

Brazilian High School Mathematics Textbooks and the Constitution of the Good Student Citizen

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ABSTRACT

In this paper, we present some of the results of a research project, which aims to analyse the framing for constitution of students as subjects that is put forward in mathematics textbooks. Two themes contained in Brazilian high school Mathematics textbooks were analysed to achieve the proposed intention: financial mathematics and interdisciplinarity. The five statements were elaborated by using the discourse analysis in a Foucauldian perspective; they show that the teaching proposed by textbooks goes beyond mathematics, normalizing the students' conducts.

Keywords: Mathematics Education. Mathematics Textbooks. High School. Discourse Analysis.

Livros Didáticos de Matemática do Ensino Médio Brasileiro e a Constituição do Bom Cidadão Estudantil

RESUMO

Neste artigo, apresentamos alguns dos resultados de um projeto de pesquisa, cujo objetivo é analisar o enquadramento para a constituição de estudantes como sujeitos que são propostos em livros didáticos de matemática. Dois temas contidos nos livros didáticos de matemática do ensino médio foram analisados para alcançar a intenção proposta: matemática financeira e interdisciplinaridade. As cinco afirmações foram elaboradas utilizando a análise do discurso de uma perspectiva foucaultiana; eles mostram que o ensino proposto pelos livros didáticos vai além da matemática, normalizando as condutas dos alunos.

Palavras-chave: Educação Matemática. Livros de matemática. Ensino Médio. Análise do discurso.

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INTRODUCTION

Mathematics textbook analysis has recently boomed as an area of research given the significance of the textbook as an element that translates the curriculum and guides teaching and learning (Fan et al., 2013). In socio-cultural-political studies of mathematics education, the textbook has been an object for studying not only the social images of school mathematics and the myths produced around it (e.g., Dowling, 1998), but also how different types of students are positioned thus making available different images for student's identity in relation to economic and nationalist agendas (e.g., Doğan & Haser, 2014). From the perspective of the *cultural politics of mathematics education* (Valero, 2017, 2018), textbooks are conceived as important technologies of power, through which ideals of the desired mathematically competent student are put forward. In these ideals, characteristics of the child as a citizen as well as of the child as a mathematics learner are articulated. Textbooks offer strong cultural theses about who the child is expected to become, "making legible and administrable the child as future citizen" (Popkewitz, 2004, p.5). These theses unfold in the meeting of the student with pedagogical practices, conducting the conduct of students towards becoming particular types of subjects. Of course, the presence of these theses in textbooks does not mean that all students will indeed be subjected in one way. However, these theses constitute a framing for what is possible to become as a mathematics learner and mathematically capable citizen. Therefore, the question that emerges when analysing textbooks from this perspective is how the mathematical contents and its pedagogy articulate certain notions of the good mathematical learner.

We present some of the results in the project "Discursive Networks in High School Mathematics Textbooks" (Silva, 2016), which aims at analysing the constitution of the student through the discursive network in mathematics textbooks. Textbook analysis helps us to understand the mechanisms that operate in the materiality of the textbooks and how they contribute to the fabrication of specific kinds of subjectivities in mathematics classrooms. In this paper, we examine the notions of mathematically competent student that emerge in textbooks when two quite current educational ideas in the curricular guidelines are made part of textbooks: the idea that learning *financial mathematics* is important for developing a sense of finances and economy; and the idea that *interdisciplinarity* is a key strategy to bring mathematics into context and thus promote meaning for students. Even though these are two different ideas that are set as distinct dimensions that the curriculum should use and contribute to, the analysis of textbooks allows to show their connection in the making of the mathematics learner in Brazil.

A FOUCAULTIAN TOOLBOX FOR TEXTBOOK ANALYSIS

For studying the main question of interest in this project, some of the tools of Michel Foucault have become useful. One of Foucault's interest was "to create a history of the different modes by which, in our culture, human beings are made subjects" (Foucault,

1982, pp.208). He wanted to understand how discourses produce specific kinds of subjects and how forms of knowledge (including mathematics) influence ways of living in the world, through mechanisms of oppression that normalize practices and lead to a very specific form of being ‘man’ (Walshaw, 2016) – or, in more general terms, being a subject. In mathematics education, the adoption of Foucaultian tools has contributed to what Planas and Valero (2016) call the socio-cultural-political axis that has emerged in the last 10 years of research in PME, and in general to new critical and political studies of mathematics education (e.g., Kolloosche, 2016). Stinson and Walshaw (2017, p.1412) emphasized the importance of such type of approach in mathematics education, because “such a perspective refutes closure and keeps the possibilities for mathematics teaching and learning open to multiple and uncertain interpretations and analyses”.

Foucault’s toolbox allows to articulate theory and methodology in a way that leaves to the researcher the possibility of building analytical forms of working with empirical materials. For the analysis of textbooks, the theoretical/methodological strategy that we have articulated based on Foucault is tracing the elements of textbooks that, when repeated systematically, articulate descriptions and narratives about financial mathematics and interdisciplinarity as part of mathematics education. Furthermore, the textbooks offer narratives about how these elements are to be incorporated in children’s actions and forms of being a teacher and student in mathematics classes. Pedagogical intentions and ideas articulate moralities with mathematical contents generating very concrete statements about what and how is to be known in order to be considered a good, competent mathematics learner. The articulations of these statements are to be found in discourse.

Foucault’s notion of discourse (Foucault, 1972, p.48-49) “is not a slender surface of contact, or confrontation, between a reality and a language (langue), the intrication of a lexicon and an experience”. Rather, it is “a group of rules proper to discursive practice. These rules define not the dumb existence of a reality, nor the canonical use of a vocabulary, but the ordering of objects.” Therefore, analysing discourse is about recognizing “practices that systematically form the objects of which they speak”. To make visible the discourse that emerges in mathematics textbooks, we use the concept of *statement*, which is “a seed that appears on the surface of a tissue of which it is the constituent element. The atom of discourse” (Foucault, 1972, p.80). Statements have four characteristics: A referent, a subject, an associated field, and a specific materiality for dealing with things actually expressed. These are repeated and reproduced, and are activated through techniques, practices and social relations (Fischer, 2001, p.202).

In the next section, we will enter into the analysis of the statements that navigate in the textbooks concerning financial mathematics and interdisciplinarity.

RESEARCH CONTEXT AND ANALYSIS

The Brazilian National Textbook Program (BNTP) makes a call for the production of textbooks. Proposals from different authors in publishing houses are examined and

evaluated according to criteria for quality textbooks in each subject. Since in Brazil there is no national curricular guidelines, these criteria define many elements of the factual mathematics curriculum. High school textbooks assessments occur every three years. If a proposal is approved, the Federal government guarantees the distribution of the textbook to all Brazilian public schools. Teachers receive a books summary (Brazil, 2014) so they can choose which collection they want to use in their classes. All the students in the country receive the collection chosen by their teacher. There is a large public investment in textbooks. In 2015, approximately 7.5 million high school books were bought and distributed by the government (Brazil, 2017). This is a lucrative business; therefore, it is important to produce high quality textbooks. Publishers and authors make a big effort to have their textbooks approved. This involves at least two things: (i) writing textbooks that fall within the criteria of the BNTP, and (ii) producing textbooks with a language that is attractive to the teachers, so that teachers choose a given collection.

The BNTP and the resulting textbooks are key elements in the governing of education, since they translate the curricular intentions in the curricular guidelines into organized structures for the teaching and learning of the school subjects. Given this context, analysing the mathematics textbooks is equivalent to analyse the current, common or most acceptable discourse about mathematics education since these are the materials that guide classroom practices in the country. In other words, these textbooks represent the “order of discourse” for the current mathematics teaching and learning in Brazil.

The corpus of the analysis for the overall project is the six textbook collections approved by BNTP in 2015. Each collection contains three textbooks, each one for a high school year. Eighteen books in total have been analysed. The analysis of financial mathematics was performed in the master’s thesis of Camila Coradetti (2017), and the analysis of interdisciplinarity was carried out in the master’s thesis of Ludiane Berto (2017). Deise Souza carried out an analysis of gender. These analyses are all part of the project. In this paper, we build on the results presented in the theses of Camilla and Ludiane, which contributed to the understanding of the overall problem of the research project. In other publications, there are details of the analysis of gender (Souza & Silva, 2017, 2018).

In general terms, an analysis of the discourse in the eighteen books were carried out by first, identifying the enunciations concerning different aspects such as financial mathematics or interdisciplinarity. First, the eighteen books were analyzed to find chapters on financial mathematics and special activities, projects or sections in which interdisciplinarity was present. Afterwards, the figures, contextualizations and activities were analyzed, seeking to explain which values and which morality was taught together with the mathematical contents. As Foucault proposed, the discursive regularities were described by means of statements.

In what follows, we will focus on how the notions of learners appear entangled in the discourses around financial mathematics and interdisciplinarity.

THE CAPITALIST CONSUMING LEARNER

In the 6 textbook collections, there appears a specific chapter called “Financial Mathematics”. The emergence of this particular element within the discursive network of the textbooks is related to the criterion of the BNTP to offer contextualization for mathematics that connect to everyday practices and social phenomena of relevance for the population (Brazil, 2014).

The Figure 1 introduces financial mathematics with a situation of buying a Smartphone that costs R\$ 1299, to be paid in 1 or 12 equal payments. The buyer thinks that she already has saved R\$ 200. The book announces that “the knowledge of simple financial operations such as loans, financing, discounts, interest rates and investment income are of great importance for a full citizenship”. Some of the elements in this presentation – costs, savings, credit, consumption and citizenship are found in many exercises in the books.



Figure 1. Introduction to financial mathematics (Leonardo, 2013, p.8).

Here (Figure 2) an explanation about savings provided in terms of possibilities for future consumption. The idea of consuming without surpassing the income appears repetitively. The situation of credit is presented: “The issue is not between buying or not buying, but between getting the merchandise paying for credit and interests, or buying with a discount in the future”. The problem continues with a situation of buying a LED TV with different forms of credit.

75. Poupar é adiar o consumo no momento presente, a fim de consumir mais no futuro. Tal ação garante um acúmulo de reservas a serem utilizadas posteriormente e um consumo que não ultrapasse a renda.

Contudo, as pessoas costumam poupar e investir pouco. Na prática, quando se compra a prazo, paga-se muito mais pelo produto, porque existem acréscimos de juro e outros custos adicionais. Comprando à vista, essas despesas são evitadas, o que deixa o produto mais barato.

A questão não está entre comprar e não comprar, mas entre receber a mercadoria pagando prestações e juro, ou poupar e comprar a mercadoria com desconto no futuro.

Figure 2. Buying electronic equipment (Souza, 2013, p.83, v.2).

“Financial planning” is a concept found in an activity that proposes the elaboration of a spreadsheet for the control of a family’s finances. Finances are compared to health: Taking care of finances is like taking care of health and being happy. “It may seem simple, but it requires planning and caution” (Leonardo, 2013, p.23). The activity asks children in groups to make a budget of income and expenses for a family.



Figure 3. Happy and healthy families in “financial planning” (Leonardo, 2013, p.23).

The analysis showed that there many activities had two options for the student to make the best choice, without a discussion about the need to carry out such consumption.

Even when there was guidance on the importance of saving money, the goal of accumulating funds was almost always to buy something in the future. For instance: “saving is delaying consumption at the present time in order to consume more in the future” (Souza, 2013, p.83) and “buying a car, owning the house or carrying out the dream trip are achievements that usually require a lot of work and investment time” (Souza, 2013, p.58). The action of consuming is part of becoming a citizen. This is present in explicit formulations about responsibility and the justification for the importance of paying taxes and the existence of tax systems. In addition, there are explanations about the national financial system and the importance of consuming products to activate the economy, generate jobs, and contributing to the country’s economic growth.

In the textbooks, there is an articulation of tasks in which mathematical contexts and procedures are to be performed, images that appeal to consumption of electronic devices and other products of importance to the consumer and to a modern society, and moral rules about being a caring, responsible and happy citizen individually and in the family. There are three statements that circulate in the textbooks concerning financial mathematics: (i) it is necessary to instruct for good decision-making, (ii) investment and savings are practices for capital accumulation, (iii) and citizenship is linked to consumer training.

THE CARING LEARNER

In the evaluation guidelines of the BNTP a criterion is interdisciplinarity. Therefore, this element appears explicitly in almost each section and topic in textbooks. In some problems, there is the mention to the disciplines within which mathematics is applied. Justifications about the importance of interdisciplinarity are explicitly connected to citizenship. Mathematics as a tool to solve problems and make models in the situations of the problems are strongly connected to moral rules about what is good and desirable as both a mathematical behaviour and a behaviour of the person.

There are interdisciplinary activities with geography, biology, chemistry and other disciplines in the curriculum. In this one, the sustainable use of water is the focus (Figure 4). Information about the use of water is presented in volume of water or use of volume of water per unit of time. “Not to leave the faucet leaking avoids a water waste of approximately 50 lt. of water per day”. The following images not only indicate amounts of water use but also bring recommendations of behavior such as “avoid long showers”, “using a bucket” for washing the car instead of a hose.



Figure 4. Context section “water consumption” (Souza, 2013, p.62, v.1).

In other types of activities topics such as obesity appear a similar entanglement between explanations of the subject – how fat tissues are built in the body –, with mathematical models and calculations – calculation of corporal mass index and the understanding of “normal weight, under-weight and overweight –, and moral instruction on keeping a healthy weight through the regulation of consumption and burning of fat.

CONTEXTO Gasolina e etanol

23. No Brasil, a gasolina utilizada nos automóveis, na verdade, é resultante da mistura de gasolina e etanol anidro combustível. Nos últimos anos, a parte correspondente ao etanol variou algumas vezes entre 20% e 25%. Contudo, é comum termos notícias de postos que adulteram a gasolina acrescentando mais etanol que o permitido. A utilização de gasolina adulterada pode trazer diversos malefícios ao veículo, como a danificação de componentes do motor, a perda de potência e o aumento no consumo.

A verificação da qualidade dos combustíveis é feita por meio de testes específicos a partir de normas estabelecidas pela ANP (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis) e pode ser realizada em laboratórios credenciados. Porém, no caso da gasolina, é direito do consumidor, ao abastecer seu veículo, exigir do estabelecimento que seja feito o “teste de proveta”, para identificar se a proporção de etanol misturado à gasolina está correta. Outro fator importante no momento do abastecimento é pedir a nota fiscal e procurar utilizar sempre o mesmo posto, pois, caso ocorra algum problema devido à má qualidade do combustível, fica mais fácil tomar as providências cabíveis.

Figure 5. Context section “gasoline and ethanol” (Souza, 2013, p.121, v.3).

In other types of exercises with chemistry, the composition of gasoline in Brazil is discussed (Figure 5). Gasoline quality control and how consumers should pay attention to the gasoline they use in their vehicles is discussed: “be a good consumer and do not be fooled” is part of the explanation of the importance of mathematics and chemistry in conducting a test to know the amount of ethanol in gasoline.

Body care activities have also been found as orientations for food education, associated to incentives for the practice of physical exercises, through explanations that value the importance of certain habits to build a healthier life. In other words, it became evident the articulation of mathematics to morals about the good life of citizens.

As a result of the overall analysis, two main statements that circulate in the textbooks concerning interdisciplinarity and students are: (i) interdisciplinarity contributes to the formation of conscious and politically correct citizen-consumers, and (ii) interdisciplinarity is fundamental to for being able to take care of the self, of the other and of the environment.

CONCLUDING REMARKS

So, what have we found in the textbooks? We have found a lot of mathematical activities that constitute a kind of manual for citizenship and morality. Among other things, there is a set of rules that constitute a condition of existence that standardizes and normalizes ways of life. School mathematics is a tool through which the child can acquire concepts, and do calculations while becoming also better citizens. The analyses have showed that there are many characteristics and that the teaching proposed by textbooks goes beyond mathematics, normalizing conducting the conduct of the students.

The students have to be good capitalist consumers to be good citizens and they are supposed to understand the importance of caring form themselves and for others. In this sense, the mathematics curriculum is a powerful instrument to govern people, so the instructions in textbooks operate a process of subjectivation in line with what the government has already explored to regulate actions to maintain order and progress. The mathematics curriculum and mathematics learning, as shown in these textbooks, is not only about mathematics; it is about politics, culture, and power.

REFERENCES

- Berto, L. F. (2017). *Enunciados sobre interdisciplinaridade em livros didáticos de matemática do ensino médio* (Master’s thesis). Federal University of Mato Grosso do Sul, Campo Grande, Brazil.
- Brazil (2014). *Guia de livros didáticos: PNLD 2015 – matemática – ensino médio*. Brasília: Ministério da Educação, Secretaria de Educação Básica.
- Brazil (2017, December 11) Fundo Nacional de Desenvolvimento da Educação. *Dados estatísticos do PNLD*. Retrieved from: <http://www.fnde.gov.br/programas/livrodidatico/livro-didatico-dados-estatisticos>

- Coradetti, C. A. L. M. (2017). *Um olhar contemporâneo para a matemática financeira presente nos livros didáticos do ensino médio* (Master's thesis). Federal University of Mato Grosso do Sul, Campo Grande, Brazil.
- Doğan, O., & Haser, Ç. (2014). Neoliberal and nationalist discourses in Turkish elementary mathematics education. *ZDM*, 46(7), 1-11. doi:10.1007/s11858-014-0605-z
- Dowling, P. (1998). *The sociology of mathematics education: Mathematical myths, pedagogic texts*. London: Falmer Press.
- Fan, L., Zhu, Y., & Miao, Z. (2013). Textbook research in mathematics education: development status and directions. *ZDM*, 45(5), 633-646. doi:10.1007/s11858-013-0539-x
- Fischer, R. M. B. (2001). Foucault e a análise do discurso em educação. *Cadernos de Pesquisa*, (114), 197-223.
- Foucault, M. (1972). *The archaeology of knowledge*. New York: Pantheon Books.
- Foucault, M. (1982). The Subject and the Power. In H. L. Dreyfus & P. Rabinow (Eds.). *Michel Foucault: Beyond structuralism and hermeneutics* (pp.208-226). Chicago: University of Chicago Press.
- Kollosche, D. (2016). Criticising with Foucault: towards a guiding framework for socio-political studies in mathematics education. *Educational Studies in Mathematics*, 91(1), 73-86. doi:10.1007/s10649-015-9648-5.
- Leonardo, F. M. (2013). *Conexões com a Matemática* (2nd ed., Vol. 3). São Paulo: Editora Moderna.
- Planas, N., & Valero, P. (2016). Tracing the Socio-Cultural-Political Axis in Understanding Mathematics Education. In A. Gutiérrez, G. C. Leder & P. Boero (Eds.), *The Second Handbook of Research on the Psychology of Mathematics Education. The Journey Continues* (pp.447-479). Rotterdam: Sense Publishers
- Popkewitz, T. (2004). The Alchemy of the Mathematics Curriculum: Inscriptions and the Fabrication of the Child. *American Educational Research Journal*, 41(1), 3-34.
- Silva, M. A. (2016). Investigações Envolvendo Livros Didáticos de Matemática do Ensino Médio: a trajetória de um grupo de pesquisa. *Jornal Internacional de Estudos em Educação Matemática*, 9(3), 36-54.
- Souza, D. M. X. de B., & Silva, M. A. (2017). Questões de gênero no currículo de matemática: atividades do livro didático. *Educação Matemática Pesquisa*, 19(3), 374-392. <https://doi.org/10.23925/1983-3156.2017v19i3p374-392>.
- Souza, D. M. X. de B., & Silva, M. A. (2018). O dispositivo pedagógico do currículo-brinquedo de matemática, marcado pela dimensão de gênero, na produção de subjetividades. *Reflexão e Ação*, 26(2), 149-164. <https://doi.org/10.17058/rea.v26i2.11747>.
- Souza, J. R. *Novo olhar matemática* (2nd ed., Vol. 1 and 2). São Paulo: FTD.
- Stinson, D. W., & Walshaw, M. (2017). "Theory at the crossroads": Mapping moments of mathematics education research onto paradigms of inquiry. In E. Galindo & J. Newton (Eds.), *Proceedings of the 39th PME-NA* (pp.1407-1414). Indianapolis: Hoosier Association of Mathematics Teachers Educators.
- Valero, P. (2017). Mathematics for all, economic growth, and the making of the citizen-worker. In T. S. Popkewitz, J. Diaz y C. Kirchgasser (Eds.). *A political sociology of*

educational knowledge: Studies of ex-clusions and difference (pp.117-132). New York: Routledge.

Valero, P. (2018). Capital humano: o currículo de matemática escolar e a fabricação do homus oeconomicus neoliberal. In E. V. Godoy, M. A. Silva y V. M. Santos (Eds.). *Currículos de matemática em debate: questões para políticas educacionais e para a pesquisa em Educação Matemática* (pp.43-68). São Paulo: Livraria da Física.

Walshaw, M. (2016). Michel Foucault. In E. De Freitas & M. Walshaw (Eds.). *Alternative theoretical frameworks for mathematics education research: Theory meets data*. Springer.