SUSTAINTABILITY IN PRACTICE: THE REALITY OF ENVIRONMENTAL EDUCATION IN A SÃO PAULO STATE SCHOOL

SUSTENTABILIDADE NA PRÁTICA: A REALIDADE DA EDUCAÇÃO AMBIENTAL EM UMA ESCOLA PÚBLICA DO ESTADO DE SÃO PAULO

SOSTENIBILIDAD EN LA PRÁCTICA: LA REALIDADE DE LA EDUCACIÓN AMBIENTAL EN UN ESCUELA PÚBLICA DEL ESTADO DE SÃO PAULO

Ana Gabriela Kolde OHI[1]
e-mail: ana.ohi@unesp.br

Matheus GANIKO-DUTRA[2]
e-mail: matheus.ganiko@unesp.br

How to reference this paper:

OHI, A. G. K.; GANIKO-DUTRA, M. Sustaintability in practice: The reality of Environmental Education in a São Paulo state school. **Rev. Hipótese**, Bauru, v. 9, n. 00, e023004, 2023. e-ISSN: 2446-7154. DOI: https://doi.org/10.58980/eiaerh.v9i00.424

| **Submitted**: 13/04/2023
| **Revisions required**: 27/04/2023
| **Approved**: 20/05/2023
| **Published**: 01/06/2023

Editor: Prof. Dr. José Anderson Santos Cruz

[1]. São Paulo State University (UNESP), Bauru – SP – Brazil. Graduated from the Bachelor's degree program in Biological Sciences, Faculty of Sciences.

[2] São Paulo State University (UNESP), Bauru – SP – Brazil. Scholarship Professor at the Department of Education. PhD program in the Graduate Program in Science Education, Faculty of Sciences.

ABSTRACT: STSE (Science, Technology, Society, and Environment) Education proposes a teaching approach in which students can participate in decision-making processes related to these subjects. This approach is influenced by Environmental Education (EE) branches, which, in turn, are connected to existing sustainability models. In this supervised internship conducted as a research project, the relationship between a public school in the interior of São Paulo state and sustainability models was investigated. Classroom observations, school analysis, and library book analysis were conducted. It was possible to identify the adoption of Standard Sustainable Development and Neocapitalist Models by the school, which are related to the sustainability branch of EE. It was found that the teacher's knowledge of the various aspects of EE allows for selecting branches that align most closely with the STSE proposal.

KEYWORDS: School library. Science Education. Initial teacher education.

***RESUMO**: A Educação CTSA (Ciência, Tecnologia, Sociedade e Ambiente) propõe um ensino no qual os alunos sejam capazes de participar das tomadas de decisão envolvendo os assuntos relacionados. Essa abordagem é influenciada pelas vertentes da Educação Ambiental (EA), as quais, por sua vez, estão relacionadas aos modelos de sustentabilidade vigentes. Neste estágio supervisionado, realizado em formato de pesquisa, investigou-se a relação de uma escola pública do interior do estado de São Paulo com os modelos de sustentabilidade. Foram realizadas observações das aulas, da escola em si e análise dos livros da biblioteca. Foi possível identificar a adoção dos Modelos Padrão de Desenvolvimento Sustentável e Neocapitalista por parte da escola, os quais estão relacionados à corrente de EA chamada vertente de sustentabilidade. Constatou-se que o conhecimento do professor a respeito ddos diversos aspectos de EA permite a escolha das vertentes que mais se aproximam da proposta CTSA.*

***PALAVRAS-CHAVE**: Biblioteca escolar. Ensino de Ciências. Formação inicial de professores.*

***RESUMEN**: La Educación CTSA (Ciencia, Tecnología, Sociedad y Ambiente) propone una enseñanza en la que los estudiantes sean capaces de participar en las decisiones que envolven los temas afines. El enfoque es influenciado por la vertientes de la Educación Ambiental (EA), que, a su vez, se relacionan con los actuales modelos de sostenibilidad. En esta pasantía supervisda en formato de pesquisa se invetigó la relación de un escuela pública en interior del estado de São Paulo con modelos de sostenibilidad. Se realizarón observaciones de clase y de la escuela y análisis de los libros de biblioteca. Fue posible identificar la adopción de los Modelos Estándar de Desarrollo Sostenible y Neocapitalista por parte de la escuela, que están relcaionados com la corriente de EA llamada vertiente de sostenibilidad. Se constató que el conocimeniento del profesor sobre las diversas vertientes de EA permite la elección que más se aproxime da la propuesta CTSA.*

***PALABRAS CLAVE**: Biblioteca escolar. Enseñanza de las Ciencias. Formación inicial del profesorado.*

Introduction

The internship holds fundamental importance in the initial training of teachers, and one of the reasons is the possibility of relating theoretical aspects of education to school practice (KRASILCHIK, 2019). Among the relevant topics for the training of education students, STSE Education (Science, Technology, Society, and Environment) is essential to prepare teachers capable of teaching based on the students' reality and to educate citizens equipped to participate in individual and collective decision-making (SANTOS; MORTIMER, 2002). Regarding social practices and the environment, sustainability plays a central role in maintaining the dynamic balance of ecosystems. However, despite appearing as a homogeneous term, there are various models of sustainability, primarily linked to economic models (BOFF, 2016).

During the academic and technical education of the first author, the Sustainable Development Pattern Model and the Neocapitalist Model were predominant. Even during the undergraduate course in Biological Sciences, there was no presentation of different proposals to achieve a sustainable society. One likely reason is that Environmental Education (EE) has various approaches. The sustainability approach has become dominant, based on the Sustainable Development Pattern Model (SAUVÉ, 2005).

This paper presents an experience report of a supervised internship in an undergraduate Biological Sciences program at a school in the interior of the state of São Paulo, Brazil, as well as an analysis of the relationship between this school and sustainability models, aiming to understand the impact on societal conceptions of this concept and how it affects individual and collective actions. The initial hypothesis was that the school also adhered to the Sustainable Development Pattern Model principles.

Theoretical Framework

Internships constitute an important stage in teacher education programs as they introduce the student teacher to the school environment, not as a student anymore, but as a developing professional. The contact with school teachers enables the intern to receive assistance and guidance regarding potential difficulties. The internship activities allow for the observation of problems and reflection on how to become an agent of change. Furthermore, internships bridge the gap between primary and higher education, enabling the discussion of school needs at the university level and the development of collective responses to the issues

raised (KRASILCHIK, 2019). The internship was conducted in this work based on the theoretical foundation of STSE Education.

STSE Education (Science, Technology, Society, and Environment) is a curriculum emphasis proposal in which science and technology are the core knowledge, while society and the environment serve as the learning context (RICARDO, 2007). The STSE proposal aims to develop knowledge, skills, and values that enable students to actively participate in decision-making processes related to relevant topics. To achieve this, it is necessary to counter the view that science is neutral and holds all the answers to humanity's problems. Presenting students with the relationships between science and sociology, philosophy, history, politics, economics, and humanities is viable. Simultaneously, technology should be taught holistically, considering the technical, organizational, and cultural aspects involved. In the context of society, it is paramount for the topics addressed to meet specific criteria, such as being considered controversial, having social relevance, and being intrinsically related to science and technology (SANTOS; MORTIMER, 2002).

The word "sustainability," an essential concept for discussing socio-environmental issues, derives from the verb to sustain (in Latin, *sustentare*), which carries the notion of balance, conservation, and preservation. In the ecological sense, sustainability refers to human practices to maintain ecosystems' natural dynamic equilibrium (BOFF, 2016, p. 33). There are various perspectives on how sustainability should be practiced, and in this work, the sustainability models proposed by Boff (2016) will be used (Table 1).

Table 1 – Sustainability Models

Model	Concept
Standard Sustainable Development Model	Propose the tripod for sustainable development: economically viable, socially fair, and environmentally sound.
Neocapitalism Model	An economic model that reduces the power of the state over the economy. In this model, there is no sustainability.
Natural Capitalism Model	Attempts to incorporate processes that favor the environment within the capitalist economic system. Examples of natural capitalist practices include the pursuit of optimal space utilization, increased productivity through chemical inputs, and the reuse of waste materials.
Green Economy Model	An extension of the natural capitalism idea proposes the achievement of harmonization between economy and ecology. The first approach would involve supporting farmers and economically vulnerable individuals through the provision of technology, seeds, and banking credit. The second approach would focus on reducing carbon production by promoting organic farming, encouraging ecotourism, and utilizing renewable energy sources, among other measures.

Ecossocialism Model	It is a socialist proposal whose essence lies in production in accordance with biological rhythms based on social justice, equity, and the restoration of worker dignity. The model also believes that all should organize and decide upon organic food, renewable energy sources, and other common interest factors.
Ecodevelopment or Bioeconomy Model	Bioeconomy suggests that there should be an economic downsizing to achieve qualitative growth, with the aim of preserving the environment for future generations. Ecodevelopment is a similar proposal that adds the inseparable union of economy, ecology, democracy, justice, and social inclusion to achieve sustainability.
Solidarity Economy Model	A humanitarian, post-capitalist economy in which the focus is on work, solidarity, self-management, improvement in quality of life, and local development before global. It would be consolidated through the formation of production and consumption cooperatives, revolving credit funds, ecovillages, heirloom seed banks, and others.

Source: Adapted from Boff (2016)

Although Environmental Education (EE) originated from collective concern for the environment and the pursuit of improving our interactions with it, it is essential to note that multiple perspectives reflect the diversity of concepts that have emerged throughout history. When considering the classifications of Environmental Education proposed by Sauvé (2005), it is evident that the sustainability-oriented perspective has experienced significant growth since the 1980s, emerging as the predominant view in the field. It focuses on the developmental sustainability model, aiming to promote and contribute to economic development while respecting environmental and social limits. However, in this sustainability-oriented approach, there is a gap in considering social concerns and a lack of emphasis on the environmental degradation resulting from economic practices.

Another relevant influencing factor is the National Policy on Environmental Education (PNEA), Law n. º 9,795/99, which defines:

> Environmental education is the process through which individuals and communities build social values, knowledge, skills, attitudes, and competencies aimed at conserving the environment, a common good of the people, essential to a healthy quality of life and its sustainability (BRASIL, 1999, our translation).

Furthermore, it is worth noting that the legislation establishes significant guidelines, such as the need to articulate Environmental Education at all levels of education, both formally and informally. This practice should be implemented in an integrated, continuous, and lasting manner. Environmental Education's objectives are aligned with STSE Education's principles, as they seek to promote an understanding of the interconnection between the environment, social aspects, and scientific knowledge.

Metodology

The internship was carried out in a state public educational institution in the interior of São Paulo. The school offers classes for high school students in the morning and elementary and high school students in the afternoon.

Observation activities were conducted on the following days: May 20 and 23, June 3, 7, and 27, and July 27, 2022. On May 20, a participation activity was also carried out, during which I assisted in solving students' doubts about the workbook activities. School observation occurred on two days: a general observation on May 23 and the end-of-semester presentation observation on June 30. On June 27, an analysis of the books available in the library was conducted. Finally, teaching classes took place on July 27. The detailed research planning can be consulted in Table 2.

Table 2 – Research Activities Planning

What I wanted to know?	How did I find out?	What did I need?
How does the school relate to sustainability? How does the school practice sustainability? What is the impact of schools on society's perception of sustainability?	Classroom and school observation. Analysis of library books.	Field notebook.

Source: Elaborated by the authors

In the observation activities of the internship, notes were taken in the field diary, following the methodology proposed by City *et al*. (2013). This methodology adopts a descriptive approach to observed behaviors and statements, avoiding the inclusion of any judgment in the notes. It is important to emphasize that the names mentioned in this documentation, whether they are teachers, students, or the school itself, are fictional, intending to preserve the identity of those involved.

During the observation activity at the school, searches were made for evidence of the proposed sustainability initiatives, considering physical structures such as recycling bins, organic gardens, composting systems, and water reuse systems, as well as the organization of collective bodies such as project groups and debates.

To select the books from the library for analysis, it was decided to choose those from the section of Biological Sciences whose titles were related to the environment. In addition, in the table of contents, an effort was made to identify chapters or sections dedicated to proposals for balance between human actions and the environment, using words such as "care," "preserve," "conserve," "recycle," "reduce," "save," "consume," "citizenship," and

"sustainability." The objective of the analysis was to identify the sustainability model proposed by the books, following the approach described by Boff (2016). Additionally, an attempt was made to determine if the books presented their definition of sustainability.

Books that suggested ways to improve the relationship between human beings and the environment, but did not delve into critiques of the societal structure, were categorized within the Standard Model of Sustainable Development. On the other hand, books that shifted responsibility and blame for the environmental crisis onto individual actions were classified under the Neocapitalist Model. Both the Green Economy Model and the Ecosocialist Model share similar proposals, such as cultivating organic food and using renewable energy. The distinction between them lies in their implementation. While the former aims to increase productivity through ecological practices, the latter proposes that resource management should serve collective interests. The Bioeconomy Model was identified by its proposition of economic degrowth for the environment's sake. Meanwhile, the Ecodesvelopment Model, which shares the same characteristic, encompasses books proposing the inseparability of economy, ecology, democracy, justice, and social inclusion. Lastly, the Solidarity Economy Model was classified based on its proposal for economic dissociation from capitalism and the creation of cooperatives for production and consumption.

The teaching practice was planned to be conducted with a 2nd-year class of High School in a double class period with a duration of 45 minutes each, totaling 1 hour and 30 minutes. The supervising teacher of the internship prepared a form to organize the lesson plan, following the proposal by Wiggins and McTighe (2019), which was filled out by the intern (Appendix A). The approach of the lesson considered the proposal by Santos and Mortimer (2002) for STS Education (Science, Technology, and Society).

Results and Discussion

Classroom Observation

Classes from the 1st, 2nd, and 3rd high school years were observed. Most of the texts written on the board were taken from the "Currículo em Ação" workbook, except for one, which was sourced from the "Brasil Escola" website. All the exercises completed by the students were from the mentioned workbook. Only in one of the classes was a connection observed between the content being discussed and the topic of sustainability. This observation arose from a student's question:

- Teacher, what should we write for question 2?

- How to save energy - replied Teacher Helena.

- And how do we do that? - the student asked.

Teacher Helena tapped a folder on his arm and said:

- Don't you know how to do it, João? Are you going to leave the fan on all the time?

In addition, during an informal conversation with the teacher in one of the classes, she mentioned that she conducted a recycling project in the previous year where students learned how to separate waste properly.

The classroom observations and the conversation with the teacher indicate that she adopts a sustainability approach in Environmental Education. This approach is based on suggestions for balancing human actions and the environment through individual actions without delving into the social and economic causes that create imbalance. However, the problem with the approach of Environmental Education focused on sustainable development is that contrary to what is claimed by the three pillars of this model, this approach is not socially just. In the context of the capitalist system, social inequality is inherent to maintaining different social classes. Furthermore, this approach is not environmentally sound as it disregards natural limits in favor of the sole objective of increasing capital (BOFF, 2016).

The scenario presented corroborates with Sauvé's (2005) indication that the sustainability approach predominates in classrooms, which is concerning because by holding individuals responsible for environmental problems, political and economic sectors can benefit, as students are not empowered to act as conscious citizens. An example of this is the student's question about ways to save energy. According to the Synthesis Report of the National Energy Balance (BEN, 2022), energy consumption in Brazil by industry, transportation, and agriculture accounts for nearly 70%, while residential consumption represents only 11%. Therefore, if the ways in which economic development is being achieved at the expense of the environment are not discussed, the consequence of this type of education is social reproduction, contributing to the dissociation between politics and environmental preservation. Thus, it becomes essential to seek alternatives for Environmental Education.

Considering that the National Policy on Environmental Education (PNEA) (BRASIL, 1999) aims to develop an understanding of the interrelationship between the environment, society, and science and to encourage the adoption of more updated sustainability approaches

(SAUVÉ, 2005), it could assist in achieving these objectives. It would also benefit the PNEA to present its definition of sustainability to guide Environmental Education practices. One way to break the reproduction cycle is by introducing alternative approaches to Environmental Education in the initial and continuing education of teachers, as this provides more options for them to act upon, allowing them to adopt the ones they identify with and consider most suitable to the teaching process.

Books from the library

A total of 26 books from the library were analyzed (Table 3). Among the sustainability models, the one with the highest number of books in its category was the Neocapitalist Model, with nine books, followed by the Standard Sustainable Development Model and the Bioeconomy Model, with 7 and 4 books, respectively. For the Sustainable Economy and Ecodesvelopment Models, there was only one book in each category, while the Natural Capitalism and Ecosocialism Models had no representative books. Only the book by Mattos, Magalhães, and Abrão (1991) presented elements of two models simultaneously, the Standard Sustainable Development Model and the Green Economy Model. No book was found to have its definition of the concept of sustainability.

Table 3 – Sustainability models in the school books

Model	Book
Standard Sustainable Development Model	PINTO, Z. A. **A água nossa de cada dia**. 1. ed. [*S. l.*]: Ministério do Meio Ambiente, 2010. 20 p.
	ALEGRIA, S.; MEDEIROS R. **Manual do defensor do planeta**. 2. ed. Rio de Janeiro: Casa da Palavra, 2012. 160 p.
	AZEVEDO, E. **Alimentos orgânicos**: ampliando contatos de saúde humana, ambiental e social. 1. ed. São Paulo: SENAC São Paulo, 2012. 388 p.
	BRANCO, S. M.; MURGEL, E. **Poluição do ar**. 4. ed. São Paulo: Moderna, 1995. 86 p.
	IRITANI, M. A.; EZAKI, S. **As águas subterrâneas do Estado de São Paulo**. 3. ed. São Paulo: SMA, 2012. 104 p.
	NEIMAN, Z. **Era verde?** Ecossistemas brasileiros ameaçados. 20. ed. São Paulo: Saraiva S.A. Livreiros Editores, 1989. 112 p.

	OLIVEIRA, R. F.; ALVES, S. W. S. **Mudanças climáticas**: globais no Estado de São Paulo. 1. ed. São Paulo: SMA e CETESB, 2012. 83p.
Neocapitalism Model	BECKER, B. *et al*. **Dilemas e desafios do desenvolvimento sustentável no Brasil**. 1. ed. Rio de Janeiro: Garamond Ltda., 2007. 148 p.
	BONAR, V. **Papel reciclar!** 1. ed. São Paulo: Scipione, 2003. 32 p.
	BRANCO, S. M. **Caatinga**: a paisagem e o homem sertanejo. 7. ed. São Paulo: Moderna, 1996. 72 p.
	BRANCO, S. M. **Ecologia da cidade**. 17. ed. São Paulo: Moderna, 1996. 72 p.
	DIAS, F. G. **Atividades interdisciplinares de educação ambiental**. 2. ed. São Paulo: Gaia Ltda., 2013. 224 p.
	FERRARO, N. G. **Eletricidade**: história e aplicações. 1. ed. São Paulo: Editora Moderna. 1996. 63 p.
	MINC, C. **Ecologia e cidadania**. 2. ed. São Paulo: Moderna, 2005. 152 p.
	MINISTÉRIO DA INTEGRAÇÃO NACIONAL E DA SECRETARIA DE COMUNICAÇÃO SOCIAL DA PRESIDÊNCIA DA REPÚBLICA. 1. ed. São Francisco: sustentável. 2008. 48 p.
	SCARLATO, F. C.; PONTIN, J. A. **O ambiente urbano**. 2. ed. São Paulo: Saraiva. 2001. 80 p.
Natural Capitalism Model	GARDINER, B. **Lixo nuclear**. 12. ed. São Paulo: Cia Melhoramentos de São Paulo, 1993. 32 p.
	RODRIGUES, S. A. **Destruição e equilíbrio**: o homem e o ambiente no espaço tempo. 15. ed. São Paulo: Atual Ltda, 1989. 98 p.
	TUNDISI, J. G. 3ª ed. **Água no século XXI**: enfrentando a escassez. São Carlos: Rima, 2005. 256 p.
Ecodesvelopment Model	KUNTSCHIK, D. P.; EDUARTE, M.; UEHARA, T. H. K. **Matas ciliares**. 2. ed. São Paulo: Governo do Estado de São Paulo e SMA, 2014. 80 p.
Bioeconomy Model	CONTI, J. B. **Clima e meio ambiente**. 3. ed. São Paulo: Saraiva S. A. Livreiros Editores, 1998. 88 p.
	GAZZETA, C.; MIGUEL, K. (coord.). **Vida, água e floresta**: como e por porque recuperar nossas matas ciliares. 1. ed. [*S. l.*]: [*s. n.*], 2010.
	ROSA, A. V. **Agricultura e meio ambiente**. 2. ed. São Paulo: Atual, 1992. 95 p.
	SANTILLI, J. **Agrobiodiversidade e direito dos agricultores**. 1. ed. [*S. l.*]: Peirópolis, 2009. 520 p.

Model of Solidarity Economy	LEONARD, A. **A história das coisas**: da natureza, ao lixo, o que acontece com tudo o que consumimos. 1. ed. Rio de Janeiro: Zahar, 2010. 304 p.
Standard Model of Sustainable Development and Model of Green Economy	MATTOS, S. N.; MAGALHÃES, N. W.; ABRÃO, S. A. M. 3. ed. **Nós e o ambiente**. São Paulo: Scipione, 1991. 56 p.

Source: Elaborated by the authors

Considering that the Standard Models of Sustainable Development, Neocapitalism, and Bioeconomy do not propose significant social transformations in the relationships with the environment and that out of these models, 20 out of the 26 books belong to them, it is evident that the majority of the books aim to maintain the current socio-environmental system. It would benefit the school to acquire more books from other models so that students can access different conceptions of sustainability. This would allow them to identify the various discourses related to the subject and base their decisions on the most suitable proposals. This measure could be supported by the National School Library Program, responsible for distributing books to all public schools in the country.

School Structure

The only element related to sustainability proposals was a recycling bin placed in the school courtyard (Figure 1). However, students are not guaranteed to dispose of recyclable waste properly. It would be important for the school to adopt sustainable practices to demonstrate to students how they can be incorporated and bring them closer to the reality of students.

Figure 1 - School's recyclable waste

Source: Authors' personal collection

End-of-Semester Presentation

Only one presentation related to a proposal for a balance between humans and the environment was observed, delivered by 9th-grade students who wrote sentences relevant to World Environment Day. The following sentences are faithfully transcribed:

> *With the Contribution of Everyone, We Can Change the World!*
> *We Need to Reduce Our Consumption to Solve Our Current Problems.*
> *There is No Throwing Away. Every waste you produce remains somewhere on the Planet.*
> *Take sustainable actions because the Planet can no longer wait.*
> *When the last tree is cut down when the last river is poisoned, when the last fish is caught, only then will we realize that money cannot be eaten.*
> *In my view, IT IS nor APPROPRIATE to litter on the GROUND* [sic].

The presentation indicates that students' conceptions of sustainability are based on Standard Sustainable Development and Neocapitalism models, which is expected since the school itself widely disseminates these models. As a result, students' actions as citizens may align with the models described in their decision-making processes. Therefore, we can observe the relevance of the school in shaping citizenship and its impact on society and the environment.

Regency

The class was held on July 27th for the 2nd-year class C. Seven students were in the room, less than half the number of enrolled students. According to the students, their classmates believed classes would only start in early August, so they did not attend.

There were two assessment moments, with the first assessment activity taking place at the beginning of the class. In this activity, students surveyed their knowledge of the positive and negative aspects of renewable and non-renewable sources for society and the environmental impacts caused by different energy sources. The main points raised were noted on the blackboard. In the second activity, the students were divided into two groups (G1 and G2). Each group received a text on engine energy sources extracted from a website (PERKONS, [between 2012 and 2022]). The texts included exercises developed by the authors, which were to be answered after reading.

Regarding the first assessment, the students could address all the proposed topics. Regarding positive social impacts, the students mentioned industries but had difficulty relating these processes to energy. Therefore, it was explained that energy sources, especially electrical energy, are directly involved in all fields of work due to our dependence on electronic devices. As for negative social impacts, an example cited by the students was the forced removal of communities residing in areas near rivers, aiming at constructing hydroelectric power plants. Regarding environmental impacts, the students mentioned water contamination due to improper disposal of nuclear waste while emphasizing the existence of energy sources that generate less waste.

In the group activity, each participant was assigned roles (Cohen; Lotan, 2017); however, a shared reading was not conducted as proposed. The reader only reads parts of the text for answers to the activities. In question 1 (Appendix B), only one of the groups answered that the engines used renewable energy, while the other mentioned non-renewable energy. Question 2 was also answered differently by the groups: G1 mentioned different types of electric motors, while group G2 stated that electric energy came from electrical sources and biogas.

Regarding the graph question, both groups correctly identified the most used energy sources in transportation but did not complete the answer regarding the social and economic factors that influence the proportion of the use of these sources. In question 4, group G1 mentioned government incentives to increase the use of renewable energies in Brazil and the population's awareness of the harmful effects of non-renewable energies. On the other hand, group G2 highlighted the increasing use of solar and wind energies.

Therefore, at the beginning of the class, the students could recall and associate the content of renewable and non-renewable energy sources with environmental and social impacts, although they faced difficulty relating the relevant energy source to industries. In the second activity, the students encountered some difficulties related to reading the text and interpreting the activities. In some cases, it was impossible to assess whether the students knew the answer due to the lack of depth in their resolution, such as in the question where group G2 mentioned that electric energy came from electrical sources but did not specify which ones.

Considering the STSE (Science, Technology, Society, and Environment) approach, some adjustments could be made to the lesson plan to avoid misconceptions. In the study of scientific content, it would be pertinent to present the concepts of primary and secondary energy and the differences between clean energy and renewable energy. It would be interesting to

include a debate on sustainable development, to complement the discussion of the socio-environmental problem.

It is recommended to reduce the size of the presented text and divide the questions into separate items, facilitating the execution of the activity. It is also important to mention that certain questions, such as teaching students how to conduct a shared reading, cannot be resolved in a single class. However, the experience provided a relevant opportunity for training, allowing the identification of issues between theory and practice that should be considered in future teaching exercises.

Lastly, we reflect on the feasibility of using the group work methodology that Cohen and Lotan (2017) proposed in supervised internships. When students in the schools where the interns are working are unfamiliar with this teaching strategy, it is necessary to dedicate a significant amount of class time to explaining how to work in groups and emphasizing its importance. Considering that internships have a reduced workload, this time should be prioritized to address other aspects of lesson planning and teaching practice relevant to teacher training and can be adequately addressed within this short period.

Conclusions

The school adopts the approach of Environmental Education focused on sustainability, considered the most widely spread within the education system. The same applies to the Standard Models of Sustainable Development and Neocapitalism. Considering that these trends reproduce the current social system, it is essential to adopt alternatives in schools. Among the measures that can be taken, changes in the National Policy on Environmental Education (PNEA) stand out to encourage the adoption of more recent sustainability approaches. It is also important to teach these approaches in the initial and continuous training of teachers, provide a variety of sustainability proposals in the library's book collection, and encourage the creation of more projects focused on alternative sustainability models. Lastly, the internship demonstrated the importance of the teacher's knowledge about Environmental Education approaches, especially in preparation for STSE Education, allowing the teacher to choose the approaches they consider most appropriate and avoiding the automatic reproduction of the most widely spread approach.

REFERENCES

ALEGRIA, S.; MEDEIROS R. **Manual do defensor do planeta**. 2. ed. Rio de Janeiro: Casa da Palavra, 2012. 160 p.

AZEVEDO, E. **Alimentos orgânicos**: ampliando contatos de saúde humana, ambiental e social. 1. ed. São Paulo: SENAC São Paulo, 2012. 388 p.

BECKER, B. *et al*. **Dilemas e desafios do desenvolvimento sustentável no Brasil**. 1. ed. Rio de Janeiro: Garamond Ltda., 2007. 148 p.

BEN. **Relatório Síntese 2022**: ano base 2021. [*S. l.*]: Ministério de Minas e Energia, Empresa de Pesquisa Energética, 2022. 66 p. Available at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2022. Access in: 20 Feb. 2023.

BOFF, L. Modelos atuais de sustentabilidade e sua crítica. *In*: BOFF, L. **Sustentabilidade**: o que é e o que não é. 5. ed. Petrópolis, RJ: Vozes, 2016. p. 41-70.

BONAR, V. **Papel reciclar!** 1. ed. São Paulo: Scipione, 2003. 32 p.

BRANCO, S. M. **Caatinga**: a paisagem e o homem sertanejo. 7. ed. São Paulo: Moderna, 1996. 72 p.

BRANCO, S. M. **Ecologia da cidade**. 17. ed. São Paulo: Moderna, 1996. 72 p.

BRANCO, S. M.; MURGEL, E. **Poluição do ar**. 4. ed. São Paulo: Moderna, 1995. 86 p.

BRASIL. Ministério da Educação. Ministério do Meio Ambiente. **Lei n. 9.795 de 27 de abril de 1999**. Dispõe sobre a educação ambiental, institui a Política Nacional de Educação Ambiental e dá outras providências. Brasília, DF: MEC, MMA, 1999. Available at: http://www.planalto.gov.br/ccivil_03/leis/l9795.htm. Access in: 28 Oct. 2022.

CITY, E. A. *et al*. Aprendendo a ver, desaprendendo a julgar. *In*: CITY, E. A. *et al*. **Rodadas pedagógicas**: como o trabalho em redes pode melhorar o ensino e a aprendizagem. Porto Alegre: Penso Editora, 2013. p. 105-122.

COHEN, E.; LOTAN, R. **Planejando o trabalho em grupo:** estratégias para salas de aula heterogêneas. 3. ed. Porto Alegre: Penso, 2017.

CONTI, J. B. **Clima e meio ambiente**. 3. ed. São Paulo: Saraiva S. A., Livreiros Editores, 1998. 88 p.

DIAS, F. G. **Atividades interdisciplinares de educação ambiental**. 2. ed. São Paulo: Gaia Ltda., 2013. 224 p.

FERRARO, N. G. **Eletricidade**: história e aplicações. 1. ed. São Paulo: Editora Moderna. 1996. 63 p.

GARDINER, B. **Lixo nuclear**. 12. ed. São Paulo: Cia Melhoramentos de São Paulo, 1993. 32 p.

GAZZETA, C.; MIGUEL, K. (coord.). **Vida, água e floresta**: como e por porque recuperar nossas matas ciliares. 1. ed. [*S. l.*]: [*s. n.*], 2010.

IRITANI, M. A.; EZAKI, S. **As águas subterrâneas do Estado de São Paulo**. 3. ed. São Paulo: SMA, 2012. 104 p.

KRASILCHIK, M. O professor na sala de aula. *In*: KRASILCHIK, M. **Prática de Ensino de Biologia**. 4. ed. São Paulo: Editora da Universidade de São Paulo, 2019. p. 169-184.

KUNTSCHIK, D. P.; EDUARTE, M.; UEHARA, T. H. K. **Matas ciliares**. 2. ed. [São Paulo]: Governo do Estado de São Paulo e SMA, 2014. 80 p.

LEONARD, A. **A história das coisas**: da natureza, ao lixo, o que acontece com tudo o que consumimos. 1. ed. Rio de Janeiro: Zahar, 2010. 304 p.

MATTOS, S. N.; MAGALHÃES, N. W.; ABRÃO, S. A. M. **Nós e o ambiente**. 3. ed. São Paulo: Scipione, 1991. 56 p.

MINC, C. **Ecologia e cidadania**. 2. ed. São Paulo: Moderna, 2005. 152 p.

MINISTÉRIO DA INTEGRAÇÃO NACIONAL E DA SECRETARIA DE COMUNICAÇÃO SOCIAL DA PRESIDÊNCIA DA REPÚBLICA. 1. ed. São Francisco: sustentável. 2008. 48 p.

NEIMAN, Z. **Era verde?** Ecossistemas brasileiros ameaçados. 20. ed. São Paulo: Saraiva S.A. Livreiros Editores, 1989. 112 p.

OLIVEIRA, R. F.; ALVES, S. W. S. **Mudanças climáticas**: globais no Estado de São Paulo. 1. ed. São Paulo: SMA e CETESB, 2012. 83p.

PERKONS. Fontes de energia para Transporte: você conhece todas elas? **Trânsito IDEAL,** [entre 2012 e 2022]. Available at: http://www.transitoideal.com.br/pt/artigo/4/educador/81/fontes-de-energia-para-o-transporte-voce-conhece-todas-elas. Access in: 10 Dec. 2022.

PINTO, Z. A**. A água nossa de cada dia**. 1. ed. [*S. l.*]: Ministério do Meio Ambiente, 2010, 20 p.

RICARDO, E. C. Educação CTSA: obstáculos e possibilidades para sua implementação no contexto escolar. **Ciência & Ensino**, v. 1, n. especial, nov. 2007.

RODRIGUES, S. A. **Destruição e equilíbrio**: o homem e o ambiente no espaço tempo. 15. ed. São Paulo: Atual Ltda, 1989. 98 p.

ROSA, A. V. **Agricultura e meio ambiente**. 2. ed. São Paulo: Atual, 1992. 95 p.

SANTILLI, J. **Agrobiodiversidade e direito dos agricultores**. 1. ed. [*S. l.*]: Editora Peirópolis, 2009. 520 p.

SANTOS, W. L. P. dos; MORTIMER, E. F. Uma análise de pressupostos teóricos da abordagem C-T-S (Ciência – Tecnologia – Sociedade) no contexto da educação brasileira. **Revista Ensaio**, v. 2, n. 2, p. 110-132, 2002.

SAUVÉ, L. Uma cartografia das correntes em educação ambiental. *In*: SATO, M; CARVALHO, I. **Educação ambiental**: pesquisa e desafios. Porto Alegre: Penso, 2005. p 17-44.

SCARLATO, F. C.; PONTIN, J. A. **O ambiente urbano**. 2. ed. São Paulo: Saraiva. 2001. 80 p.

TUNDISI, J. G. **Água no século XXI**: enfrentando a escassez. 3. ed. São Carlos, SP: Rima, 2005. 256 p.

WIGGINS, G.; MCTIGHE, J. **Planejamento para a compreensão**: alinhando currículo, avaliação e ensino por meio do planejamento reverso. 2. ed. Porto Alegre: Penso, 2019.

CRediT Author Statement

Acknowledgements: Not applicable.

Funding: This work was supported by the Coordination of Improvement of Personal Higher Education - Brazil (CAPES) - Funding Code 001.

Conflicts of interest: There are no conflicts of interest.

Ethical approval: The research respected ethics by using fictitious names for the participants.

Data and material availability: Yes, the didactic activity used in the research is included in the appendices of the article.

Authors' contributions: Ana Gabriela Kolde Ohi planned the supervised internship, developed the didactic activity, collected research data, and wrote the article. Prof. M. Matheus Ganiko-Dutra supervised the internship and reviewed the lesson plan, the didactic activity, and the article.

Processing and editing: Editora Ibero-Americana de Educação.
Proofreading, formatting, normalization and translation.

APPENDIX A

Lesson Plan

<table>
<tr><th colspan="2">Identification</th></tr>
<tr><td colspan="2">Title of the Lesson: Energy Sources
Subtitle: Socio-environmental impacts</td></tr>
<tr><td>Target Audience: 2nd year of High School</td><td>Duration of the Lesson: 1 hour and 30 minutes</td></tr>
<tr><th colspan="2">Stage 1. Desired Understandings and Learning Objectives</th></tr>
<tr><td colspan="2">National Common Curricular Base or São Paulo Curriculum Skill that will be addressed in this lesson:
• (EM13CNT309) Analyze socio-environmental, political, and economic issues related to the world's current dependence on non-renewable resources and discuss the need to introduce alternatives and new energy and material technologies, comparing different types of engines and processes for producing new materials.
Learning objectives for this lesson:
By the end of the lesson, students will be able to…
• Define what renewable and non-renewable energies are, considering that some resources are depletable and others are not;
• Classify types of energy sources as renewable or non-renewable
• Relate positive and negative aspects of energy sources to society;
• Identify environmental impacts caused by different energy sources.</td></tr>
<tr><td colspan="2">Socio-environmental problem that will be addressed in the lesson:
• Positive and negative aspects of different energy sources for society;
• Social influence on the use and discontinuation of energy sources and environmental impacts caused by energy sources.
Scientific knowledge associated with this problem
• • Concept of energy;
• • Types of energy;
• • Energy conversion;
• • Classification, identification, and distinction between renewable and non-renewable energy sources.
Technological knowledge associated with this problem:
• Methods of obtaining energy sources and their conversion into products.</td></tr>
<tr><td colspan="2">What are the possible decision-making actions at the following levels:
• • Individual:
• • Being able to take a stance in decision-making regarding the use of different energy sources.
• • Collective:
• • Writing a bill that prohibits nuclear power plants in Brazil, drafting a letter to Congress expressing opposition to the construction of new hydroelectric power plants in the São Francisco River, among others.</td></tr>
<tr><th colspan="2">Stage 2. Learning Checks
In which formal assessments will the achievement of the learning objectives for this lesson be observed? What evidence will the teacher need?</th></tr>
</table>

Evidence of learning: *Describe what evidence will the students be required to produce for the teacher to assess their learning. If necessary, please describe the instructions and planning for the assessments and/or activities.*
At the beginning of the class, the teacher will request that the students engage in a three-minute discussion in pairs regarding the positive and negative aspects of various renewable and non-renewable energy sources for society, as well as the environmental issues caused by these energy sources. Subsequently, the teacher will ask the students to share their discussions, and she will record the key points of their responses on the blackboard. The teacher will take a photo of the blackboard for future assessment of the answers.
At the end of the class, a group activity will be conducted with role assignments following Cohen and Lotan's proposal (2017). • Each member of the group will be assigned a role based on their birthdate. Therefore, the student whose birthday comes first will be the harmonizer, the next student will be the timekeeper, and so on. • Note: The writer may request to switch roles with another group member. Next, the teacher will provide the text on engine energy sources to each group's resource monitor. During the discussions, she will assist the groups in carrying out the activity. The assessment will take place by reading the group's responses after the class.

Stage 3. Planning of Learning Experiences.

Time	What will the students do? *How will the class engage the students?*	What will the teacher do?	Materials required
07:00-07:10	The students can ask questions about becoming a biologist/biology teacher and gaining admission to a Public University.	The teacher will finish organizing the desks into small circles (around 4 tables per circle). She will also introduce herself and discuss how she will get the students' attention if necessary.	Not necessary.
07:10-07:20	The students should mention some positive and negative points related to energy sources they learned about last semester, as well as environmental problems caused by these sources.	Presentation of the socio-environmental issue: Since it is a review class, the teacher will provide context and ask the students to mention some positive and negative socio-environmental aspects caused by energy sources, as well as the environmental problems associated with these sources. The teacher will write down the mentioned problems on the blackboard.	Whiteboard and maker.
07:20-07:40	The students will copy the text and ask questions if necessary.	Analysis of related technology: The teacher will write a text on the blackboard about technologies related to acquiring energy sources and their conversion into products. For this purpose, an example of a renewable energy source (sugarcane biomass) and a non-renewable energy source (petroleum) will be used. The other	Whiteboard and maker.

		renewable and non-renewable energy sources used in Brazil will also be highlighted - natural gas, coal, uranium, hydroelectric, firewood and charcoal, bleach, wind, biodiesel, solar, and thermal. Upon completing the text, the teacher will explain its content.	
07:20-07:40	The students will copy the text and ask questions if necessary.	Study the scientific content defined by the problem and the technology used: The teacher will define in the table what renewable and non-renewable resources are and the origin of the raw material for each energy source. Then, she will explain the content.	Whiteboard and maker.
7:40-8:15	The students will listen to the teacher explain the role distribution within the group and ask questions. The resource monitor will collect the text with the questions. They will read and answer the questions together on paper. Ultimately, the writers will submit the group's answers to the teacher.	Study of alternative possibilities The teacher will guide the creation of the activity based on the text about energy sources for engines.	Printed Text, Whiteboard and maker.
8:15-8:25	The students will listen and ask questions.	Return to the socio-environmental problem: The teacher will conclude the class by explaining the expected answers and addressing any doubts from the students, emphasizing the socio-environmental issues.	Whiteboard and maker.
08:25-08:30	The students will arrange the tables in rows.	The teacher will request that the students arrange the tables in rows.	Not necessary.

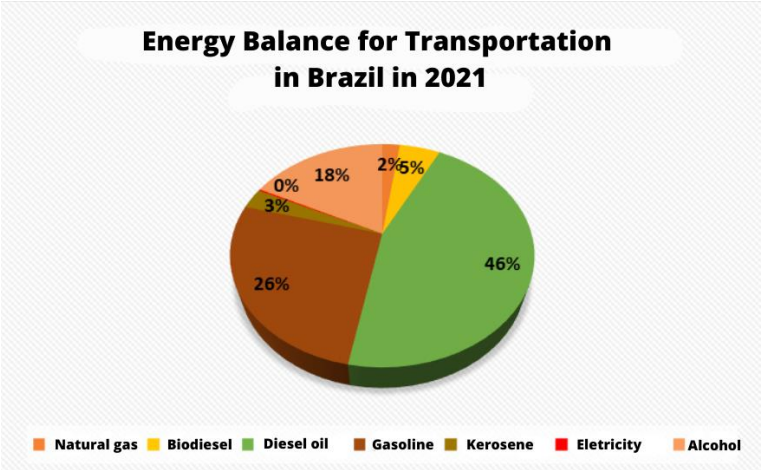
Source: Elaborated by the authors

APPENDIX B

Activity Card

After reading the text, please answer the following questions:

1. Are the alternative energy sources used in engines renewable or non-renewable?
2. From which sources can the electric energy used in electric vehicles come?
3. Based on the graph below, describe the types of energy sources (renewable or non-renewable) most used in Brazil in 2021 for transportation and the possible social and economic factors related to the use or discontinuation of these sources.



Adapted from: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2022

Group Product: Suggest ways to increase renewable energy use in Brazil.