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The Problematic Issue of Gender in Mathematics Textbooks: A Comparative Analysis Between Brazil and the USA

A questão de gênero em livros didáticos de matemática: uma comparação entre materiais do Brasil e dos Estados Unidos

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Abstract

Textbooks, which are still one of the most used tools in the mathematics classroom worldwide, have a substantial impact on the production of students' subjectivities. In this sense, despite research showing a need to eliminate gender bias in mathematics textbooks, they still reproduce the portrayal of what it means to be a girl/woman or a boy/man in our current society. Therefore, this study compares two of the most used 6th-grade mathematics textbooks in Brazil and the USA to unveil the ways gender subjects were presented. This analysis concluded that textbooks are still major tools to reproduce and create stereotyped gender positions for girls and boys, influencing the creation of students' subjectivities in both countries.
Keywords: Textbooks; School mathematics; Gender Studies; Production of Subjectivities.

Resumo

Os livros didáticos, que ainda são uma das ferramentas mais utilizadas na sala de aula de matemática em todo o mundo, têm um impacto substancial na produção de subjetividades dos alunos. Nesse sentido, apesar das pesquisas mostrarem a necessidade de eliminação do preconceito de gênero nos livros didáticos de matemática, eles ainda reproduzem o retrato do que significa ser menina/mulher ou menino/homem na sociedade atual. Portanto, este estudo oferece uma comparação entre dois dos livros didáticos de matemática do 6º ano mais utilizados no Brasil e nos Estados Unidos, a fim de desvelar as formas de apresentação das questões de gênero. Esta análise concluiu que os livros didáticos de matemática ainda são ferramentas importantes para reproduzir e criar posições de gênero estereotipadas para meninas e meninos, influenciando na criação de subjetividades dos alunos em ambos os países.
Palavras chave: Livros didáticos; Matemática escolar; Estudos de Gênero; Produção de subjetividades.

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Introduction

In this article, we compared two of the most used mathematics textbooks for the 6th grade in Brazil and the equivalent at the same grade of education in the United States. Our goal is to investigate how these two textbooks replicate stylized gender practices to go beyond the teaching and learning of mathematics, comparing the most widely used curriculum materials in the respective countries. In this study, we intend to identify and analyze the similarities and differences present in each textbook through the lenses of Gender Studies. It is noteworthy to recognize that the primary intention of these textbooks would be to assist in teaching the school discipline mentioned above; however, simultaneously, they end up normalizing the conduct of students through the speeches replicated in all areas of life for gender performances consequently producing students' subjectivity.

In this article, the biological information of the sexes (LAQUEUR, 1990) and ideas about femininities and masculinities (gender) are not treated in the same way that studies have approached them historically using positivist research paradigms. In this study, gender is seen as signs constructed discursively (RICHARD, 1996), supported by supposed truths that manage and direct the practices of social bodies. In this sense, we understand that both the female and the male bodies are produced from a set of regulatory practices through discourses (BUTLER, 2010). Therefore, this study is mobilized to describe and analyze the practices of gender performances that permeate the two textbooks. We assume that the mathematics textbook is an important tool that influences the production of students' subjectivities.

We start from the assumption that school mathematics practices, through their contents, help, reinforce, justify and validate values and moralities, which are the contingent notions of gender understandings today, thus producing subjectivities. It is important to define that recognizing oneself is fundamental for the production of subjectivity: "(...) in order to be concerned with yourself, it is necessary to know yourself; to know yourself, you need to look at an element that is just like you; it is necessary to look at an element that is the very principle of knowledge and knowledge (...) "(FOUCAULT, 2006, p. 89; grifo nosso). The subject is constituted in a double sense, because he/she/they is subjugated to a set of control mechanisms, at the same time that he/she/they has to practice the relationship with himself/herself/themselves, to know himself/herself/themselves; finally, the subject is always

subjected to the games of power over himself/herself/themselves and practiced by himself/herself/themselves. Therefore, historically textbooks work in pedagogical ways, through the production of subjectivities, by instructing how boys and girls, in different ways, should be and act in the world, what practices are expected for each of these two performances, male and female.

In short, our point is that mathematics textbooks can be a way of teaching students their positions to carry out desired stylized gender practices, teaching individuals how to be and act in the world based on their supposed biological sex.

Literature Review

We understand that it is necessary to deepen the discussion about how textbooks end up producing subjectivities. To this end, we return to 1978, in Brazil, when, from a Marxist-based analysis, educator Maria de Lourdes Nosella brought contributions to the field of research on textbooks in Brazil, with the defense of her master's dissertation. “The Beautiful Lies: the ideology underlying didactic texts," which later came to be published as a book (NOSELLA, 1981). It is important to note that the material was originally designed to be academic, not commercial. However, since its publication, it has reached 12 editions, which suggests the pertinence and interest of the public about the results in education research, more specifically about textbooks in Brazil. In her analysis, the author unraveled reading texts of what today would be equivalent to the Early Years of Elementary Education, interpreting them as composed of a disposition of ideas that benefited or guaranteed the social organization of the dominant class through a process of imposed ideologization to the dominated class. In her work, well-grounded in theoretical premises, especially Freirian, and with a robust critical analytical character, the author denounces the oppressive bias that permeated the analyzed texts, which ended up functioning as means to guarantee the maintenance of social inequalities.

Moving on to researching the same type of curricular materials but, through an analysis using the lenses of contemporary criticism, specifically in the field of mathematics education, Dowling (1996) had been already discussing the role of the mathematics textbooks as cultural products with the alleged objective of producing and reproducing school mathematics, thus

being an active agent in the teaching and learning processes. However, Dowling (1996) problematized the narratives of some materials and the dispositions of activities, in addition to other strategies, which, in Dowling's interpretations, led to a certain production of meaning on the part of the reader; that is, Dowling was already talking about the production of subjectivities.

In subsequent research, Dowling (1998) warned about the little interest by research in mathematics textbooks research and defended the need to expand investigations in this area, given its relevance for thinking about formal educational processes.

More recently, Fan, Zhu, and Miao (2013) published a study on mathematical education textbooks and concluded that this area of research is dispersed and, still, with many open thematic demands to be researched. However, the authors point out that research that covers gender and racial issues, for example, has shown a downward trend worldwide in recent years and concluded that this might be due to overcoming these problems in mathematics textbooks. However, this conclusion is not what research concerning gender issues in mathematics textbooks has shown. In Brazilian studies, it is possible to mention the results found in Souza e Silva (2018) and Neto and Guida (2019). Globally, researchers have also questioned the decline in gender research in the field of Mathematics Education in the 21st century (GREVHOLM, 2011; LUBIENSKI; GANLEY, 2017). In particular, in the United States, this phenomenon occurred because disparities in the acquisition of high school diplomas and admission to higher mathematics courses between men and women narrowed between the last two decades of the twentieth century. (DALTON et al, 2007; PEREZ-FELKNER et al., 2014). However, recent studies continue to emphasize the importance of gender discussions in mathematics at different levels of education (LUBIENSKI; ATAIDE PINHEIRO, 2020).

Thus, we assume that the gender issue in mathematics education is not an overcome problem but demands attention. Then, we suggest how gender issues are still necessary guidelines for the current debate in the field of research in mathematics education.

For example, in 2015, the United Nations Educational, Scientific and Cultural Organization (UNESCO) announced the need to "eliminate gender bias in textbooks." This report analyzed textbooks from different countries around the world and concluded that girls and boys are represented in very different ways in most of the materials analyzed: girls were represented with passive, loving characteristics, participating in domestic activities and other

stereotyped positions for women, while “boys and men worked in exciting and valuable ventures and occupations” (UNESCO, 2015, p. 01).

Currently, mathematics textbooks also play a significant role in maintaining these gender positions, as shown in Neto (2018) and identified by another UNESCO report:

> Even in some mathematics textbooks, such as those in Turkey, the traditional roles of women in the home (mother, daughter) are portrayed in the context of cooperation. Accompanied by the image of a mother and daughter cooking together, the following statement illustrates this pattern: “There were four eggs on the table. Ayse brought two more eggs for the mother. They added up to six eggs ” (AYDIN et al. Apud UNESCO, 2016, p. 13).

Still, on the functions of the textbook for basic education, a set of studies pointed to the importance attributed to textbooks that can be understood as substantial elements for the constitution of the subject today (PEÑALOZA; VALERO, 2016), which, for its turn also applies to mathematics textbooks (SILVA et al., 2018).

In this way, the role of textbooks in the production of subjectivities understood in this investigation is deeply linked to the construction of gender notions that replicate social practices and even end up validating them.

Gender as a problem and school mathematics

Mathematical knowledge has long been associated with scientific progress and, therefore, with the economic well-being of individuals and nations (VALERO, 2017). Recently, it has been argued that citizens' mathematical knowledge is a promoter of diversity and equity to overcome different types of social injustice. Many voices affirm the need for an increase in the mathematical performance of the population, nationally and internationally, in the name of the development of nations (OECD, 2013). Despite this, in this article, we understand school mathematics as a cultural policy, as proposed by Valero (2018), “(...) school mathematics is political because the historical constitution of knowledge and associated practices have emerged and are part of the classifications and organizations that regulate social life and, within them, notions of who people are and should be ”(p. 108). Therefore, as a cultural policy, in the wake of this understanding, school mathematics curriculum operates beyond the

processes of teaching and learning as a set of practices inserted in rationality that, in no way, is neutral. However, it carries and replicates stereotyped gender rationalities as advocated by Nosella (1981).

It is important to understand how Gender Studies have comprehended this category's historical and social construction, which is gender.

The notion of gender as a category of historical analysis has been defended for some time, mainly by Joan Scott when affirming that:

> By gender I mean the discourse of the difference of the sexes. It is not simply related to ideas, but also to institutions, structures, daily practices, as well as rituals, and everything that constitutes social relations. Discourse is the instrument of entry into the order of the world; even though it is not prior to social organization, it is inseparable from it. It follows, then, that gender is the social organization of sexual difference. It does not reflect the biological reality first, but it builds the meaning of this reality. The sexual difference is not the original cause from which the social organization could derive: it is, rather, a mobile social structure that must be analyzed in its different historical contexts (1998, p. 15).

In this study, we base our understanding of gender on the work of Butler (2010), *Gender Trouble*, for having remarkable relevance in the debates on the theme, since, with this book, Butler opens the discussion of the notions of gender as a problem. Questions such as "to whom is gender issues an interest?" or "how is gender produced?" became an agenda for discussions based on Butler's proposals and her interlocutors.

We base our understandings of gender as proposed by Butler (2010), for whom both gender, body, and sex are effects of discursive practices. More specifically about gender, she points out that this is "a mechanism through which the notions of male and female are produced and naturalized" (BUTLER, 2006, p. 70). This understanding is in line with Foucault's (2014) understanding, as it interprets that these discursive practices operate through government technologies that have repercussions on "[...] immediate everyday life, which classifies individuals into categories, designates them by their own individuality, connects them to their identity, imposes on them a law of truth that they need to recognize and that others must recognize on them "(FOUCAULT, 2014, p. 123), thus, the aforementioned discursive practices work to constitute and replicate well-established notions about which attitudes, behaviors, and practices are appropriate or not for our time, as well as, for which bodies they are. In short,

these discursive practices help us to understand how to be and act in the world, according to a determined time and body.

In that sense, what makes us women? Many researchers, especially philosophers and anthropologists, dwell on the conditions that make us become women, or men, in a *free adaptation of the expression* coined by Simone de Beauvoir (1980). As an example, it is possible to highlight Margaret Mead (1971), one of the most eminent anthropologists to date, referred to in studies on the constitution of the notions of being a man and being a woman. Mead (1971) investigated fourteen communities, mainly in Asia, seeking to understand how they elaborate what is to be male and what is to be female. She concluded that the identity constructions vary a lot in these nations. Even so, she claims that there are regularities that can be found in the cultures she studied. For us, it is interesting to highlight the realization of the "[...] man's need for fulfillment" (MEAD, 1971, p. 131), establishing a strong relationship between pride and masculinity. From this, she talks about how the corporal activities attributed to the bodies that perform the masculine are, recurrently, recognized as more valuable in all the societies studied by Mead. She affirms that

> In every society, the need for human fulfillment can be recognized. Men can cook, weave or dress dolls or hunt hummingbirds. If such activities are suitable for them, society as a whole and both sexes will consider them important. (MEAD, 1971, p. 131. Grifo nosso).

Therefore, the different ways in which different cultures understand and standardize the development of human beings necessarily passes through historical and social constructions of what is meant to live in a gendered body, but, above all, there are some convergences, among them, the need for the prestige of the activities performed by men, whatever those activities may be.

Other important results on the production of a well-established gender idea can be found in Federici (2019), in which she points out that the classification of women in the category of witches, in the context of Europe when capitalism began to emerge, as well as in other parts of the world, it is very important to describe a set of social and cultural practices that should be repressed in women. The figure of the witch, especially in Europe, played a pedagogical role in the communities that were beginning to draw a new economic order that

demanded specific social dynamics on the part of women and, also, on the part of men. The figure of the witch, her practices, was what a woman should not be; it was the counterexample that is still valid today.

In this research realm, the statement that one learns to live gender in social relations is striking. However, as much as we have an idea of what it means to be a man and a woman in our society today, these categories are by no means static and/or universalizing. Ribeiro (2019), for example, ponders about the first feminist movements that claimed access to the job market and fought against the image of women as fragile, delicate beings who demand care; we disregard that this is an idealized woman. These are white women, in general, because black women are not usually described with such characteristics, which can be evidenced in the title of the first work of bell hooks, “And am I not a woman?”, From 1981. Bell hooks asks exactly the difference in descriptions that characterized what this individual described as "woman", in the singular, which ended up leaving out another broad spectrum of the different forms of "being a woman."

Based on these studies, we will undertake the analysis of the selected teaching materials, understanding that they also operate in the production and replication of practices that teach us about behaviors, moralities, appropriate attitudes, in addition to mathematics, of course.

Methods and Methodology

The idea to elaborate this article arises from the interest of the two authors who have been researching with textbooks in Brazil and the US and have noticed the urgency of addressing gender issues in the field of Mathematics Education. Textbooks were chosen as research tools because these tools still function as the main teaching manual for teachers and the main learning manual for students in the mathematical learning process in the world (FAN, 2013). Thus, the results presented here are part of a study that sought to understand how the notions of gender appeared represented in the most used materials in both countries. For this analytical exercise, we compare the two selected materials by highlighting the similarities and differences in the gender inscriptions in the mathematics textbooks. From Brazil, we examined the book Praticando Matemática [Practicing Mathematics] (ANDRINI;

VASCONCELOS, 2015) as it is one of the most used textbooks in public schools, as of 2018, according to the data available on the textbook website. In correspondence, the American textbook chosen was Glencoe MATH (CARTER et al., 2015) due to its popularity among the most used textbooks in the United States (WEISS et al., 2001).

Our methodological approach consisted of a careful read of each textbook and selection of the appeal for characters who performed genderized performances (professions, occupations, and activities performed); this exercise was done by selecting each section, image, or excerpt where gender was mentioned. Thus, mathematical tasks, exercises/activities, and images and drawings were the contents analyzed.

In the textbooks analyzed, we understand that the system of images that surrounded the female and male representations wove a discursive logic that exposed the desirable gender practices of girls/women and boys/men; after all, there is an intrinsic relationship between "image and representation of truth "(COLLANGE; ALMEIDA; AMORIM, 2014, p. 826) because it is understood that the images

> [...] are promoters of cut 'truths', 'decontextualisations' or a vision led to aspects previously considered more important to teaching, to the detriment of the possible different meanings that they could add or bring, even from the point of view of objectivity and retraction of the real (ibid., 836).

In this sense, representations such as images and caricatures are used to tell a narrative that refers to different discourses, resulting from a game of forces. These images are fundamental elements in the analytical process, as we show in the following results.

Results

In this section, the results obtained with the cataloging of each material will be described. We will start with data from Brazil and then present some examples from the United States.

Brazil

Through discreet counting, 155 images and mentions of boys/men were found compared to 123 references to girls/women. Despite the numerical difference (it is important to note that the representation of boys/men was greater than that of girls/women), our view is on the attributes of gender representation: the practices and tasks these characters are performing in their representations.

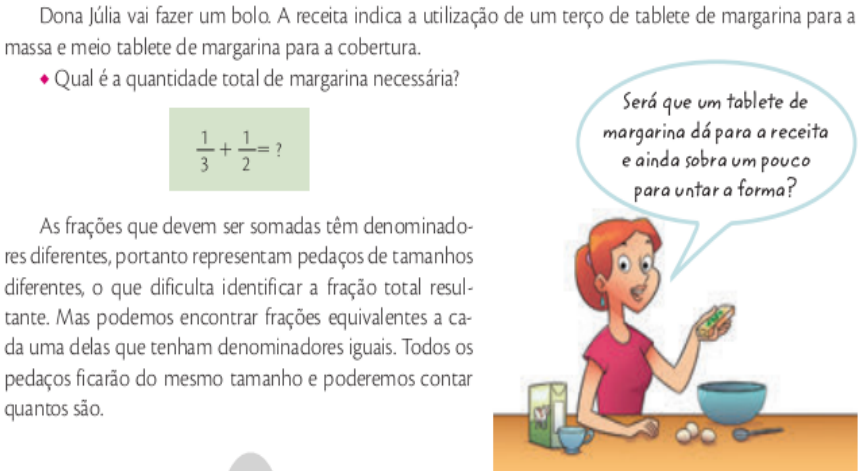
For example, concerning professional activities, we have identified 24 types of careers for boys/men. Some of them are farmers, TV presenters, astronomers, singers, managers, drivers, salespeople, fishers, doctors, teachers, mathematicians, and other activities strongly linked to paid work and, sometimes, stimulating / challenging jobs. As shown in Figure 1 below, a group of entrepreneurs is deciding how to share the profits. In this specific case, they needed sufficient understanding of the percentage to make an efficient decision. To know how much money each man will receive, they need to perform some arithmetic operations.

Translation

6. The manager of a company received the task to share a prize of R$12,000.00 among three employees, according to the efficiency of each employee. If one of them received 20% of the prize and the other received 55%, how many Brazilian Reals did the third employee receive?

Figure 1: Andrini; Vasconcelos (2015, p. 237)

On the other hand, girls/women were often represented as seamstresses, school principals, journalists, doctors, teachers, salespeople, and secretaries. They were also responsible for running the house, including food purchases. In addition, all (100%) of the activities that required a character to cook were represented by girls/women. An example of this recurrence can be seen in Figure 2, in which Julia needs to know fraction concepts to calculate the amount of butter needed for her recipe.


Dona Júlia vai fazer um bolo. A receita indica a utilização de um terço de tablete de margarina para a massa e meio tablete de margarina para a cobertura.

- Qual é a quantidade total de margarina necessária?

$\frac{1}{3} + \frac{1}{2} = ?$

As frações que devem ser somadas têm denominadores diferentes, portanto representam pedaços de tamanhos diferentes, o que dificulta identificar a fração total resultante. Mas podemos encontrar frações equivalentes a cada uma delas que tenham denominadores iguais. Todos os pedaços ficarão do mesmo tamanho e poderemos contar quantos são.

Translation

Ms. Julia will make a cake. The recipe indicates a third of a butter stick to the dough and half of a butter stick to the topping. What is the total necessary butter to make this recipe?

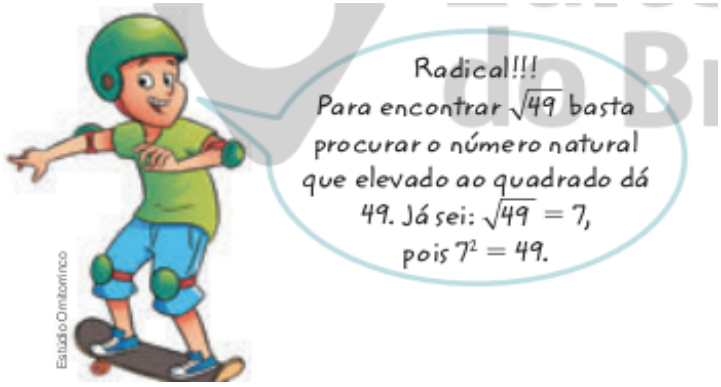
Figure 2: Andrini; Vasconcelos (2015, p. 192)

This result should not be surprising; after all, in our society, domestic work is still considered an activity of a fundamentally female nature (ROMITO, 1997); however, this means that domestic work is still ignored in society, hiding its physical and social costs. After all, "domestic work is understood as part of being a woman" (HILLESHEIM, 2004, p. 46); it is considered something that would complete the fundamental essence of being a woman, and this ends up being splashed in mathematics textbooks in Brazil. Domestic activities relegated to men, however, have a different nature from those of women. According to Hillesheim (2004), these tasks would have an intrinsic component of virility associated with them. A type of work considered "heavier" and, thus, would emphatically mark the sexual division of domestic work.

Therefore, it is possible to conclude that the stereotyped attributes of gender are reinforced by the Brazilian textbook in relation to the social division of labor. Boys/men were

represented occupying various professions related to leadership, science, and entrepreneurship, in general socially valued occupations. Most professions were strongly linked to business practices through neoliberal rationality. In contrast, girls/women are shown to be kind, caring, and passive concerning their professions (usually doing housework).

Another important result to highlight is related to sports practices. Boys/men appeared practicing different types of sports throughout this book, eventually to contextualize some mathematical content as can be seen in Figure 3, in which the adventurous boy plays with his skateboard, super radical!:



Translation

"Super cool! To find the root square of 49, you just need to find the natural number that when squared is equal to 49. I got this: $\sqrt{49} = 7$, because $7^2 = 49$."

Figure 3: Andrini; Vasconcelos (2015, p. 84)

Meanwhile, concerning sports, girls/women have been represented at most as going for a walk. Another point worth mentioning is that boys/men appear to play sports in the same proportion as girls/women appear in shopping activities, mainly purchasing shoes, clothes, accessories, etc.

56. Viviane tem R$ 185,00 para fazer compras. Das coisas que viu, ela decidiu comprar:

- 2 pares de sapatos por R$ 68,00 cada um;
- 1 camiseta por R$ 14,00;
- 5 pares de meias por R$ 3,00 cada um.

Escreva e resolva a expressão numérica que indica quanto dinheiro sobrou. $185 - (2 \cdot 68 + 14 + 5 \cdot 3) = 20$

Renaldo Rosa

Translation

56. Viviane has R$185.00 to buy clothes. From the things she saw, she decided to buy:

- 2 Pairs of shoes, R$68.00 each;
- 1 t-shirt, R$14.00;
- 5 pairs of socks, R$3.00 each.

Write and solve the numerical expression that indicates how much Money Viviane still has left.

Figure 4: Andrini; Vasconcelos (2015, p. 65)

It is important to note that, as shown in figure 4, to make their purchases of clothing and accessories, they need to know mathematics. However, still, they perform activities very different from those that boys perform.

Thus, it is evident that the analyzed Brazilian textbook replicated a series of gender stereotypes, not contributing to overcoming problems announced by several international calls (UNESCO, 2018).

United States

In the US American textbook, the division of gender was clearly marked by subtle stereotypes along the lines of the textbook. From a binary point of view, gender was represented in a relatively similar way. There were 230 mentions of girls/women compared to 210 of boys/men. In these citations, names, pronouns, or nouns identified by gender, such as father or mother, were the unit of analysis. Some of these quotes were accompanied by photos, which in this article were counted as separate units. A total of 74 images portrayed boys/men in contrast to 57 depicting girls/women. Therefore, while browsing through the book, male representation is more often perceived.

Regarding the professions mentioned throughout the textbook, there was a notable difference. At the end of each chapter, a 21st Century Career plan was presented to students, along with an image that represented a specific gender. The careers offered were Cosmetic Chemistry (woman), Special Effects Animator (man), Sports Equipment Designer (man), Pastry Chef (man), and Scientific Illustrator in Natural History Art (woman), so it was possible to conclude that the scope of things that men can do was greater compared to women. Throughout the book, women have been treated primarily as artists who do things that "girls do," such as making bracelets, scrapbooks, or teaching. Men were represented as gardeners, athletes, chefs, teachers, musicians, entrepreneurs, builders, etc.

Ultimately, one of the aspects perceived in this textbook is how the concept of boys/men and girls/women were arranged throughout the book concerning "mathematical knowledge / doing." For example, the HOT (Higher Order Thinking) problems affirmed this way of thinking.

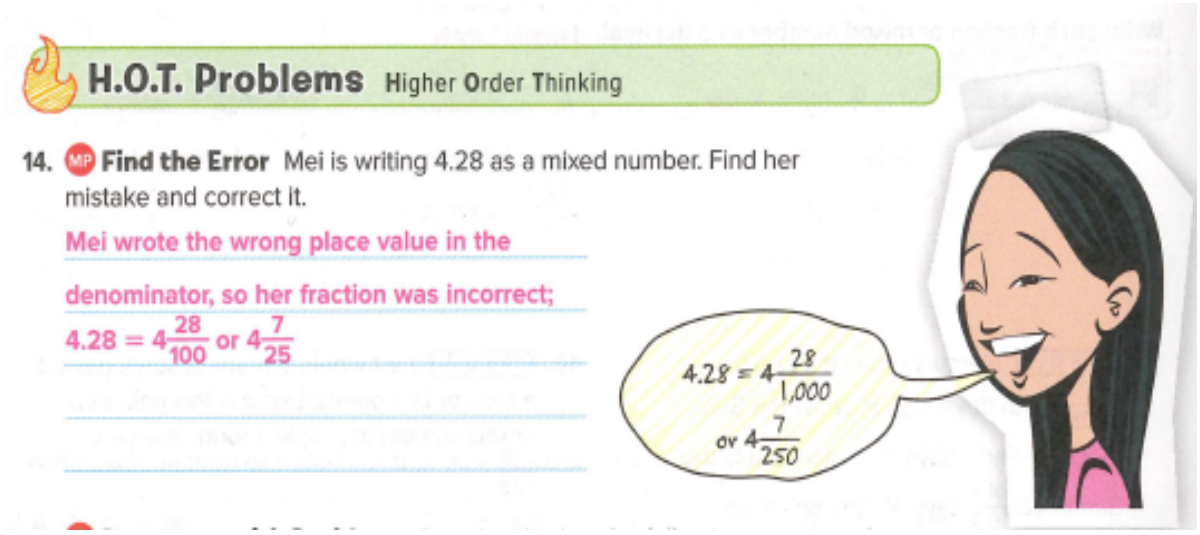


Figure 5. Carter et al.(2015, p.94)

Most of these HOT problems portrayed a student trying to solve a mathematical problem without success. One of the sub-questions in a HOT problem was to find the student's error and correct it. Of the ten times that a HOT problem refers to finding a student's mistake, seven times were mistakes made by girls/women, which influences how we think about the girls/women who make more mistakes in mathematics when compared to boys/men. Throughout the book, an attempt to balance gender representation is clearly observed, but the book fails to show equitably that both genders make mistakes in mathematics. This lack of equitable representation of errors leads us to a biased creation of gender subjects, as can be reinforced in the following two activities shown in figure 6.

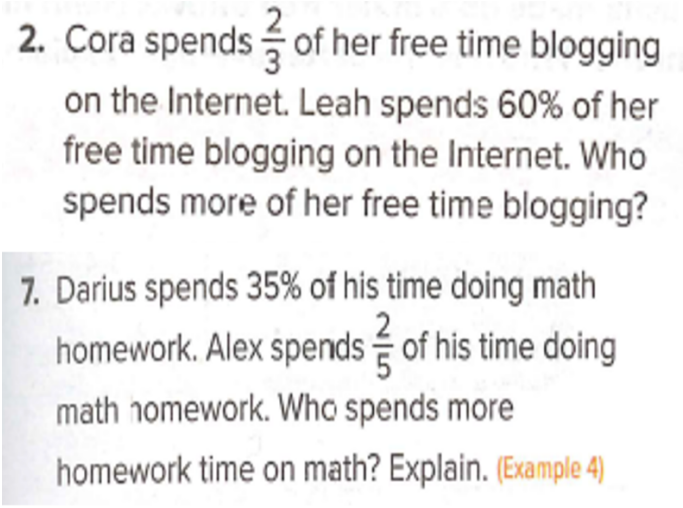


Figure 6: Carter et al. (2015, pp.132-133)

As throughout the book, the activities above reinforce that boys are more dedicated to their engagement with mathematical knowledge/doing. At the same time, girls are more likely to not engage in the same way.

Another relevant fact is that, repeatedly, boys/men were always willing to lead the conversation, while girls/women were displayed in the background serving boys/men.

Final Considerations

Based on the interest of both authors to compare the research they have been doing in Brazil and the US, this research concluded that, in both textbooks, there was a specific social belief implicit in the different genders displayed throughout the material. Boys/men represented in these textbooks still carry the ideas of a patriarchal performative society, in which men are strongly related to the ideas of power. At the same time, women are left in the background and are seen as "the supporting being." Particularly, in the US textbook, girls/women are generally described below average in "doing/knowing math" compared to boys/men. A similar situation occurs in the Brazilian textbook with the inclusion of women, often being represented in less socially valued and less challenging work activities.

In summary, the US American textbook seems to present a slightly greater concern in distributing the characters according to gender in a more equitable way, which does not

happen in the Brazilian material. However, this is not enough to escape the gender stereotypes present in the works, as demonstrated.

In the same vein, our analysis shows evidence of the need to continue to deepen investigations with this focus to challenge gender inequalities in all spheres of society, including in mathematics textbooks.

Therefore, from the analysis of the two textbooks from two very different countries, it is possible to conclude that mathematical knowledge and morality are articulated and end up teaching many things. The combination of these two elements, it seems, enhances the teaching of values because, socially, they are ignored in the face of what is necessary and, hypothetically, neutral, mathematical knowledge. In this sense, mathematics apparently continues to operate as a neutral discipline, which naively teaches children to count and measure, among other activities considered essential to the exercise of citizenship today. With this article, we hope to have shown that mathematics is not neutral, no matter where we are. This knowledge even seems to be a powerful instrument that reproduces stereotypes that must be challenged and deconstructed with the utmost urgency. We hope that this article will help us rethink mathematics as a cultural policy today.

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