for comparison, as shown in Figure 4.

FIGURE 4: Comparison of data in absolute and relative values of homicides of Black women from 2013 to 2017
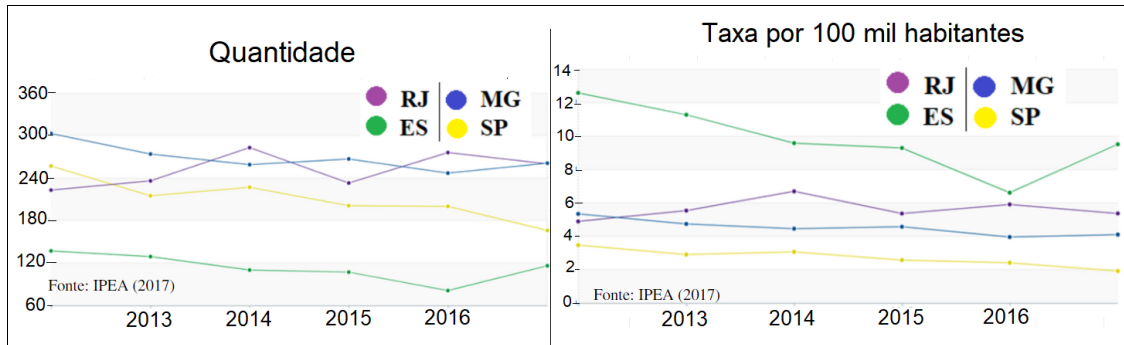
Source: Adapted from IPEA (2017).

After presenting the graphs comparing the behavior of trendlines in terms of quantity (absolute value) and rate (relative value), Marcela asked about the difference between rate and quantity. Gabriela promptly explained that the rate shows the relationship between the population and homicides. She also mentioned that she did a quick Google search and found that ES has the smallest population, so she concluded by saying, "ES is a more violent state, right, because it has fewer people and more homicides." The need to go to a search platform to gather information about the population of each state to draw better conclusions about the data demonstrates that Gabriela recognized the need to understand the context in which the data emerged (Gal, 2002). Although this research was not requested, it is important to highlight how the incorporation of actions like this is essential for the development of statistical literacy. It's worth noting that, subsequently, Table 1 was presented to show the population estimate of the Southeast region, as essential contextual knowledge for understanding the data.

TABLE 1: Population estimate of the Southeast Region in 2017

ESTIMATIVAS DA POPULACAO RESIDENTE NO BRASIL E UNIDADES DA FEDERAÇÃO COM DATA DE REFERENCIA EM 1° DE JULHO DE 2017 BRASIL E UNIDADES DA FEDERAÇAO	
BRASIL E UNIDADES DE FEDERAÇÃO	POPULAÇÃO ESTIMADA
Brasil	207.660.929
Região Sudeste	86.949.714
Minas Gerais	21.119.536
Espírito Santo	4.016.356
Rio de Janeiro	16.718.956
São Paulo	45.094.866

Source: Adapted from IBGE (2017).

Regarding this example, the researcher posed the following question: "Suppose we are in an election period, and the governor of ES needs to disclose data on homicides of black women. Which one will he use?" In unison, everyone said that the graph representing quantity (absolute numbers) would be chosen because it would give the impression that ES was the least violent state. However, João commented as follows: "The worst part is that a graph like this on TV stays on the screen for a short time." João's comment is very relevant because, according to Kataoka et al (2011), statistical messages constantly reach the population through the media. Considering that these messages are displayed quickly and are usually not adequately explained by the message sender, the discourse produced by the sender about the message becomes more memorable to the recipient than the statistical information itself.

Furthermore, Evandro mentioned the example: "I think the same thing happens with a private preparatory course that announces a 95% approval rate but segregates students and samples the data that will be presented to the public." Evandro was referring to institutions that announce high approval rates in exams but only consider part of the students when calculating the reported percentage. This example

demonstrates that, based on the discussion in the meeting, Evandro can make connections with other contexts known to him.

Building on this, the researcher asked the following: in cases where the way data was being presented influenced how the recipient would interpret them, could it be declared that Mathematics is neutral? Faced with this question and reflection, they unanimously agreed that they concurred that Mathematics is not neutral. It is worth noting that in the questionnaire proposed before the workshop, only Paulo and Guilherme answered that Mathematics should not be neutral. Thus, through this example, a significant change of opinion about the supposed neutrality of the discipline was observed. This aligns with the need to take education for citizenship as one of the main objectives of education, as D'Ambrósio (2012) asserts, and supports what Hooks (2017) advocates about the need for addressing social issues in the classroom not only for representation but to change ideas.

To provoke reflection on the influence of race on the homicide rate of women, the researcher presented Table 2 with the homicide rate of black and non-black women by state. It is worth noting that as soon as the data were presented, Gabriela questioned whether there was a catch and if the data were reliable, and the researcher affirmed that the data were secure. Such questioning confirms the growing sense of distrust regarding data, something that is essential for the development of statistical literacy (Gal, 2002).

TABLE 2: Homicide Rate of Women in the Southeast Region by Race.

Taxas de homicídios de mulheres negras e não negras da /região Sudeste por unidade federativa em 2017 - por 100 mil habitantes			
Estado	**Mulheres Negras**	**Mulheres Não negras**	**Mulheres**
Minas Gerais	4,10	2,73	3,65
Espírito Santo	9,51	3,15	7,50
Rio de Janeiro	5,36	3,44	4,65
São Paulo	1,91	2,17	2,18

Source: Adapted from IBGE (2017)

After the collective analysis of the data, everyone concluded that only in São Paulo, the difference in the rate was small, but in the other states, it was very disparate. From this, the researcher asked the group if this disparity could be considered merely a coincidence. This question generated a lot of discussion. In general, the participants had very different opinions.

It is worth noting that immediately after the question was asked, Guilherme typed in the chat: "I prefer not to comment on this subject." Even when called to the discussion by his colleagues and the researcher, the student remained silent until the beginning of the third moment. Guilherme's behavior aligns with what Hooks (2017) points out about the tensions and conflicts that can be generated when adopting a critical pedagogy in the teaching of a subject like Mathematics. However, even though the student remained silent, it is considered that the fact that he has the opportunity to access discussions on this topic, even if only as a listener, contributes positively to his education.

Regarding the above-mentioned question, João mentioned that he believes that race influences the disparity in the data because he observes many news reports about crimes involving skin color. Evandro agreed with João but added that "they attribute everything to color, even thefts," which was promptly countered by Marcela, who said it would be dishonest to compare crimes committed by black people with homicides of black

women, and João agreed. Paulo emphasized that, due to the values being presented in rates, this significant difference, especially in the state of ES, could only be associated with race.

At this point, Gabriela recorded the following statement in the chat: "I think they will always want to highlight black women even if there are other cases, they hide them to elevate and be able to victimize black women." Marcela immediately expressed a different opinion, and the researcher invited Gabriela to analyze the rates for black and non-black women again and explained that it is correct to make the comparison between rates due to proportionality. However, Gabriela responded that she understood that the comparison was honest but that she still believes it would be better to use data only about women, without distinguishing by race because the bigger issue is women's deaths. Gabriela's statement highlighted the lack of a racial perspective in her reflection.

This situation reminded the researcher of her own journey, during which the belief in the existence of racial democracy was present due to her individual experiences.

Next, the graph illustrated in Figure 5 was displayed, created by the Núcleo de Pesquisas de Economia e Gênero of FACAMP, which reflects the results of microdata from the Continuous National Household Sample Survey by IBGE. The graph presents data on unemployment by race and gender in Brazil, aiming to provide more elements for the discussion.

The graph features grouped columns showing the unemployment rate by race and gender in Brazil during the years 2019 and 2020, divided into quarters (2019.4, 2020.3, and 2020.4). The unemployment categories are divided into five groups: Brazil, black women, black men, white women, and white men.

Additionally, the graph allows a comparison of how the unemployment rate varied among different groups over this period and how these variations may have been affected by economic and social factors. It is essential to observe the trends over the quarters and any

significant disparities in the unemployment rate between the groups, as this may indicate specific employment challenges faced by different segments of the population.

FIGURE 5: Unemployment Rate by Race and Gender in Brazil
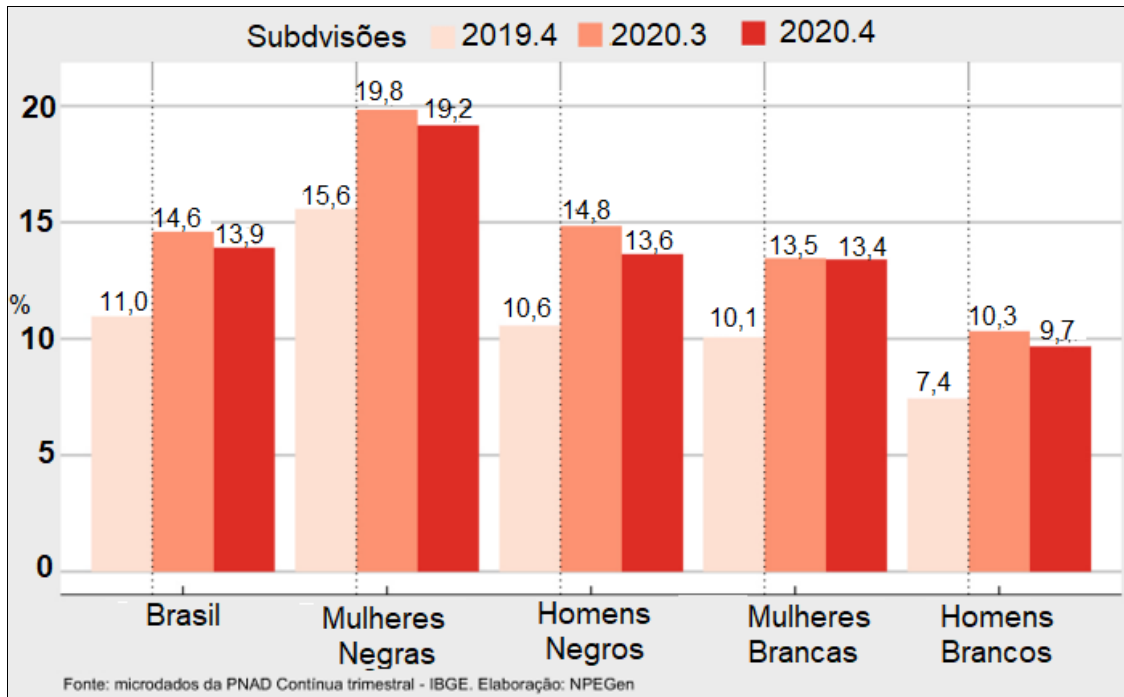
Source: Filleti, Gorayeb and Cardoso de Melo (2021).

After the display of the graph, Guilherme expressed astonishment at the significant difference in the data. João countered Gabriela's earlier statement, saying that it wouldn't be possible to consider it a coincidence when bad things always happen to black people, and the others agreed. It is worth noting that the students mentioned the word "discrimination" and acknowledged that race has an influence, but at no point did they use the word "racism." This theme was revisited in the following meeting.

Moment 3

For this part of the meeting, first, the following question was asked: "Are statistical messages always presented honestly?" To reflect on this

issue, some erroneously presented and/or manipulated statistical messages in the media were selected. After inviting them to observe Figure 6, the majority reacted with laughter at the situation depicted. In the first scenario, a difference of more than 11 points in ratings is represented by a minuscule difference between the bars. In the second scenario, a difference of only 0.8 was represented disproportionately.

FIGURE 6: Graph depicting TV channel audience ratings for TV Record

Source: UOL[5] (2008).

Paulo commented that the TV channel must have intentionally messed up the scale to create the impression of success. Guilherme added that he imagines, based on the numbers, that the competing channel must be Rede Globo. However, if the channel wanted to present more impressive results, they could use Rede TV as the competing news program. Guilherme's statement once again reveals the importance of contextual knowledge, and through it, it was observed how they began to formulate critical questions about the presented data (Gal, 2002).

After the presentation of Figure 7, it was explained that the graph shown concerns the evolution of COVID-19 cases in Bahia. In this graph, the blue line represents the expected projection for the evolution of cases, and the red line represents how the increase in cases actually occurred. Furthermore, the reporter used her own hand to measure for the viewers the difference between the estimated evolution and what happened.

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[5] Available at: http://celebridades.uol.com.br/ooops/ultimas-noticias/2008/07/17/record-ilude-com-manipulacao-de-grafico-de-ibope.htm (Acessed on: 01 set. 2021.)

FIGURE 7: Recording from a Bahia news program

Source: Twitter[6].

After being asked if this way of expressing was appropriate, Evandro responded positively and said that he believes that by using the palm, which is a unit of measurement used in daily life, the reporter managed to explain in a way that everyone could understand. However, Paulo warned that the difference will always depend on the screen's size. In response to this, Evandro agreed and stated that he hadn't paid attention to this detail and probably wouldn't have noticed it on his own. Marcela said, "I agree, but I believe she wasn't ill-intentioned. She just wanted to raise awareness, but she lacked knowledge, even though she's a reporter, and many people who watched probably didn't notice." Marcela's comment exemplifies how formal education, whether at the primary or higher education level, does not guarantee the development of statistical literacy (Gal, 2002).

It is worth noting once again that the participants in this research are mathematics teacher education students, meaning they have completed primary education and likely have some familiarity with statistical knowledge. However, some of them did not notice the reporter's error in using the palm as a unit of measurement to compare the lines in the graph. In this context, the importance of initial teacher education by providing reflections on the correct reading and interpretation of statistical data was emphasized. Next, two graphs presented by GloboNews were displayed, one on inflation and the other on unemployment in Brazil, as shown in Figure 8.

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[6] Available at: https://twitter.com/miltonneves/status/1243332725035151361 (Acessed on: 15 ago. 2021.)

FIGURE 8: Graphs presented on GloboNews

Source: Adapted from GIZMODO/UOL[7] and Blog Sociedade Sustentável[8] (2014).

When displaying the graph on inflation, the first reaction shown by Paulo led to the question, "Did you change the numbers, teacher? It's not possible for them to have presented it like this." Evandro mentioned, "What shocked me the most was the difference between 5.91% and 5.92% there. At the moment, it goes by quickly, and we fall for it because we don't even look at the number, just at the bars." Gabriela commented that when she watches a news broadcast that she considers trustworthy, she doesn't analyze the graph and absorbs the information from the presenter's speech. Marcela stated that from that moment on, whenever possible, she would pause the news to analyze it because she found the error absurd. The comments of the teacher education students illustrate the importance of examples like these being addressed in primary education to instill a certain sense of skepticism about the statistical information received.

Next, the unemployment graph was presented, and immediately Paulo exclaimed, "Teacher, why do they make so many mistakes?" The researcher responded with the question, "Do you believe these errors are accidental?" Based on this question, the teacher education students said that due to their frequency, they believe it's intentional. Guilherme added

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[7] Available at: https://gizmodo.uol.com.br/mentir-visualizacao-dados/ (Acessed on: 15 ago. 2021.)
[8] Available at: http://pafranco2005.blogspot.com/2014/11/a-manipulacao-subliminar-da-globo.html (Acessed on: 01 set. 2021.)

that these graphs should have had the purpose of discrediting someone but that he doesn't see the point because they refer to the entire country. At this point, João interjected, saying he believes it could be related to the presidential elections, which points to an understanding of the context (GAL, 2002). The others did not comment on the relationship between the graphs and the elections. Following João's comment, the researcher mentioned that the graph's data were released in a period close to the election in which former President Dilma Rousseff was running for re-election. In this sense, the error could have been accidental or produced to discredit her government.

Following this, they discussed how fake news is used in politics, and Evandro added, "The problem with an uninformed person due to manipulation is that they misinform others." Gabriela said she believes that in the past, media outlets simply published false information, but with the internet, they had to refine their methods of manipulation and started using people's lack of knowledge for it. In light of this, the following question was posed: "Is it possible that these statistical pieces of information could be used in statistics education in primary education?" On this topic, the students asserted that even though they hadn't learned in this way, they considered that it would be more beneficial to use real data because, in Gabriela's words, it "makes students more critical."

It's worth noting that, at the request of the students, other manipulated statistical messages were included for discussion in future workshops.

Conclusion

In this study, we aimed to identify emerging knowledge in a workshop on statistical literacy designed for students entering a Bachelor's program in Mathematics.

Firstly, it is necessary to argue that any result should be considered in light of the circumstances experienced at the time of the research. Concerning this study, it's worth noting that this investigation took place under atypical conditions because the admission to the master's program occurred in March 2020, and the defense took place in August 2022. This period constituted a murky time for the global population, which was struck by the COVID-19 pandemic, resulting in various emotional and socio-economic losses worldwide.

While these losses are undeniable, it's essential to highlight that the context of the pandemic was quite conducive to students understanding the importance of statistical literacy for an individual's civic education. The pandemic brought about a vast amount of statistical data that dominated the media, and often it was not interpreted correctly.

The reflections woven into the theoretical framework (Gal, 2022; D'Almbrósio, 2012, 2016; Hooks, 2017) contributed to the creation of the workshop, which, in turn, facilitated the reintegration of the students' statistical knowledge, discussions on racial relations, and the potential for these discussions in mathematics classes. The future teachers developed a more discerning perspective on statistical concepts and racial issues, acknowledging that statistical literacy activities offer opportunities to address social issues in mathematics classes from primary education onward.

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