Comics as a didactic device for teaching arithmetic mean in the context of statistical literacy

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Abstract: This article aims to reflect on using comics to teach the arithmetic mean. It is a proposal based on references that deal with statistical literacy. This proposition aligns with several studies that show the potential of using comics in the school context. The methodology we adopt is qualitative and theoretical in nature. Reflections under theories approaching statistical literacy show that the textual genre addressed is configured as a didactic device that favors the teaching of arithmetic mean, exploring reading, writing, creativity, criticality, and reflection skills in line with statistical literacy principles.

Keywords: Comics. Teaching Arithmetic Mean. Statistical Literacy.

Los cómics como dispositivo didáctico para la enseñanza de la media aritmética en el contexto de la alfabetización estadística

Resumen: En este artículo nuestro objetivo es reflexionar sobre el uso del cómic para la enseñanza de la media aritmética, es una propuesta basada en referentes que abordan la alfabetización estadística. Esta propuesta está en línea con varios estudios que muestran el potencial del uso del cómic en el contexto escolar. La metodología que adoptamos es de carácter cualitativo y teórico. Las reflexiones a la luz de los aportes teóricos en torno a la alfabetización estadística muestran que el género textual abordado se configura como un dispositivo didáctico para favorecer la enseñanza de la media aritmética, explorando habilidades de lectura, escritura, creatividad, criticidad y reflexión en consonancia con los principios de la alfabetización estadística.

Palabras clave: Cómic. Enseñanza de la Media Aritmética. Alfabetización Estadística.

História em quadrinhos como dispositivo didático para ensinar média aritmética no contexto do letramento estatístico

Resumo: Neste artigo nosso objetivo é refletir sobre a utilização da história em quadrinhos para o ensino de média aritmética, trata-se de uma proposta fundamentada em referências que tratam do letramento estatístico. Essa proposição vem ao encontro de diversas pesquisas que mostram a potencialidade do uso das histórias em quadrinhos no contexto escolar. A metodologia que assumimos é de cunho qualitativo e teórico. As reflexões à luz de aportes

teóricos referentes ao letramento estatístico evidenciam que o gênero textual abordado se configura como dispositivo didático para favorecer o ensino da média aritmética, explorando habilidades de leitura, escrita, criatividade, criticidade e reflexão em consonância com princípios do letramento estatístico.

Palavras-chave: História em Quadrinhos. Ensino de Média Aritmética. Letramento Estatístico.

1 Introduction

In modern society, information circulates almost instantly, making it necessary to understand our insertion in this universe to be educated, qualified, and adapted to deal with such a scenario. In this way, skills such as dynamic and reflective reading of various information, writing and representing data and texts, familiarity with reading graphs and tables, and a critical stance in a social environment become necessary elements for developing work and life in society. Thus, people who develop such skills are considered literate in writing, reading, mathematics, and statistics and are, therefore, more likely to adopt a critical stance toward everyday information (Batanero, 2011).

In this sense, when discussing skills and abilities for statistical literacy, Gal (2002) emphasizes

> a) the ability to interpret and critically evaluate statistical information, arguments supported by data, or phenomena that people may encounter in different contexts, including the media, but not limited to them, and b) the ability to discuss or communicate opinions regarding this statistical information when relevant. (Gal, 2002, p. 2-3, our translation).

To work on these skills and abilities, Gal (2002) draws our attention to the origin and importance of the data used. Thus, we infer that a given problem situation within the scope of statistics teaching must be circumscribed in a socially and culturally significant context for the student. We understand that literacy in any field, whether mathematics, language, or statistics, is a long-term process that can last a lifetime. In this sense, any teaching proposal to promote citizens' literacy will always be provisional and inconclusive, as it is credible.

Our choice of studying the arithmetic mean is to indicate how a given context can be approached using a teaching device with social meaning and importance, such as comic books. It is worth mentioning that studying the arithmetic mean, like any other statistical content, involves rescuing and acquiring several interconnected concepts to understand this content. Furthermore, when using comics, students must develop reading, writing, communication of ideas, expression of understanding, and a critical stance toward the problems and social demands involved in the story (Rama; Vergueiro, 2014; Vergueiro, 2009; Nunes; Oliveira, 2018).

In this sense, we will reflect on the production of comic strips that contextualize the arithmetic mean object and can contribute to the complex task of statistical literacy. Thus, our objective in this article is to reflect on a proposal for teaching the arithmetic mean through the textual genre of comics to assist in developing statistical literacy.

To achieve the objective, we used qualitative and theoretical research (Prodanov; Freitas, 2013; Menezes et al., 2019) in order to enable the investigation of the arithmetic

mean, subject to an undefined and finished view, from a didactic perspective[1].

2 Reflections for a Theoretical Framework

In this section, we present a brief description of the theoretical support we used to propose and reflect on a didactic device for teaching and learning the arithmetic mean, with which we intend to teach statistics to contribute to developing statistical literacy (SL) in school environments. The main authors of our theoretical framework are Batanero (2000), Godino (1996), Ara (2006), Coutinho (2013), Lopes (2008), Batanero and Godino (1991), Campos (2011), Snee (1990), Moore (1998), Mallows (1998), Chance (2002), Pfannkuch and Wild (2004), Campos (2007), Campos (2016), Soares (1998), and Gal (2002).

Based on several of those authors' studies, we understand that statistics teaching has been present in school curricula since primary education, covering a large part of basic education and, in many cases, it is part of the curriculum of several higher education courses, given its importance for the development of skills in various professions and the promotion of critical thinking in life in society.

The recognition of this importance and the inclusion of statistics in school curricula is due to the work carried out by the Education Committee of the International Statistical Institute [2] (ISI) and then, from 1991, by the International Association for Statistical Education [3] (IASE), which, over three decades, has promoted congresses and specific publications aimed at introducing statistics in schools (Batanero, 2000). In this sense, we verified the researcher's concern regarding understanding statistical concepts in the classroom approach on measures of central position, especially the arithmetic mean (AM), during the teaching and learning of this object of knowledge. Thus, the author mentions that:

> The new curriculum designs incorporate statistics teaching in primary and secondary schools, emphasizing the inquiry-based approach and students' work with open interdisciplinary projects. The new curricular designs incorporate statistics teaching in primary and secondary education, emphasizing the inquiry-based approach and students' work with open interdisciplinary projects. To successfully approach this proposal, the teacher must be aware of the complexity of statistical concepts, even the "elementary" ones, whose meaning must be constructed progressively. (Batanero, 2000, p. 1, our translation).

The author takes as an example the meaning of measures of central tendency to discuss the complexity and difficulties in understanding the notions that involve these tendencies. The quote is not recent but shows us how important it is that teachers master statistical concepts and understand the complexity of this knowledge, which is still a problem in teacher initial and continuing education. This way, teachers will be able to help students gradually master the ideas of fundamental statistical concepts, which is not a simple task. To achieve this mastery, it is necessary to adapt the ideas involved in knowledge to reach students' cognitive abilities and provide teaching situations that involve consistent learning, as with AM.

Batanero (2000) also highlights that statistics is traditionally taught as an integral part of mathematics content and not as a science with its characteristics, concepts, and properties that govern its teaching content. This author highlights that this problem has its genesis in that

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[1] This article is an excerpt from the first author's master's thesis and presents fragments of a comic book he created.
[2] https://isi-web.org/
[3] https://iase-web.org/

statistics teaching, as its researchers wish to see, is still expanding in research and development of its application and teaching to students. This directly impacts the understanding and insertion of its knowledge objects, such as the arithmetic mean. It is in this sense that the researcher emphasizes:

> Although statistics as a science is experiencing notable expansion, research on statistics teaching is still scarce, and we are only beginning to understand students' main difficulties in the most important concepts. It is also necessary to experiment with and evaluate teaching methods adapted to the specific nature of statistics, to which the general principles of mathematics teaching cannot always be transferred (Batanero, 2000, p. 1, our translation).

In this way, we understand that developing statistics teaching as a science, i.e., dissociated from mathematics, will allow better development of this knowledge, providing the teacher with criteria for organizing the teaching of topics in this science. Thus, we will be able to reflect on the set of difficulties related to statistics teaching linked to the learning that certain concepts present to students. We understand the need for an epistemological search for their meanings to better understand statistical objects (for example, the arithmetic mean) immersed in mathematical objects. However, mathematical knowledge itself is somewhat complex, which Godino (1996) emphasizes:

> Therefore, the problem of understanding is closely linked to the way mathematical knowledge is conceived. Mathematical terms and expressions denote abstract entities whose naturalization and origin we must explain to elaborate a valuable and effective theory of what we understand when understanding these objects. This explanation requires answering questions such as: What is the structure of the object to be understood? What possible forms or modes of understanding exist for each concept? What aspects or components of mathematical concepts are possible and desirable for students to learn at a given time and given circumstances? How do these components develop? (Godino, 1996, p. 418, our translation).

According to Coutinho (2013), this area of knowledge –statistics– is seen as a science, consequently requiring mathematics teaching degree courses to promote the development of reasoning, literacy, and statistical thinking in future teachers. Thus, teachers will be able to design and manage activities to develop, as their main goal, statistical reasoning (Garfield, 2002), statistical literacy (Gal, 2002), and statistical thinking (Snee, 1990) in their future students. This will contribute to forming a reflective, critical citizen and, consequently, the emergence of a more just and egalitarian society.

Assuming the concept that the practices used in statistics teaching –with their methods of collecting and obtaining data, organizing them into graphs and tables, and moments of analysis and inferences of statistical problems– are not easy to assimilate in the school environment, we have the understanding that "statistical literacy," "statistical reasoning," and "statistical thinking" are those provided with an interpretative and interactive reading, with proper understandings and interpretations, followed by a critical stance, questioner and observer in the most diverse contexts in a dynamic and plural society, equipped with media and technological devices. In this context, we understand that comics have a didactic space in mediating the teaching of topics from the different curriculum components of basic school (Brasil, 2018).

Our purpose in using comics agrees with Soares (2006), for whom the term literacy is associated with the acquisition and adequate use of reading and writing, given professional

and social demands. The author believes that the phenomenon of literacy is evidenced when people can read books, newspapers, and magazines, write a letter, visualize data and statistical information on the packaging of a product, on an energy bill, a medicine leaflet, and others. Expanding on these ideas, we have statistical literacy (SL), which, according to Gal (2002), considers an adult statistically literate when they can understand phenomena and trends of social and personal relevance, including birth and mortality rates, crime rates, population growth, and industrial production. Furthermore, it is assumed that a statistically literate adult critically reads the reality around them, based on statistical thinking (ST), in the sense given by Snee.

> I define statistical thinking as processes that recognize that variation is everywhere and present in everything we do. All work is a series of interconnected processes that identify, characterize, quantify, control, and reduce variation by offering opportunities for improvement. (Snee, 1990, p. 11).

In this sense, Hoerl and Snee (2012) recognize in ST a philosophy of learning and action based on the following principles: all work occurs in a system of interconnected processes, variation exists in all processes, and understanding and reducing variation are key elements to achieving success.

In turn, statistical reasoning is defined by Garfield and Gal (1999) and Garfield (2002) as

> the way people reason with statistical ideas and understand statistical information... This involves making interpretations based on data sets, graphical representations, and statistical summaries. Much of statistical reasoning combines ideas about data and chance, which leads to making inferences and interpreting statistical results. Underlying this reasoning is a conceptual understanding of important ideas such as distribution, center, spread, association, uncertainty, randomness, and sampling. (Garfield, 2002, p. 1).

Statistical reasoning is a topic of interest for many types of people, including: Which allows you to analyze information and statistical data from the most diverse social phenomena. Literacy and thinking come to support people when faced with statistical information in advertisements, magazines, and media in general, enabling the understanding of statistical concepts covered in these most diverse social communication instruments (Gal, 2004).

According to Garfield (2002), to develop more advanced statistical reasoning, teaching must provide conditions for the student to compare concepts, evaluate the most appropriate way to analyze a variable or a set of variables (a database), change representation, understand counterexamples, etc.

In this sense, more advanced statistical reasoning can also develop statistical thinking. Likewise, developing statistical thinking can take one's statistical reasoning to a more advanced level (Campos, 2011).

In this relationship between themes, we realize variation is the central element of statistical thinking and is one of the necessary contents for an individual to be statistically literate. Research on reasoning about variation can contribute to the development of statistical thinking and literacy (Snee, 1990; Campos, 2011).

On the other hand, some research in mathematics education, such as Ramos's (2005),

Costa's (2007), and Coutinho and Miguel's (2007), indicate that a large part of Brazilian teachers do not work or work little, in basic education, with statistical contents. This reality in the Brazilian scenario goes against what was suggested by the Ministry of Education (MEC) through the promulgation of the National Curriculum Parameters – PCN (Brasil, 1997, 1998), in addition to the following addenda: National Curriculum Parameters + or PCN + (Brasil, 2002), the Curriculum Guidelines for Secondary Education – OCEM (Brasil, 2006) and the National Common Curriculum Base – BNCC (Brasil, 2018) regarding the teaching of statistics in Brazilian basic education. Furthermore, research by Goulart (2007) and Silva (2007) shows that statistics content has frequently been used in external assessment tests for official Brazilian exams. In our view, this highlights the importance of students acquiring this knowledge.

In his studies, Lopes (2008) highlights the importance and relevance of teaching statistics, starting from the early years of elementary school. In the mathematics curriculum proposals experts presented in their studies, they have sought to justify this importance in students' education, highlighting what they should know and what procedures they should develop in teaching and learning statistical concepts.

Lopes (2008) states that the simple insertion of stochastic teaching[4] just as an additional topic to be taught in one or another year of basic education emphasizing only a part of descriptive statistics will not lead the student to the development of statistical thinking and probabilistic thinking through the use of their calculations and formulas. She argues that the data and problematization must be analyzed, and a strategy for solving the problem and an analysis of the results must be developed. In teaching statistics, to give more sense and meaning to the objects under study, we must start by problematizing them regarding students' daily lives. In this sense, Lopes (2008) highlights that:

> It seems essential to our students' education to develop statistical activities that always start from a problematization because, just like mathematical concepts, statisticians must also be inserted in situations linked to their daily lives. Therefore, this study will help them realize their future work in different branches of human activity and contribute to their general culture (Lopes, 2008, p. 58).

In this context, we believe that when teachers propose situations to carry out certain activities, they must consider students' realities to give more sense and meaning to what is being said and studied. To this end, students must be led to experience situations that force them to think and build knowledge to make decisions when solving problems. For this reason, we understand that the scope of statistical literacy may also come up against adverse situations, such as the one mentioned above, concerning the constitution of the curriculum, being seen as an obstacle to the development of statistical literacy and, consequently, of reasoning and statistical thinking.

3 Characterization of the Arithmetic Mean in the National Common Curriculum Base

The study and teaching of the arithmetic mean gains importance in statistical education due to the civic education that this statistical object can provide in the context of an information society. In this aspect, the Common National Curriculum Base (BNCC) (Brasil, 2018), which deals with a common curriculum for Brazilian basic education, is one of the

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[4] Stochastic refers to the interface between the concepts of combinatorics, probability, and statistics that enable the development of particular forms of thinking involving random phenomena, interpretation of samples, and the elaboration of inferences (Lopes & Moran, 1999).

documents that shows the importance of teaching statistical objects, including the arithmetic mean.

According to the BNCC (Brasil, 2018), mathematics was established as a science through human being's search for answers to problems arising from their social practices, such as agriculture, commerce, and civil construction. The need to deal with counts, measurements, calculations, movements of physical objects, and geometric shapes arose from these practices. In this scenario of searching for answers, new knowledge was produced, giving rise to new problems and generating new, increasingly abstract knowledge.

The BNCC states that mathematics, as a science, is based on procedures such as analyzing regularities to establish patterns, formulating hypotheses, and presenting results through rigorous methods of internal validation and development of different types of reasoning in a synthetic, direct, and objective language with a lower degree of ambiguity. This knowledge is the basis of a series of processes that organize contemporary life, assist in decision-making based on the possibility of examining patterns and regularities, as with the statistical mathematical object, and enhance the capacity for abstraction, which gives mathematics a fundamental role in school. It allows students access to this knowledge, enabling them to expand their understanding of the world and interact in civic life.

Analyzing the second preliminary version of the BNCC, we observed that these assertions are included in the general education objectives in statistics in high school mathematics regarding the education axes. In the EMMT04 axis, the new BNCC (Brasil, 2018, p. 560) requests "establishing relationships between mathematical concepts of geometry, quantities and measurements, statistics and probability, numbers and operations, algebra, and functions, as well as between mathematics and other areas of knowledge." This advances to the EMMT05 axis, which states that we must "critically analyze the uses of mathematics in different social practices and natural phenomena, to act and intervene in society" (Brasil, 2018, p. 560). In this axis, we glimpse some practices developed in the teaching and learning process for studying statistical objects, such as the arithmetic mean.

This attention to statistics can also be observed in this second preliminary version of the document, where we identify the division of mathematics for high school into five units of knowledge (Brasil, 2018). One of these units is Statistics and Probability, given its importance for life in society. Furthermore, in Brasil (2018), we have:

> Statistics: mean and range of a data set.
>
> (EF07MA35) Understand in meaningful contexts the meaning of average statistics as an indicator of the research trend, calculate its value, and relate it intuitively with the amplitude of the dataset (Brasil, 2018, p. 307).
>
> (EM13MAT316) Solve and elaborate problems in different contexts involving calculation and interpretation of central tendency measures (mean, mode, median) and dispersion measures (amplitude, variance, and standard deviation) (Brasil, 2018, p. 529).

The word "average" is identified in the quote by which we know that the arithmetic mean is included. Thus, this statistical object, considered in our research, is relevant to mathematics teaching in basic education but needs a better definition, as we will see below.

Use of Arithmetic Mean (Average) Terminology

The term mean, or average, appears in different moments and environments, which

typify its social existence.

- We expect to hear phrases like: "I have grades above my *average* in math."

- In competitions or situations involving speed –with people, motorcycles, cars, etc.– there are lines like: "This pilot reached a speed *average* of 230 km/h on its route."

- This word can also be used when we want a person to assume a more centralized stance in a conversation regarding a specific subject. That is why we commonly hear: "Hey you, don't you try to score some brownie points with me."

In these examples, we find some of the applications and uses of the word *average*, which, in a way, takes us back to a common thought, in the sense of determining something – which can be a value, a measure, or an attitude– that is capable of generalizing and/or grouping a set of values or ideas, to give sense or meaning to the term in use. However, in statistics teaching, when we study the statistical topic measures of central tendency (MCT), the arithmetic mean appears as one of its objects of study. When we work with numerical values, the term arithmetic mean (AM) means that if all distinct values could be represented by the same value, equal to all, without prejudice to their final amount, this value would be the average between them. For example, the AM of natural even numbers greater than 1 and less than 10: MA = (2 + 4 + 6 + 8) ÷ 4 = 20 ÷ 4 = 5. The AM obtained is an odd number, i.e., we can question the students: Does the arithmetic mean of a finite sequence of even numbers always result in an odd number? (Bussab & Morettin, 2015).

The definition for the arithmetic mean, as portrayed by Batanero and Godino (2002, p. 713), "[it] is the number that is obtained by adding all the values of the statistical variable (x_i) and dividing by the number of values (N)." Batanero and Godino (2002) say that the arithmetic mean is the main measure of central tendency and the best way to represent an estimate of an unknown quantity when we make several measurements or collect specific values or data. However, it is worth highlighting that other interpretations and applications of the term in question deviate from this usual rule.

When we carried out some searches in the research repositories of national and international universities to determine the epistemology of the term in question, we found that, around 400 BC, Archytas of Tarentum, a mathematician from the Pythagorean era, defined the term arithmetic mean using a different meaning than it currently has. He introduced us to three types of averages: arithmetic mean, geometric mean, and harmonic mean. Archytas of Tarentum defined the arithmetic mean as: "*A number is the arithmetic mean of two others when the excess of the first to the second is equal to the excess of the second to the third*" (Fonseca, 2013, p. 91). In its algebraic description, this excess was represented by a subtraction between the terms of the mean and had the following composition in the current notions:

- Since a, b, and c are three real numbers, with a > b > c, the average between them would be obtained by a – b = b – c. In this case, the term b is taken as the arithmetic mean of the other two values, a and c, and represents the semisum of these terms. Using a more modern mathematical organization, this can be represented by:

$$b = \frac{a + c}{2} \quad (1)$$

The quotient *b* in (1) summarizes a more adapted definition: the sum of two values divided by their quantity, which is the arithmetic mean between them. This is one of the notions used to generalize the arithmetic mean for a sequence with more than two values. In

this sense, using this same reasoning, we have the algebraic abstraction of the arithmetic mean of a sequence with n values:

$$\overline{x} = \frac{x_1 + x_2 + x_3 + x_4 + \cdots + x_n}{n} \quad (2)$$

In this representation of (2), the initial term $\overline{x}$, represents the value of the arithmetic mean, the terms $x_1 + x_2 + x_3 + x_4 + \cdots + x_n$ are the numbers or elements for which the mean is desired, and the variable n indicates the quantity of numbers or elements for which we want to calculate the arithmetic mean. Or, in a more summarized way, we have:

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (3)$$

In the representation of (3), the term $\overline{X}$ represents the average value, Σ is the symbol for the sum of n terms, from the first term $i = 1$, until the last term $i = n$, X_i represents all the terms of the sum, and n is the total number of terms added together.

We saw in (1), (2), and (3) the representative symbols for the calculus of the arithmetic mean. These mathematical symbols are relevant to understanding and using this object of statistics in the most diverse social contexts. Furthermore, Batanero (2000) highlights: "In daily life, we find the average in the media and professional work, for example, when we analyze the numbers of stock market evolution indexes, in prices, in production, employment, and other economic indicators" (Batanero, 2000, p. 41 – 58, our translation).

From Batanero's quote, we extracted the context to produce our comics, whose story develops from a salary issue inserted in the professional work scenario.

4 Comics and their Multiple Interfaces

When they were created, comic books were entertainment most of the time and featured science fiction characters and stories. Over the years, they have undergone several transformations and adaptations, mainly in the Western world (Santos; Ganzarolli, 2011; Xavier, 2017). Although seen as entertainment, the drawings in the comic books also represented a way of expressing art, and their stories brought a form of communication. Given these competencies, people began to observe the utilitarian side that comics provided and the possibility of their inclusion in the educational environment. From this possibility, comics began to be used in teaching environments, performing various educational functions and helping to introduce the most varied themes (Kawamoto & Campos, 2014).

Connecting the understandings of Soares (2006) and Gal (2004), we can infer the potential of using the textual genre comics as a teaching device to support teachers during their teaching. This is because it is a textual genre that encourages reading and is well-accepted by people. Thus, the creation and use of a comic book in the context of the classroom is a didactic alternative for teaching and learning arithmetic mean. In this didactic mediation, comics currently represent a means of mass communication with great social reach. This statement is proven by the worldwide circulation of thousands or even millions of copies of publications in the most varied genres. This genre has a loyal audience, always eager for new things, as shown by Rama and Vergueiro (2014) when, in their research, they stated:

> Even the emergence and competition of other means of communication and entertainment, increasingly abundant, diverse, and sophisticated, did not prevent comics from continuing to attract many fans at the beginning of this century. Such

popularity of comic books did not happen by chance. Their production, dissemination, and marketing, organized on an industrial scale, allowed the various stages of their preparation to be professionalized, enabling them to reach astronomical print runs (Rama & Vergueiro, 2014, p. 7).

For Rama and Vergueiro (2014), comics have the characteristic of meeting the needs of human beings. This fact can be confirmed when we observe that they extensively use an element of communication that has been present in human history since its genesis. Books and historical documents confirm that primitive men already used graphic images to portray and document their life paths. Rama and Vergueiro (2014) state that primitive man, even intuitively, had already understood that an image is loaded with information. Today, with the development of humanity and the most varied forms of communication, this fact can be confirmed because, based on images and their characteristics, they can express a range of intentions, such as feelings, representations, emotions, information, opinions, etc.

When combined with context and writing, comics become relevant instruments in terms of students' education and cognitive development, as they enable the development of skills inherent to this genre of language.

In this sense, encouraging reading involves developing variables related to the school environment. When students work on and internalize these variables, such as affection, intelligence, understanding, respect, sensitivity, and others, they contribute significantly to learning effectiveness. For this reason, including this genre in classrooms would not cause students to reject it. In general, they enthusiastically welcome the inclusion of comics, showing that this genre is a solid ally for teaching and learning and awakens the pleasure of reading.

To this end, as students are inclined to read comics, it is up to the teacher to use and choose this textual genre appropriately, combining comic books with encouraging the habit of reading. In this context, we see comics as a motivating resource that encourages students to exercise their imagination and helps them develop their sense of criticality and creativity.

For Rama and Vergueiro (2014), the utilitarian function of comics in the educational environment had already been noticed and implemented in several countries in the mid-1940s. In their research, the authors attested to this fact, reporting that:

> On the other hand, the perception that comic books could be used efficiently to transmit specific knowledge, that is, performing a utilitarian function and not just entertainment, was already common in the "comic book" environment long before its "discovery" by communication scholars. The first educational comic magazines published in the United States, such as True Comics, Real Life Comics, and Real Fact Comics, published during the 1940s, featured anthologies of comic books about famous historical characters, literary figures, and historical events. (Rama & Vergueiro, 2014, p. 17).

With this, we emphasize that comics allow us to approach different topics in the classroom. This textual genre enables the transmission and study of subjects such as citizenship, ethics, context, historical moment, the approach to specific subjects, the treatment of interdisciplinarity, and the use of transversal themes. With these possibilities for interdisciplinary approaches through comics, it is up to teachers to make a good selection of themes and subjects, which will contribute to the cognitive development desired by the topic, as well as assist the development of statistical literacy.

According to Nunes, Mendes, and Oliveira (2018), comics are no longer seen as a simple instrument of fun and have started to play an extremely important role in the teaching and learning process within the different areas of knowledge. According to these authors, the PCN and PNLD highlight the different genres of comics, such as cartoons and comic strips, as teaching alternatives in basic education. In this way, the incentive to read and write is expanded, and students' vocabulary is enriched, in line with what the presented forms can encompass, making them easy to understand for those who read them, regardless of region.

Vergueiro and Ramos (2009) affirm that work with comics can be used in teaching different subjects and can be explored as an intertextuality tool in different areas of knowledge. In this way, the resource in question can contribute to the inclusion and debate on different types of teaching content. According to the authors, teachers must be attentive when they base their classes on comics because the stories may contain inappropriate content for some grades. Therefore, as teaching mediators, teachers must carefully reflect and plan activities related to working with this genre. According to Borges (2001, p. 12), in the educational context, comics "can contribute in different ways because, besides entertaining, this literary genre can also support the development of readers' ability to analyze, interpret, and reflect."

In teaching mathematics, the didactic potential of comics can favor the exploration, representation, understanding, and dissemination of mathematical notions. Furthermore, the development of comics in the classroom enhances articulations between different mathematical and extra-mathematical concepts in exploring errors and mental calculations. In this sense, Nunes, Mendes, and Oliveira (2018) highlight that comics are resources that can help introduce various mathematical notions. Moreover, the plot as a whole and the illustrations, in particular, seem to have the potential to encourage students to accept challenges, which may lead them to engage in solving the proposed problems based on the announced context.

From the perspectives of the authors' ideas discussed in this section, we see the potential of inserting comics into pedagogical spaces, such as classrooms, to help students approach various study topics. This reinforces our view on the importance of developing reading and writing to enable interpretation and understanding of the contents of mathematics, statistics, and other curricular components (Brasil, 2018). Therefore, in comics, we have the concrete possibility of interdisciplinarity between mathematics, statistics, and other curricular components, which can support teaching and give meaning to didactic actions, i.e., to the teaching and learning process.

5 Comics as a Teaching Device

Comic books (comics) as a didactic device –following Silva, Silva, and Nunes (2023)– can contribute to AM teaching as the story described and illustrated streamlines teaching and learning, promoting student entry into a study process that can favor statistical literacy, close to Gal's (2002) concepts.

In this way, we developed a comics proposal to address the arithmetic mean based on Gal's (2002) statistical literacy model. The story described and illustrated in the comics entitled *Média Aritmética: pensando estatisticamente* [Arithmetic Mean: thinking statistically] is linked to social problems, including micro companies, young entrepreneurs, unemployment, men's and women's professional remuneration inequalities, and direct agreement between employees and employers. However, what predominates in our comics is the context of professional work (Batanero, 2000). It is opportune to address a currently hotly

debated social issue: disparities between men's and women's professional wages (Lima, 2018). Figure 1 illustrates part of the ideas described in this paragraph.

The unfolding of the dialogue between the two employees results in the proposition of a meeting to discuss the salary issue (Figure 2).

Based on Figures 1 and 2, we propose to observe the following situations to discuss in the classroom, which we suggest to be interdisciplinary (Brasil, 1998; Zabala, 2002): 1) Inequalities between men and women in work environments and society. This can raise awareness of changing attitudes and social values; 2) Using the Brazilian Constitution (Brasil, 1988) to assist in the search for fundamental rights provided for by law; 3) The importance of developing ethical and moral values among human actions. This may contribute to the emergence of a more just and egalitarian society, and 4) In terms of educational curriculum subjects, the presence of objects of study of the Portuguese language and aid for reading practice.

Figure 1: Dialogue that shows dissatisfaction with wage inequality
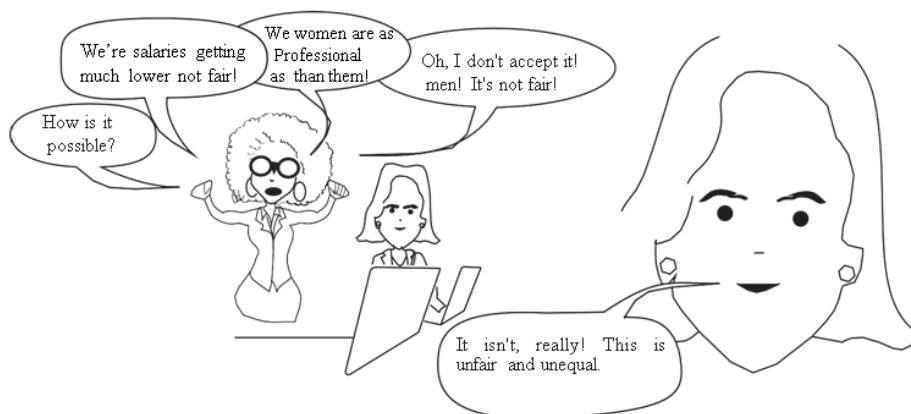
Source: Comics prepared by the authors.

Figure 2: Dialogue of the meeting proposal to discuss the salary situation
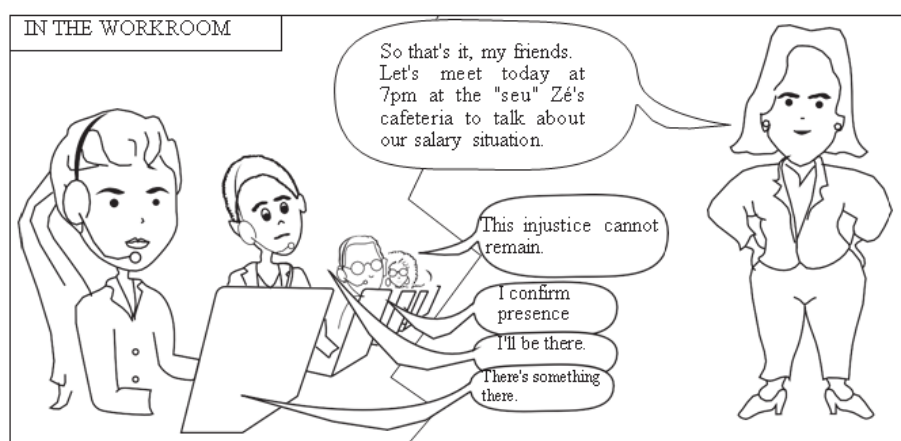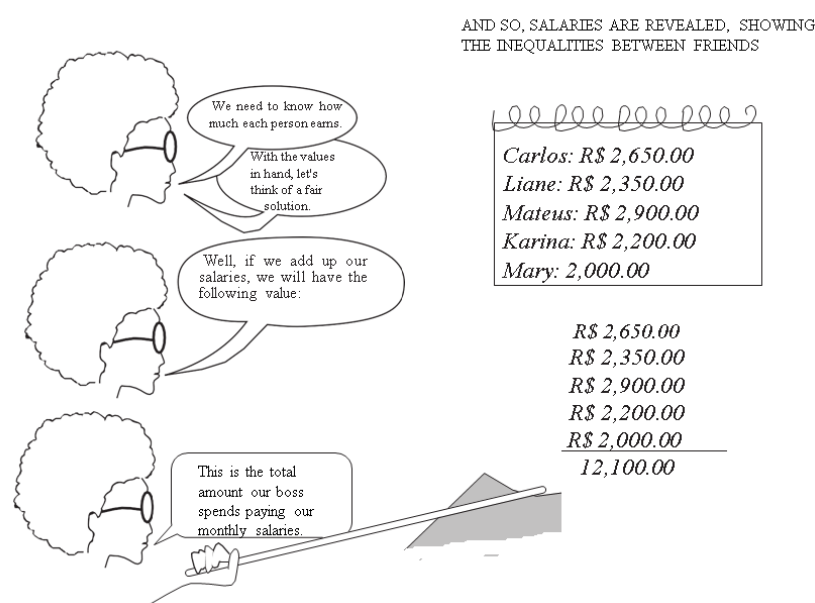

Source: Comics prepared by the authors (2019): Arithmetic Mean: thinking statistically

As the meeting unfolds, the mathematical object of the additive operation of the salary values that each person receives for their professional activities emerges. The salary gap between men and women becomes visible at this moment in the comic strip's plot (Figure 3). Next, the sum of salaries is divided by the number of employees, five (Figure 4). In this part

of the story, the plot tends toward the intended climax: teaching arithmetic mean. At this moment in history, the teacher can encourage students to visualize and reach new horizons that emanate from a situation or information as a debate and discussion to warn students about what may not be so *visible* or predicted in the context.

The comics brings elements of Gal's model (2002), which enhances the approach, for example, of statistical and mathematical knowledge and the possibility of discussions on the topic in question that will lead to deepening knowledge of a context that deals with wage equality between men and women. This is a critical issue whose socialization favors the exposure of ideals that reveal students' beliefs, attitudes, and critical stances.

Figure 3: Dialogue that reveals the individual salary of each employee and the sum of these values

Source: Comics prepared by the authors (2019): Arithmetic Mean: thinking statistically

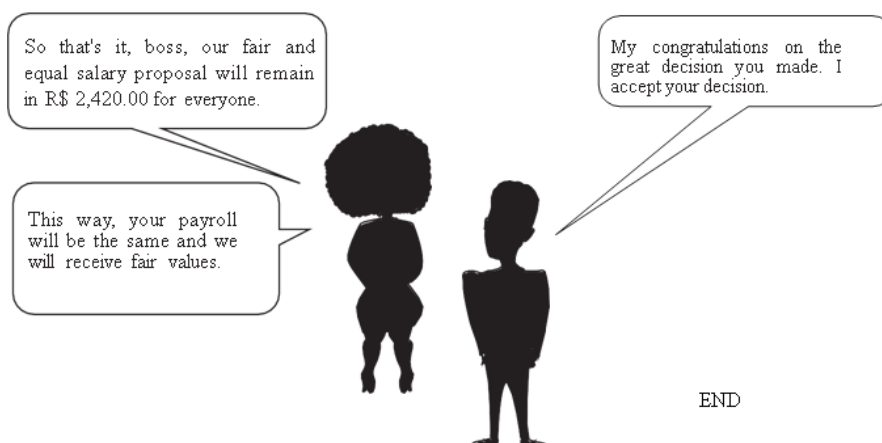**Figure 4**: Dialogue that reveals the sum of salaries divided by the number of employees
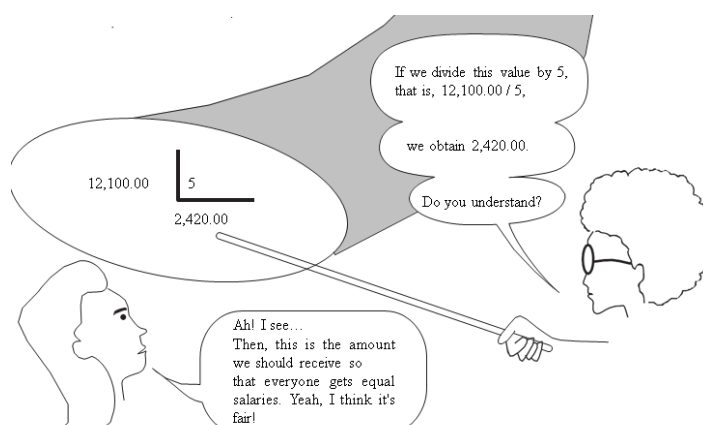
Source: Comics prepared by the authors (2019): Arithmetic Mean: thinking statistically

Figures 3 and 4 discuss different situations for calculating average salaries. At this moment, the arithmetic mean appears as a tool to solve a social conflict. Thus, AM begins to

gain sense and meaning for the student based on a context addressed in the proposed comics. This relationship between thinking about a solution and the problem situation triggers the exercise of statistical literacy for decision-making (Batanero, 2011; Coutinho, 2013). At this point, the teacher can use the following situations: 1) Show and reinforce how the average calculation is done; 2) Discuss its meaning within the context and encourage reflection; 3) Work with changes in the values that make up the average in the situation raised and reinforce the reflection of this change in the arithmetic average and 4) Reflect on the result of the average within the context of the problem, which is a relevant point in the sense of assisting in the development of statistical literacy regarding the average. The climax of the comics's story is reached when everyone agrees that they should receive the same salary (arithmetic average of the salaries of the five employees), and the proposal is presented to the employer (Figure 5).

Figure 5: Dialogue that reveals the calculation of the average salaries of the five employees

THE FOLLOWING DAY ...

So that's it, boss, our fair and equal salary proposal will remain in R$ 2,420.00 for everyone.

My congratulations on the great decision you made. I accept your decision.

This way, your payroll will be the same and we will receive fair values.

END

Source: Comics prepared by the authors (2019): Arithmetic Mean: thinking statistically

The proposal is in line with Gal (2002) and with the notes of Kataoka et al. (2011, p. 874-876) when highlighting, based on Wallman (1993), that statistical literacy is:

> competence to understand and critically evaluate statistical results that permeate our daily lives, along with the ability to recognize the contribution that statistical thinking can bring to public and private, professional and personal decisions.

From this perspective, the teacher can use the comic book as a teaching device to explore critical reading, analysis, and discussion of the situation and make inferences about relevant information and data presented. In other words, what is at stake are competencies for interpreting and critically evaluating statistical information and the skills to articulately communicate and discuss such information (Gal, 2002).

In the final phase of our comics, we emphasized a resumption of the events that occurred during the reading. At this moment, our intention refers to fixing the solutions presented to the problem, including its dismemberments arising from the characters' reflections. We understand that, in this resumption phase, we subject students to review, even if only partially, the entire process that occurred and how the arithmetic mean was used to solve situations arising from the problem.

6 Final Considerations

Reflecting on the proposition idealized and exposed in this article –based on statistical literacy– allows us to infer that the articulation of the comic strip and the teaching and learning of the arithmetic mean can encourage students to read, make appropriate choices for working with statistics using actual data and information, reflect and interpret the results obtained in solving a problem situation, contributing to the awakening of criticality, work in groups to develop interaction, integration, and team leadership. Thus, the proposition enhances the understanding of the world, helping to form more critical citizens aware of their attitudes and social practices.

In this sense, the teacher's role as mediator is essential in choosing a topic to be addressed and which is part of students' social context so that the study gains dimensions conducive to their understanding, resulting in a pleasurable and meaningful reading for the student, providing the cognitive development of the meanings and interpretations that the text can carry.

Therefore, teachers must aim for moments of discussion that bring out attitudes and feelings of ethics and social justice, which occur when students realize they are play an important role in their own learning and that their collaboration will help them in their education and social responsibility development.

Finally, we highlight that the reflections put forward in this research can contribute to teaching practices related to the study of statistics content, such as the arithmetic mean, in line with the development of reading and writing skills, helping to exercise statistical reasoning, statistical thinking, and statistical literacy. Therefore, we hope that this research assists new studies on the topic, as we understand that, due to its complexity and the little use and appreciation given to statistical education in school environments, this subject emerges new possibilities for study and research.

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