

# Neglected Diseases in Brazilian Biology Textbooks

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**Abstract** According to epidemiological and economic relevance, either by direct or indirect cost, six neglected diseases (ND) were elected by the Brazilian government as major research problems: dengue, tuberculosis, leprosy, malaria, leishmaniasis and Chagas disease. These diseases are presented in Brazilian schools basically with the help of textbooks that are evaluated, acquired and distributed freely in public schools by the National Textbook Program (PNLD). Thus, we investigated how these six diseases and their structural concepts were presented in the biology textbooks approved by PNLD 2012/13/14. The six selected diseases were found in almost every collection approved in the PNLD 2012/13/14, exceptions being tuberculosis and leprosy, and we found 30 problems out of 144 insertions. In this sense, we emphasize the need more rigorous evaluation processes in the textbooks so that the content can be understood as potentially significant material.

**Keywords:** *neglected diseases, textbooks, meaningful learning, structural concepts*

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## 1. Introduction

Brazil has the largest number of cases and the highest disease burden related to neglected diseases in the Latin American and Caribbean region [1] and this problem should be a matter of debate and study in high schools. The term neglected diseases (ND) was proposed in the 1970s by the program "the Great Neglected Diseases" of the Rockefeller Foundation, coordinated by Kenneth Warren [2]. This terminology refers to a group of diseases caused by parasitic and infectious agents (viruses, bacteria, protozoa and helminths) that are endemic in low-income countries, contributing to the maintenance of social inequality and representing an obstacle to the country development. They were named "neglected" due to the commercial disinterest of pharmaceutical industries. In Brazil some of diseases considered neglected are dengue, Chagas disease, schistosomiasis, leprosy, leishmaniasis, malaria, tuberculosis [3,4].

According to epidemiological and economic relevance [1], six ND were elected by the Brazilian government as major problems for research [5], i.e., diseases with higher number of cases and high cost treatments for the government. They are Chagas disease, leishmaniasis, leprosy, malaria and tuberculosis. Dengue, despite its epidemiological and economic relevance differs from other diseases because it has a high indirect cost: its economic onus is associated with low productivity [6,7]. A study commissioned by the Ministry of Health (MS) reported in 2013 that data from 2008 in the Department of Informatics of the Brazilian National Health System (DATASUS) indicated that ND accounted for 1.0% of the total disease burden estimated for all of Brazil, but with

great heterogeneity among the various regions of the country (Table 1) [8]. Disease burden is a measurable index of the impact of each disease on the health of the population and its indicator is the DALY (disability-adjusted-life-years) that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health. Thus, we investigated how these six diseases were presented in the high school textbooks used in Brazil.

Teachers in Brazil usually adopt oral classes and textbooks as their main educational resources to develop and present specific contents to their students [9,10]. From the 1930s, the Brazilian Ministry of Education and Culture (MEC) has implemented the use of textbook in schools [11], aiming to improve the quality of education and the level of contents, as well as enabling free access to books by students. The National Textbook Program (PNLD) was created in 1985 allowing the governmental acquisition and free distribution of textbooks to the public elementary schools [12]. The distribution of textbooks for public high schools began with the creation of the PNLD for High School, through Resolution 38 of October 15th 2003 [13]. Since 2010 PNLD is regulated by a specific law (7.084/2010) that established the process of evaluating the books to improve the quality of the content presented in these textbooks [14].

PNLD evaluates the technical-editorial and educational aspects of textbooks. Technical-editorial evaluation is conducted by the Institute of Technological Research of the University of São Paulo, and educational evaluation is made by a team of teachers who work in higher education and basic education in the country. In educational evaluation each collection (organized in three volumes) is sent to two referees and when necessary for specialists of biology knowledge areas, without identifying the author

and the publisher. Evaluation is made using a form with the following criteria: respect to the law and the construction of citizenship; coherence and methodological adequacy; adequacy of the graphic-publishing project; correction of concepts, information and procedures; teacher's manual. After evaluating the reviewers prepare a consolidated document. At last the coordinators make the review of all documents [15]. PNLD 2012/13/14 approved eight of the sixteen evaluated collections, and the educational proposals of books indicate a constructivist perspective, especially the theory of meaningful learning and concept maps.

The theory of meaningful learning proposed by Ausubel [16,17] proposes that the construction of new knowledge depends on the interaction of prior knowledge / subsumer with a potentially significant material. In order for a significant learning to occur, the presented content needs to establish a relationship with the pre-existing knowledge so that this interaction motivates students' interest in perceiving and creating new meanings. Successive interactions confer new meanings to a prior understanding serving to anchor new significant learnings. This prior knowledge may correspond to scientific concepts present in the cognitive structure of the learner. This demonstrates the importance of the mapping of key/central/structural concepts in the curriculum content that may facilitate the teaching-learning process. The use of central concepts is also supported by Raul Gagliardi [18]. He proposes that these structural concepts allow the transformation of the cognitive system, leading the learner to acquire new knowledge and to modify others previously built.

In this framework we search to identify the structural concepts related to six ND in textbooks approved by PNLD 2012/13/14. We aim to contribute to learning of infectious diseases and the evaluation process of the textbooks.

## 2. Methods

Throughout our study, the collections were indicated by their respective codes used by MEC, to preserve the identity of authors and publishers. We verified that all collections included topics of infectious and parasitic diseases that could be classified as ND. We then chose to

study in these 8 collections the frequency of texts related to six ND: malaria, leishmaniasis, Chagas disease, dengue, tuberculosis and leprosy. Among all other diseases that are discussed in the books, these six ND are the most relevant concerning epidemiological and economic aspects in Brazil [5], and their important character associated to emergence/reemergence in the country's sanitary scene has also to be taken into consideration.

We read integrally all contents of the books, identifying all pages containing any reference to selected diseases, noting the presence and absence of specific structural concepts in each collection. Etiologic agent, route of transmission, life cycle and geographic distribution were selected as examples for common structural concepts related to infectious diseases. Social determinants for ND were rarely mentioned in the textbooks. The criteria used to analyze the arrangement of the contents in the textbooks were: textual inaccuracy - wrong informations identified in the text after comparing the biology textbooks with a gold standard reference (book/guide national or international); irrelevance of images - images difficult to understand or inaccurate; and absence of images - lack of images in all content related to the disease. These criteria are in accordance with the common criteria of PNLD 2012/13/14 (adequacy of the graphic-publishing project and correction of concepts) [15].

## 3. Results and Discussion

The six selected diseases were found in almost every collection approved by the PNLD 2012/13/14 (Table 2). Exceptions were tuberculosis, absent from one of the collections, and leprosy that was not present in two out of the eight collections (n/a in Table 2). Overall, collections that performed well in all three criteria, in each specific disease, got 19 positions in Table 2 (shown as "ok" in Table 2). Multiplying each of these positions by 3 (the number of criteria) they represented 57 "good" insertions in the books. However we found 30 problems (non-attained criteria) during analysis (shown as "a", "b", and "c" in Table 2), indicating partial failure of the general evaluation process conducted by MEC, at least in this context of ND. These "problems" are described in more detail below.

Table 1. DALY of ND in the regions of Brazil

Neglected Diseases	North		Northeast		Southeast		South		Midwest		Brazil	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%
<b>Group I - Neglected</b>	<b>30.730</b>	<b>100</b>	<b>126.139</b>	<b>100</b>	<b>113.300</b>	<b>100</b>	<b>51.414</b>	<b>100</b>	<b>32.807</b>	<b>100</b>	<b>354.390</b>	<b>100</b>
Tuberculosis (TB)	13.133	42.7	61.232	48.5	56.759	50.1	12.716	24.7	5.566	17.0	149.405	42.2
Chagas disease (ChD)	1.838	6.0	32.485	25.8	43.361	38.3	37.565	73.1	22.669	69.1	137.918	38.9
TB + ChD	14.971	48.7	93.717	74.3	100.120	88.4	50.281	97.8	28.235	86.1	287.323	81.1
Malaria (M)	8.252	26.9	642	0.5	148	0.1	51	0.1	213	0.6	9.306	2.6
TB + ChD + M	23.223	75.6	94.359	74.8	100.268	88.5	50.332	97.9	28.448	86.7	296.629	83.7
Dengue hemorrhagic fever (DHF)	2.116	6.9	7.312	5.8	4.192	3.7	78	0.2	1.608	4.9	15.306	4.3
Leprosy	2.518	8.2	6.201	4.9	2.934	2.6	852	1.7	1.676	5.1	14.180	4.0
Visceral leishmaniasis	2.256	7.3	8.311	6.6	2.127	1.9	21	0.0	724	2.2	13.439	3.8
Schistosomiasis	91	0.3	8.716	6.9	3.629	3.2	88	0.2	134	0.4	12.658	3.6
Cutaneous leishmaniasis	526	1.7	428	0.3	139	0.1	43	0.1	202	0.6	1.338	0.4

Adapted from ENSP/Fiocruz, 2013.

**Table 2. Content quality in the textbooks approved by the PNLD 2012/13/14 related to ND**

Textbook	Diseases					
	Dengue	Tuberculosis	Leprosy	Chagas disease	Leishmaniasis	Malaria
25027COL20	ok	c	c	b	ok	b
25028COL20	ok	c	c	a, b	ok	b
25031COL20	ok	c	c	ok	b	ok
25033COL20	b	ok	c	ok	c	b
25035COL20	b	c	c	ok	ok	ok
25036COL20	a	ok	c	b	ok	ok
25130COL20	ok	n/a	n/a	b	b	b
25168COL20	ok	b	n/a	ok	ok	b
problems found	3	6	8	5	3	5

# ok -compatible with PNLD; a-textual inaccuracy; b-irrelevance of images; c-absence of images; n/a-not available.

Textual inaccuracy was found only in two collections. (i) In the first, the authors affirm that "Who has had dengue, even under an asymptomatic form, or is carrier of a chronic illness such as diabetes, rheumatoid arthritis or lupus, may contract dengue haemorrhagic fever provoked by another type of virus" (25036COL20 p. 32). The author does not make it clear that the "other type of virus" mentioned is one of the four dengue serotypes (DENV-1, DENV-2, DENV-3, DENV-4), different from the one responsible for prior infection since dengue infection confers lifelong immunity against the specific infectious serotype. Secondary infection or multiple infections with different serotypes leads to severe forms of the disease, i.e., dengue hemorrhagic fever and dengue shock syndrome [19,20]. (ii) In another collection (25028COL20 p. 274), we identified an inaccuracy in the text commenting on Chagas disease, where the authors say "Unfortunately, this parasitic disease is still incurable." Chagas disease presents a parasitological cure of almost 100% when treated early in the acute phase [19, 21]. Thus, to mention the concept of cure for Chagas disease authors should define which criteria are being used to support such a affirmation.

Irrelevance of images appear in content related to dengue and tuberculosis. (i) In one collection, the poster of a combat dengue campaign is displayed next to the text with caption: "Forms of transmission of viral diseases" (25035COL20 p. 54). The image is merely illustrative, because the information transmitted by the poster is unreadable. (ii) Another collection (25033COL20 p. 36) presents the image of a violet vase with sand on the plant saucer as a dengue prevention strategy. This image is also merely illustrative because *Saintpaulias*, commonly known as African violets, is not a good example for the prevention of dengue. They are very sensitive to excess water and accumulation of water in the plant saucer causes root rot and kills the plant [22]. Nevertheless, the image, although irrelevant, may still serve as a warning. (iii) A third collection (25168COL20 p. 52) presents tuberculosis using an illustration next to the legend: "bacteria and disease", and that is the only image used to illustrate the tuberculosis content. However, the image can be confused with the diagnosis of other diseases, for example pneumonia.

Irrelevance of images is also found in the depiction of

the life cycle of protozoa. Among the problems found in the Plasmodium life cycle depiction are (i) the excess of arrows and cells in the drawing (25027COL20 p. 115, 25033COL20 p. 79); (ii) the use of Anopheles mosquito images for symbolizing the definitive and intermediate hosts and the absence of migration of sporozoites to the liver (25028COL20 p. 275); (iii) absence of invasion of hepatocytes and lack of precision in representing the infected red blood cells (25168COL20 p. 65); (iv) the absence of erythrocyte invasion by the parasite (25130COL20 p. 120). In the cycle of Leishmania (v) two collections (25031COL20 p. 74, 25130COL20 p. 125) illustrate only vertebrate and invertebrate hosts. With Chagas disease something similar occurred in one of the books. (vi) In the picture called "Chagas cycle" the author uses a drawing that shows only the transmission routes of the disease (25130COL20 p. 122). (vii) In another book the lack of coherence makes it difficult to read the *Trypanosoma cruzi* cycle (25027COL20 p. 109). (viii) Two other books (25028COL20 p. 274, 25036COL20 p. 65) describe practically all the cycle of *T. cruzi* through text boxes, underutilizing the potential of images as learning facilitators.

In relation to the absence of images, one collection had no illustrations of leishmaniasis and most of the collections had no images related to tuberculosis or leprosy (Table 2). After reading all the chapters in the textbooks approved by the PNLD 2012/13/14 mentioning the selected diseases we perceived a need for illustrations, particularly of scientific images that portray the reality (through optical and electron microscopy photography).

The most common structural concepts related to the selected ND in the textbooks were: etiologic agents, route of transmission, life cycle, symptoms, prevention and treatment (Table 3). We highlight that the concept of symptoms was present in practically all the books approved by the PNLD, in the texts of the six diseases. Due to the low frequency with which they appear in the books, host, diagnostics, reservoir and geographical distribution are not mentioned in the body of the table. The concept of the nature of infection (virus, bacteria, protozoa) is introduced to students in a unique context, in the titles of the book chapters, and for that reason not entered in the data below.

**Table 3. Presence of structural concepts of ND in textbooks approved by the PNLD 2012/13/14**

Textbooks	Structural concepts					
	Etiologic agents	Route of transmission	Life cycle	Symptoms	Prevention	Treatment
25027COL20	A	A	T,C,M	A	A	D,T,L,C,S
25028COL20	T,L,C,S,M	A	C,M	A	D,C,M	D,C
25031COL20	A	A	C,M	A	D,C,M	C,M
25033COL20	T,C,S,M	D,T,C,S,M	nd	A	D,T,C,M	D,L
25035COL20	A	A	T,C,M	A	A	D,T,L,C,M
25036COL20	T,L,C,S,M	D,C,S,M	C,S,M	A	D,T,C,S,M	A
25130COL20	D,C,S,M	D,C,S,M	C,S,M	C,S,M	D,C,S	S,M
25168COL20	D,T,C,S,M	D,T,C,S,M	T,C,M	D,T,C,S,M	D,T,C,S,M	T,C,M

# D-dengue; T-tuberculosis; L-leprosy; C-Chagas disease; S-leishmaniasis; M-malária; A-all diseases; nd-no disease.

Social determinants for ND were rarely mentioned in the textbooks, and only comments about income, culture, environmental conditions, housing and sanitation were introduced in the context of the presentation of each disease. (i) The income was cited in two books that addressed the neglected character of the selected diseases (25028COL20 p. 321, 25168COL20 p. 66). (ii) There were five books that touched upon the issue of culture, highlighting only the relationship between eating habits (the intake of sugar cane and açafá) and the contamination by *T. cruzi* (25027COL20 p. 109, 25028COL20 p. 275, 25031COL20 p. 70, 25033COL20 p. 78, 25130COL20 p. 123). (iii) Environmental conditions are cited in five books, always referring to the climatic conditions conducive to malaria cases (25027COL20 p. 114, 25028COL20 p. 275, 25031COL20 p. 76, 25036COL20 p. 67, 25168COL20 p. 65). (iv) The type of housing was mentioned in all the books, but seven of them described the relationship between the “kissing bug” and the wattle and daub houses (25027COL20 p. 108, 25028COL20 p. 274, 25031COL20 p. 70, 25033COL20 p. 78, 25035COL20 p. 95, 25036COL20 p. 65, 25130COL20 p. 121). (v) All the references to sanitation dealt with the vector control and these data were classified as prevention (Table 3), according to the same classification employed by the authors of the books analyzed in the present work.

## 4. Conclusion

The meaningful learning includes five commonplaces: the teacher, learner, content, context and evaluation [23]. Thus, the sharing of meanings [24], and the predisposition of the student to learn [23] should be considered due to the uniqueness of each student and teacher. However, the content of the ND is presented in Brazilian schools basically with the help of textbooks and the author only need classify the living beings to comply with the PNLD. The ND are included in the content without the program define which diseases and how their concepts should be presented in the books. In this sense, the absence of structural concepts, especially those associated to social determinants of each disease, represent a barrier to meaningful learning of ND.

The Brazilian textbooks of biology end up promoting a literal and decontextualized learning by disregarding the cultural, economic and social conditions of the students.

The significant potential attributed to the concepts depends on the relevance of the material to the students, i.e., on the relationship between the content and the context of the subject [23]. We then observed a new dimension of neglect, besides the low interest of the pharmaceutical industry: the low interest of the education system in including social determinants in education curriculum and textbooks.

The structural concepts presents in textbooks may facilitate the teaching-learning process and promote meaningful learning of the ND and the construction of meaning that can be used throughout life for learning new content related to the disease topics. To build new concepts the students need central concepts that act as organizers of biological knowledge [18]. Thus, we emphasize the need for more rigorous evaluation processes regarding the presentation of ND in the textbooks so that the content can be understood as potentially significant material, once Brazil stands out on the world in relation to the number of cases and disease burden. We hope that our results contribute to the debate about the content presented by textbooks concerning the ND and the learning on this subject, since students plays fundamental role in combating endemic diseases as multipliers of information in their families, and health education is one prevention and control measure recommended by MS.

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