

# Socio-Scientific Issues in Didactic Books of Elementary Science: What Are the Goals?

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## ABSTRACT

In this article, we discuss the approach and the objectives of Socio-Scientific Issues in the content of textbooks of Science in Elementary School II. Thus, we analyze the structure of the works and the objectives: i) relevance, ii) motivation; iii) communication and argumentation; iv) analysis and v) understanding. It is about a documentary research of a qualitative approach, the data were analyzed through the Discursive Textual Analysis of the authors Roque Moraes and Maria do Carmo Galiuzzi, published in 2007, by the publisher of UNIJUÍ/RS. It was possible to identify that the Socio-Scientific Aspects are present throughout the texts of the chapter and in extra sections, boxes and text boxes, contemplating different objectives. In this context, the objectives presented in the excerpts made it possible to identify the potentialities of the Socio-Scientific Aspects approaches in the process of critical formation of students, as well as, in the development of discussions about the impacts of science and technology in society.

**Keywords:** Science teaching; Didactic works; Science and technology.

## Aspectos Sociocientíficos nos Livros Didáticos de Ciências do Ensino Fundamental: Quais São os Objetivos?

### RESUMO

O artigo discute a abordagem e os objetivos dos chamados Aspectos Sociocientíficos – ASC no conteúdo dos livros didáticos de Ciências do Ensino Fundamental II. Desse modo, foi analisada a estrutura das obras e os objetivos: i) relevância, ii) motivação, iii) comunicação e argumentação, iv) análise e v) compreensão. Trata-se de uma pesquisa documental de abordagem qualitativa. Os dados foram analisados por meio da Análise Textual Discursiva dos autores Roque Moraes e Maria do Carmo Galiuzzi, obra publicada em 2007, pela editora da UNIJUÍ/RS. Foi possível identificar que os mencionados Aspectos Sociocientíficos estão presentes ao longo dos textos dos capítulos

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e em seções extras, boxes e caixas de textos, contemplando diferentes objetivos. Nesse âmbito, os objetivos apresentados nos excertos possibilitam identificar as potencialidades das abordagens dos Aspectos Sociocientíficos no processo de formação crítica dos estudantes, bem como, no desenvolvimento de discussões sobre os impactos da ciência e da tecnologia na sociedade.

**Palavras-chave:** Ensino de Ciências. Obras didáticas. Ciência e tecnologia.

## INTRODUCTION

Understanding the purposes of scientific teaching for the school subject of Sciences is key for making decisions. Santos (2007) points out that this education could be turned to a responsible social action when it aims to a comprehension of social implications of science and technology or the scientific methodology itself, which is considered, by many authors, as the goal of educational Science curriculum for Science and Technology studies (STS).

For Auler and Delizoicov (2006), the STS movement and their respective interactions are related to the critical compression of reality, that is, the understanding that happens through the problematization of historical constructions about the scientific-technological activity. For Zeidler et al. (2005), the curricula of the STS movement present, in their proposal, subjects related to socio-scientific aspects when they are approached from the perspective of promoting understanding of the nature of scientific activity and the development of argumentation.

Santos (2002) presents in his studies a humanistic perspective to discuss the Socio-scientific Issues – SSI – in the teaching of Sciences. Thus, he defends a curriculum that incorporates discussions of values and critical reflections inherent to the human condition. In this case, the focus is on an education in which students can reflect on their role in the world in the face of the implications of science and technology.

Still according to the author, SSIs are included in STS curricula through social themes involving discussions of scientific literacy and humanistic scientific education. Discussions of themes, in addition to understanding scientific concepts, involve subjects related to environmental, political, social and ethical aspects (Santos, 2002).

Thereby, Santos and Mortimer (2009) emphasize that the contents related to science and technology cover environmental, political, economic, social and cultural themes and can be translated as socio-scientific questions or as socio-scientific topics. In their studies, these authors defend the term “socio-scientific issues” – hence the acronym SSI – because they understand that issues related to science and technology are inherent to scientific activity and can be present in the science curriculum through an approach that can be thematic or even just punctual.

The thematic approach can be presented as a topic or a broad subject, thus involving themes such as environmental pollution, energy resources and transgenic. The punctual approach can contemplate examples of phenomena or day-to-day facts inherent in scientific context with technological applications, as well as issues addressed on this subject (Santos & Mortimer, 2009).

Considering the above, the SSI approach contemplates methodological proposals related to the social re-signification of Science teaching, which must be done through a dialogic and critical perspective, since the construction of knowledge must encompass the development of capacities related to participation and understanding scientific and technological controversies (Pérez, 2012).

Many authors believe that the dialogic perspective of Paulo Freire can contribute in the critical foundation of the approach of the SSI in the Science teaching. Thus, Freire's assumptions are present in the discussions of the authors such as Pérez (2012), Santos (2002), Santos (2007) and Auler and Delizoicov (2006).

Through the considerations of the authors mentioned above, it is possible to perceive that the perspectives of the SSI approach in this teaching contribute in the development of discussions related to the critical positioning on the issues inherent to the production and the repercussion of scientific knowledge, as well as to the formation of citizenship. In this perspective, Pérez (2012) emphasizes that the achievement of a democratic society will be possible only when citizens have the basic knowledge about the functioning of science and present the capacity to structure criteria of ethical and moral judgment for the evaluation of scientific and technological controversies.

We believe that the SSI approach must be present in the contents of science teaching, because, according to the authors mentioned, this approach covers discussions about the relationship between science and society, as well as controversial social issues presented in the media. Given this importance, the textbooks come into the picture in this discussion. It is possible to note that textbooks are still considered as one of the main methodological tools of teachers.

According to Martins, Gouvêa and Vilanova (2012), the importance of textbooks relates with historical contexts of the constitutive practice of schools and school education. Thus, the importance is centered around the debate about the democratization of knowledge, economic interests in its production and marketing and government investments in evaluation programs.

Neto and Fracalanza (2006), in their researches, present three groups on the use that teachers claim to make of the didactic book in their teaching activities. In the first group, teachers indicate that they use the textbooks to carry out the annual teaching planning, as well as to prepare the classes during the school term. In the second group, they bring the didactic textbook as support material for classroom and extracurricular activities. In the third group, teachers comment that the textbook is used as a bibliographic source, both to enrich their own knowledge and to the students' learning process.

Based on Santos and Mortimer (2009), the authors Oldoni, Fortuna and Leite (2018) analyzed the approaches on SSI present in the textbooks of Sciences of the 6th grade of elementary education of the Programa Nacional do Livro Didático (PNLD – National Textbook Program), in 2017. In this work, they verified that the thematic approach is the most common in the textbooks analyzed, since it refers to subjects related to environmental impacts, their causes and scope, as well as attitudes and possible alternatives to revolve or

minimize problems. This approach can include environmental, political, social, economic, ethical and STS aspects. In addition, the thematic approach is usually presented in the form of news from particular media, providing debates and discussions among students.

As for a more focused approach, SSIs are issues related to the advancements and limits of technology, as well as the environmental problems caused by human activities. This approach is presented through informative texts, allowing discussions on the social, environmental, ethical and STS aspects. Given the results presented in the analysis, the authors realized that both approaches are efficient to present SSI in textbooks, because they allow debates and discussions that allow students to develop critical and reflective thinking (Autor 1, Autor 2 & Autor 3, 2018).

In this paper, a study was carried out on SSI in Science textbooks for Elementary School II. The analysis was conducted based on the works by Ratcliffe (1998). For the author, the SSI approach has been presented in teaching science with different objectives and that can be related to five categories: i) relevance, ii) motivation, iii) communication, iv) analysis and v) understanding.

(1) Relevance – encouraging pupils to relate their experience of school science to real problems and developing social responsibility; (2) motivation – for exploring the issue further; (3) communication – assisting pupils in verbalising, listening and argument; (4) analysis – assisting pupils in skills of systematic and thoughtful reasoning; (5) understanding – learning science concepts. (Ratcliffe, 1995, p.192)

Considering the importance of textbooks in the educational context and the SSI approach in the content of the subject Science, the research problem that guided this analysis was: What are the objectives in the approach to the socio-scientific issues of textbooks of Science in Elementary School II?

## **METHODOLOGY**

This study shows a qualitative approach, for, according to Silveira and Córdova (2009), it concerns “[...] about aspects of reality that cannot be quantified, focusing on the understanding and the explanation of social relation dynamics” (p.32, our translation). Thus, we perform a process of analysis and interpretation of the content on SSI in textbooks, trying to detect what the implications are in the classroom.

According to Godoy (1995), the qualitative study can be carried out in different ways, among them documentary research, ethnography and case study. The documentary research allows the examination of different materials that have not yet received an analytical look or that can be reexamined seeking new understandings and interpretations.

Since this is a documentary research, 11 collections of science textbooks were analyzed (Table 01). They are collections approved by the PNLD<sup>1</sup> 2017. The data were analyzed through the Discursive Textual Analysis, by authors Moraes and Galiazzi (2007).

The PNLD, developed by the National Fund for Educational Development–FNDE, has the objective of making textbooks available to students of elementary public education, with the aim of promoting the universalization of teaching. (Höfling, 2006).

Table 1  
Analyzed textbooks.

Textbook	Title	Author/Year of publication
LD1 	<i>Apoema</i> Science Project	Ana Maria Pereira, Margarita Santana, Mônica Waldhelm, 2015.
LD2 	Explore and know: nature sciences	Sônia Lopes, 2015
LD3 	Natural Sciences: Learning from day-to-day life	Eduardo Leite do Canto, 2015
LD4 	Science	Carlos Barros, Wilson Paulino, 2015
LD5 	Science	José Trivellato Júnior, Sílvia Trivellato, Marcelo Motokane, Júlio Lisboa, Carlos Kantor, 2015

<sup>1</sup> Under the convening on the public notice no. 2/2015-CGPLI, by the Ministry of Education – MEC for PNLD 2017, 13 textbooks were approved for the final grades of Elementary School (BRASIL, 2017); however, we only managed to obtain 11 of them.

Textbook	Title	Author/Year of publication
LD6 	Araribá Project: Science	Maíra Rosa Carnevale, 2014
LD7 	Teláris Project: Science	Fernando Gewandsznajder, 2015
LD8 	Science Company	José Manuel Usberco, Eduardo Schechtmann, Luiz Carlos Ferrer, Herick Matin Velloso, 2015
LD9 	For Living Together: Nature Sciences	André Catani, João Batista Aguiar, Fernando Tapajós Roselino, 2015
LD10 	Science Times	Eduardo Passos, Ângela Sillos, 2015
LD11 	New Thinking	Demétrio Gowdak, Eduardo Martins, 2015

The textbooks of the 6th grade of Elementary School II were used and, during the analysis, a cut of the units was made in order to facilitate the study. Hence, the chosen theme was “Atmosphere”, from the axis “Earth and Universe”, present in the National Curriculum Parameters – PCN. It should be emphasized that the choice of the theme was motivated by its importance, since this content can contemplate controversial subjects about environmental and social impacts and to deal with these subjects would facilitate the analysis of the SSI.

## ANALYSIS AND DISCUSSION

Initially, the structure of the works and the SSI approach were analyzed. Through the analysis, it was possible to identify this approach of SSI in two ways: a) throughout the texts of the chapter or b) in extra sections, boxes and text boxes (Autor 1, Autor 2 & Autor 3, 2018).<sup>2</sup>

Table 2  
*Socio-scientific issues in the textbooks.*

Categories	Analysis units
a) SSI in the texts of the chapter	LD2; LD4; LD5; LD9; LD10,
b) SSI in extra sections, boxes and text boxes	LD1; LD2; LD3; LD4; LD5; LD6; LD7; LD8; LD9, LD10; LD11

Note: Adapted from (Oldoni, Fortuna and Leite, 2018).

Following the results presented by Autor 1, Autor 2 & Autor 3 (2018), the SSI approach throughout the texts of the chapter presents explanations and information inherent to the knowledge of science and its relation to society. It was possible to verify that the theme “Environmental pollution” highlighted the approach. The controversial issues of science and technology and their relationship with society have also gained an emphasis on texts. In addition to explanations of the SSI, some texts were accompanied by questions and suggestions for debates or activities on the subject.

SSI issues presented in the extra sections, in boxes and in text boxes bring the possibility of critical discussions and the development of communication. The tables are articulated with the themes of the chapter; they are contextualized but require more attention from the teacher, since most of them are presented with a smaller writing font, or located at the ends of the pages.

The SSI boxes feature pictures or illustrations, questions for thoughts, and themes that spark interest in reading. In some cases, the titles bring the perception that SSI-related issues will be addressed, for example the boxes in LD1 and LD7 are titled “Science and Technology.” Most of the content that relates to SSI is located at the end of the chapter. Although presented at the end of the chapter, the extra sections and boxes can enhance the SSI approach, as they relate the subject to the student’s daily life, helping to understand the content, as well as the development of social responsibility through questioning and awareness of the varied impacts of science and technology.

The analysis of the work structure, presented and discussed in Autor 1, Autor 2 & Autor 3 (2018), allowed to understand the presentation of the content about the SSI, as well as the number of approaches that the textbooks present on the theme of our study. From this perception, it was possible to analyze the excerpts of the textbooks and

<sup>2</sup> Presented in July 2018, at the 19th National Meeting on Chemistry Education – ENEQ.

the respective objectives. We reiterate that the analysis of the objectives was based on the studies of Ratcliffe (1998) and the simplification of the objectives in each book is presented in Table 3.

Table 3  
Objectives of each excerpt.

Textbooks/ No. of Excerpts	Relevance	Motivation	Communication	Analysis	Understanding	
LD1	01	X		X	X	
	02	X			X	
LD2	01	X		X		
	02	X	X		X	
LD3	01				X	
LD4	01	X	X	X	X	
	02	X	X			
LD5	01				X	
	02		X	X		
LD6	01		X	X		
	02	X	X	X	X	
LD7	01		X		X	
	02				X	
	03	X				
LD8	01	X			X	
	02			X	X	
LD9	01		X	X	X	
	02	X			X	
	03	X		X		
	04			X	X	
	05					X
	06			X	X	
LD10	01	X		X	X	
	02	X	X	X	X	
LD11	01			X	X	
	02	X		X	X	
	03	X		X	X	
Total	54	15	8	14	12	16

In Table 3, we try to explain the number of excerpts about SSI and, in each one of these excerpts, to identify the exposed objectives, for this we based on Ratcliffe (1998). It is possible to notice that the same excerpt can present more than one objective. In addition, some objectives stand out in the excerpts in the approach of the SSI, as is the case, for example, of the objectives **understanding**, **relevance** and **communication**.

Thus, through the information presented in the table, it is possible to notice that each objective was expressed in a fair number of approaches. From the total of 27 excerpts about the SSI, the objective directed to the **understanding** of scientific knowledge

presented the largest number, that is, 17 approaches. The objective that presented the fewest excerpts was that of **motivation**, with 8 approaches.

It is worth noticing that the **relevance** is present in 9 textbooks. The works seek to contextualize the content with the students' daily experiences. Most of the time they contemplate controversial subjects to awaken in the student the social responsibility, as can be verified in the Excerpt 03:

Human activities create pollutants that change the composition of atmospheric air. Particulate matter and gases are produced by automobile engines, industrial machines and fires. Although these substances are harmful to the environment and to the human being itself, many argue that this is the cost of progress. Give your opinion: is it possible to have economic development without polluting the air? (LD9, p.184, our translation)

Sasseron and Carvalho (2011, p.72), in their bibliographic review studies, emphasize the importance of the development of social commitment in students. In this regard, they point out the work of Jiménez-Aleixandre and Lemke about “[...] the planning and the proposition of a Science teaching capable of providing means so that the students think about the problems they face and search for solutions and goals for a sustainable future for the planet” (our translation).

It is verified that, in addition to the objective **relevance**, Excerpt 03 of LD9 also contemplates the **communication**. Through the exposed questioning, it is possible to instigate the students to reflect or provide the dialogue between them. Communication is understood as the goal that encompasses various attitudes related to listening and respecting the opinion of the other, being sensitive and understanding different explanations and different thoughts.

Excerpts from LD2, LD3 and LD7 did not address the objective **communication**. The other textbooks present it in some excerpts, but not in all of them. The approach that has the aforementioned objective is always accompanied by a text, which may be present in the box or in the text of the chapter itself. See the description of Excerpt 01, present in the box “De olho no tema” (“Keeping an eye on it”).

Brazil is the world's second largest producer of ethanol and the world's largest exporter of ethanol. In the 1970s, the Brazilian government launched the National Fuel Alcohol Program (Proálcool) because of the world oil crisis. At the beginning of the 21st century, the government resumed its incentive to use ethanol as fuel, with the development of flexible-fuel vehicles available on the market since 2003. Look for information on biofuels. What is the importance of researching new sources of energy alternatives to oil? What is the relationship between the search for renewable energies and global warming? (LD6, p.159, our translation)

For Ibraim, Medonça and Justi (2013), the insertion of argumentative practices in science teaching provides students with the appropriation of scientific language as well as the development of scientific reasoning. Besides, “[...] the student’s domain of language thus becomes a valuable tool for the development of cognitive processes and guides the construction of knowledge itself (Oliveira et al., 2009, p.22, our translation).

The objective **communication** can be seen as related to that of the **analysis**, which, in turn, refers to the development and the cognitive requirement of the students. For Krasilchik (2007), in addition to the argument about the importance of scientific and technological knowledge, there must be problematization on that knowledge through debates related to its use in the decision making and not as mere accumulation of information. This way, the development of reasoning can be facilitated through the problematization of knowledge.

In addition, the movement of reading and interpretation of graphs are perceived to promote cognitive effort in the students. This can be seen in Excerpt 01 of LD11, in which the objective **analysis** is identified in the interpretation of a graph on the relation of CFC consumption in Brazil and the goals of the Montreal Protocol. The initial proposal for the clipping is the collective reading of a text on the international commitments against the destruction of the ozone layer with the presentation of the graph and, next, a questionnaire on the information shown in the graph.

The objective **motivation** is related to the act or desire to develop, in students, the taste for science. According to Santos (2007), school science education has been developed in a decontextualized way. Therefore, it happens that the routine practice of performing exercises that do not require conceptual understanding provides the students’ lack of interest in the study of the sciences in general. Through the basic understanding of terms, scientific knowledge and concepts, it is possible to understand various situations and information present in everyday life (Sasseron & Carvalho, 2011).

For that matter, the lack of understanding of the knowledge can provide the lack of interest of the students by the subject of Sciences. The excerpts on SSI that presented the objective **motivation** bring explanatory texts with the description of phenomena present in the daily life of the student with illustrations and images. The following excerpt from LD4 (p.144) brings the subject “Espuma na água” (“Foam in the water”) that occurs in the Tietê River, from the city of São Paulo towards other cities in the countryside of the state.

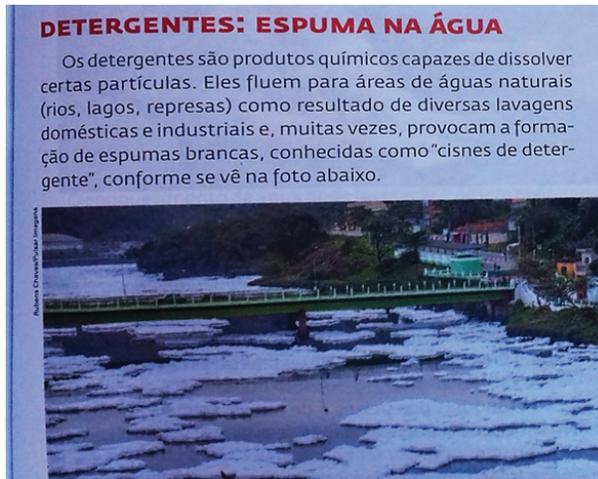


Figure 1. Excerpt image from LD4 about SSI and the objective motivation (Barros, C. & Paulino, W., 2015, p.211).

It is possible to perceive that the objective **understanding** is related to that of the **motivation**, starting from the presupposition that the understanding awakens in the student the interest by the content. Thus, the objective **understanding** refers to the understanding of scientific concepts and subjects related to the nature of science.

In order to aid in the learning of scientific concepts, considering the critical understanding of the interactions between science, technology and society becomes essential. In these interactions, the historical problematization of the construction of knowledge is considered fundamental (Auler & Delizoicov, 2006).

In fact, working the specific contents of the discipline of Sciences from the SSI approach can foster the construction of new values that contribute to the collective learning of the students. For this reason, this approach can encourage teachers in the processes of transformation of pedagogical practice (Pérez, 2012).

The objective **understanding** is present in a greater number of excerpts, and it was possible to observe that the socio-scientific aspects approach is accompanied by examples of events that aid the learning of concepts and phenomena related to science, as stated in the following section of LD10 (p.164):



Figure 2. Excerpt image from LD6 about the objective understanding (Maira, R. C, 2014, p.164).

Among the 11 works analyzed, the LD9 was noted as the one that presented the largest number of approaches – 9 excerpts –, presenting objectives related to **communication, analysis and understanding**. The only objective that was not contemplated in the excerpts of LD9 was **motivation**.

Therefore, we can note that a single excerpt can present several goals, or remain limited to the one or two approaches. The textbooks that included the greatest number of objectives in the excerpts were: LD4, LD6 and LD10. In addition, the LD4 and LD6 were the only ones that presented excerpts with all the objectives. Excerpts from LD1, LD2, LD5 and LD11 were limited to three objectives. The excerpts that included the least number of objectives were the LD3, LD7 and LD8.

## FINAL CONSIDERATIONS

With this work, we were able to identify how SSIs are addressed in the science textbooks, as well as their objectives. In addition, SSIs in textbooks contribute to the development of discussions among students, and also sharpen their critical thinking on topics involving scientific knowledge.

Among the objectives analyzed, the one that was present in greater number was the one of the **understanding**, this because the SSI found in the books help in the understanding of the scientific knowledge. In addition to this, the **relevance** was also

highlighted in the content of excerpts, relating the contents of the discipline of Science with the daily experiences of students, and can arouse discussions in the classroom.

The objective **motivation** was what was less present in the approaches, although, in the current context of the classroom, it is one of the most necessary, since many students do not have interest in scientific knowledge. For this reason, it is essential that the teacher use this in-room approach so that students are encouraged to learn science.

**Communication** was noticed as an objective related to that of the **analysis**, with several excerpts presenting both objectives, because it is believed that, when using the argumentative practice, possibly the scientific reasoning will be developed.

In this context, the presence of SSI in textbooks is of great importance, since it shows that the works use a methodology that enhances discussions and debates in the classroom about the impacts of science on society. However, before the textbooks, it is the teacher's commitment to use motivating resources to approach SSI in the classroom, because these resources help in the education of the students.

In this paper, therefore, we discuss that the presence of the SSI approach in the science curriculum is a theoretical and legal requirement, a requirement that is positively present in the PNLD textbook guide. It is necessary, however, to be attentive to the quality of this approach, since this analysis showed that there were excerpts that contemplated few objectives, although others have presented satisfactory results in relation to the quality of its content.

Finally, we emphasize the importance of the teacher to know and analyze, in a detailed way, the characteristics of the textbooks approved in the PNLD, so that the chosen material is coherent with the perspectives of the teaching-learning process in Science in Elementary School.

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## AUTHORS CONTRIBUTIONS STATEMENTS

R.F.L. oriented and supervised the development of the research. J.F.W.B.O. developed the theoretical deepening and elaborated the methodology of analysis. R.F.L. obtained the material for data collection. J.F.W.B.O. and C.F. carried out data analysis. The three authors discussed the results obtained and contributed to the preparation and revision of the final version of this manuscript.

## DATA AVAILABILITY STATEMENT

Data supporting the results of this study will be made available by the corresponding author, J.F.W.B.O., upon reasonable request.

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