

ARTICLE

**SOLID WASTE IN BRAZILIAN BASIC EDUCATION IN THE LIGHT OF CRITICAL ENVIRONMENTAL EDUCATION: AN INTEGRATIVE REVIEW<sup>1</sup>**

**LORRAYNE ISIDORO-GONÇALVES<sup>1</sup>**

ORCID: <https://orcid.org/0000-0001-9478-3146>  
<lorryneisidoro@gmail.com>

**ROBERTO JOSÉ GERVÁSIO UNGER<sup>2</sup>**

ORCID: <https://orcid.org/0000-0002-1815-2585>  
<roberto\_unger@eean.ufrj.br>

**ANNA CRISTINA CALÇADA CARVALHO<sup>1</sup>**

ORCID: <https://orcid.org/0000-0002-0128-942X>  
<anna.carvalho@ioc.fiocruz.br>

<sup>1</sup> Instituto Oswaldo Cruz (FIOCRUZ). Rio de Janeiro, RJ, Brasil.

<sup>2</sup> Universidade Federal do Rio de Janeiro. (UFRJ). Rio de Janeiro, RJ, Brasil.

**ABSTRACT:** We analyzed academic production on the teaching of solid waste in Brazilian basic education based on an integrative review of publications between 2018 and 2022. The CAPES Journal Portal, the CAPES Theses and Dissertations Catalog, the Brazilian Digital Library of Theses and Dissertations, Google Scholar, and the annals of ENPEC and CONEDU were consulted. The keywords used for the search were: “garbage”, “solid waste”, “education”, “teaching”, “school”. The themes were categorized by Braun and Clarke's thematic analysis (2006), and the teaching modalities followed Krasilchik's classification (2004). Of the 931 studies identified, 109 addressed teaching experiences about solid waste in Brazilian schools. A third of the studies were published in 2019 (33%), 42% were carried out in the northeast, 60% involved initiatives in Elementary Education, and public schools were the location of most of the work (84%). The teaching experiences were diverse, most of which were developed through lectures, practical classes, and projects in different disciplines. Waste management and consumption reduction were the main thematic categories identified. Most of the educational practices addressed the teaching of solid waste in a technical way; Few studies have discussed the socioeconomic and cultural causes, as well as the collective responsibility for waste management. A contextualized approach to each reality, involving the school community and its surroundings, can contribute to promoting more critical and integrative practices regarding solid waste at school.

**Keywords:** critical environmental education, solid waste, trash, school, integrative review.

**RESÍDUOS SÓLIDOS NA EDUCAÇÃO BÁSICA BRASILEIRA À LUZ DA EDUCAÇÃO AMBIENTAL CRÍTICA: UMA REVISÃO INTEGRATIVA**

**RESUMO:** Analisou-se a produção acadêmica sobre o ensino de resíduos sólidos na educação básica brasileira a partir de uma revisão integrativa das publicações entre 2018 e 2022. Foram consultados o Portal de Periódicos da CAPES, o Catálogo de Teses e Dissertações da CAPES, a Biblioteca Digital

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Brasileira de Teses e Dissertações, o Google Acadêmico e os anais do Encontro Nacional de Pesquisa em Educação em Ciências e do Congresso Nacional de Educação. As palavras-chave utilizadas para a busca foram: “lixo”, “resíduos sólidos”, “educação”, “ensino” e “escola”. Os temas foram categorizados pela análise temática de Braun e Clarke (2006) e as modalidades didáticas seguiram a classificação de Krasilchik (2004). Dos 931 estudos identificados, 109 abordaram experiências de ensino sobre resíduos sólidos nas escolas brasileiras. Um terço dos estudos foi publicado em 2019 (33%), 42% foram realizados no Nordeste, 60% envolveram iniciativas no ensino fundamental, e a escola pública foi o local da maioria dos trabalhos (84%). As experiências de ensino foram diversas, sendo, a maioria, desenvolvidas por meio de aulas expositivas, aulas práticas e projetos em diferentes disciplinas. Gestão de resíduos e redução do consumo foram as principais categorias temáticas identificadas. Grande parte das práticas educativas abordou o ensino de resíduos sólidos de forma técnica; poucos trabalhos discutiram as causas socioeconômicas e culturais, bem como a responsabilidade coletiva da gestão dos resíduos. Uma abordagem contextualizada a cada realidade, envolvendo a comunidade escolar e o seu entorno, pode contribuir para promoção de práticas mais críticas e integradoras sobre os resíduos sólidos na escola.

**Palavras-chave:** educação ambiental crítica, resíduos sólidos, lixo, escola, revisão integrativa.

## **LOS RESIDUOS SÓLIDOS EN LA EDUCACIÓN BÁSICA BRASILEÑA A LA LUZ DE LA EDUCACIÓN AMBIENTAL CRÍTICA: UNA REVISIÓN INTEGRATIVA**

**RESUMEN:** Analizamos la producción académica sobre la enseñanza de los residuos sólidos en la educación básica brasileña a partir de una revisión integradora de publicaciones entre 2018 y 2022. Se consultaron el Portal de Revistas CAPES, el Catálogo de Tesis y Disertaciones de la CAPES, la Biblioteca Digital Brasileña de Tesis y Disertaciones, Google Scholar y los anales de ENPEC y CONEDU. Las palabras clave fueron: “basura”, “residuos sólidos”, “educación”, “enseñanza”, “escuela”. Los temas fueron categorizados según el análisis temático de Braun y Clarke (2006) y las modalidades de enseñanza siguieron la clasificación de Krasilchik (2004). De los 931 estudios identificados, 109 abordaron experiencias de enseñanza sobre residuos sólidos en las escuelas brasileñas. Un tercio fueron publicados en 2019 (33%), 42% fueron realizados en el nordeste, el 60% involucró iniciativas en la Educación Primaria y las escuelas públicas fueron la ubicación de la mayor parte de los trabajos (84%). Las experiencias docentes fueron diversas, la mayoría se desarrollaron a través de conferencias, clases prácticas y proyectos en diferentes disciplinas. La gestión de residuos y la reducción del consumo fueron las principales categorías temáticas identificadas. La mayoría de las prácticas educativas abordaron de manera técnica la enseñanza de los residuos sólidos; pocos estudios han discutido las causas socioeconómicas y culturales, así como la responsabilidad colectiva en la gestión de residuos. Un abordaje contextualizado de cada realidad, involucrando a la comunidad escolar y su entorno, puede contribuir a promover prácticas más críticas e integradoras respecto de los residuos sólidos en la escuela.

**Palabras clave:** educación ambiental crítica, residuos sólidos, basura, escuela, revisión integradora.

## **INTRODUCTION**

In recent years, environmental issues intensified by globalization have given global attention and emerged as prominent topics on international agendas (UNPD, 2015). Within this context, a key focus of the debate has been the production and management of solid waste, which is defined as the byproducts of human activities that can be reintegrated into the production cycle through methods such as reuse, recycling, or composting (Brasil, 2010; Logarezzi, 2004; Rocha, 2018).

According to data from the World Bank (2018), in 2016, 2.01 billion tons of waste were produced worldwide, and this production is expected to increase by 60% by 2030. Of this total, an estimated one-third is dumped directly into the environment (World Bank, 2021), losing its treatment and recovery potential through currently available economic and technological processes (Brazil, 2010).

In Brazil, solid waste management also represents a major challenge. In 2022, 81.8 million tons of waste were produced, of which 39% was dumped in inappropriate places (Abrelpe, 2022), impacting the lives of 77.5 million people and resulting in environmental and health costs of billions of dollars per year (Abrelpe, 2021).

In this scenario, improper waste disposal is a key issue, resulting in soil, air, and water contamination, in addition to increasing the risk of vector-borne diseases (PAHO, 2018). Waste burning, another of these factors, releases toxic gases, accounting for 5% of annual greenhouse gas emissions (World Bank, 2018). According to Loureiro (2004), Oliveira, and Sánchez (2018), the hegemonic discourse disseminates the idea that people, in general, are equally responsible for the exploitation and destruction of natural resources, as well as for the production of waste.

However, according to the National Solid Waste Policy (PNRS), the responsibility for waste management in cities lies with the public authorities (Brasil, 2010). Although 75.1% of municipalities have some type of selective collection system, unfortunately, it does not reach the entire population (Abrelpe, 2022). Due to their lower organizational power and political participation, the poorest populations are those who suffer most directly from the consequences of inadequate solid waste management and environmental degradation (Acsegrad, 2010; Oliveira; Sánchez, 2018; Pacheco, 2007).

Faced with a broad and complex socio-environmental issue like waste production and management, it is necessary to invest in scientific research and promote effective awareness on the topic. It is crucial to understand that the solid waste problem will not be solved simply by “throwing trash in the trash can” (Brasil, 2022a). Solid waste management involves sociocultural, economic, and environmental factors, which demand multisectoral solutions and a new perspective on how we relate to the means of production and the exploitation of nature, going beyond capitalist logic.

In addition to defining the boundaries of waste production and management, collective responsibility for this issue must also be considered, involving schools, businesses, mass media, and society as a whole in the debate on environmental education, as recommended by the National Environmental Education Policy (Brazil, 1999). Furthermore, the discussion on the importance of waste production and management in local areas is embedded in the discourse of regulatory agencies, such as the United Nations (UN), and in the Sustainable Development Goals (SDGs), which address the issue of waste in 9 of their 17 goals.

At the educational level, the development of environmental education practices in schools is increasingly necessary. This approach contributes to a collective and organized search for understanding and overcoming the structural causes of environmental challenges, contributing to an integrated view of socio-environmental problems (Guimarães, 2004; Guimarães, 2011; Layrargues, 2002; Reis, 2019). The diversity of approaches to environmental education reflects different conceptions of the relationship between humans and nature, ranging from more pragmatic and individualistic perspectives to more critical and systemic practices (Layrargues, Lima, 2014). Therefore, the objective of this study was to identify, through an integrative review of the scientific literature, experiences related to teaching about solid waste in Brazilian basic education, aiming to provide elements for reflection and future promotion of teaching initiatives based on the critical environmental education.

## **CRITICAL ENVIRONMENTAL EDUCATION**

Throughout the 20th and 21st centuries, different pedagogical approaches emerged to discuss how to construct an education that embraces social reality and the possibilities for action in the development of students. Environmental education is one of these approaches (Layrargues; Lima, 2011), which emerged at the end of the 20th century from the demand for an education that would contribute to minimizing the environmental impacts observed globally. Throughout the development of this field, distinct approaches emerged from different political-pedagogical currents, called macrotrends (Layrargues; Lima, 2011). Initially, environmental education developed from a conservationist perspective, based on the logic of “knowing to love, loving to preserve,” an approach that tends to adopt a strictly ecological perspective, unconcerned with the social context.

During the evolution of the field, the social dimension began to be considered in educational practices, giving rise to two main approaches: pragmatic and critical. Pragmatic environmental education

is considered a variation of conservationism, stemming from the logic that “everyone must do their job” as a solution to the socio-environmental crisis, toward sustainable development (Layrargues; Lima, 2011). Critical environmental education, on the other hand, aims to understand reality, considering the political dimension of the environmental crisis in favor of societal transformation (Guimarães, 2011). In this sense, Loureiro and Layrargues (2013) understand that environmental education seeks three primary pedagogical situations:

To conduct a consistent analysis of the complex context of reality to have the necessary foundations to question the historically produced social conditions that imply social reproduction and generate inequality and environmental conflicts;  
 To develop the autonomy and freedom of social agents in the face of the relations of expropriation, oppression, and domination inherent in capitalist modernity;  
 To implement the most radical transformation possible of the dominant societal pattern, which defines the situation of intensive degradation of nature and, within it, of the human condition (Loureiro; Layrargues, 2013, p. 64).

Both Guimarães (2011) and Loureiro and Layrargues (2013) contend that for genuine progress to occur, environmental education must transcend a superficial understanding of problems that oversimplifies complex issues, and instead engage with their political, historical, and cultural dimensions. This narrow perspective deepens the divide between people and nature, which lessens our capacity to recognize the interconnectedness of life and obstructs the development of effective solutions to socio-environmental injustices. When discussing solid waste from the viewpoint of critical environmental education, several authors observe that the subject is often approached in a practical and overly simplified manner, neglecting the systems that contribute to the current environmental crisis (Logarezzi, 2004; Reis, 2019).

Layrargues and Torres (2022) point out that the discussion about waste often boils down to a technical approach, blaming individuals for improper disposal without critically questioning how production and consumption generate this waste. In this regard, Leonard (2011) argues that the problem lies not with the consumer, but with an economic model based on limitless growth, the production of disposable goods, and planned obsolescence.

By treating the waste issue as a matter of individual behavior change, environmental education ends up reproducing market logic. This approach reinforces the idea of a “generic and abstract individual,” separated from their social context, held responsible for problems that are, in fact, structural. Thus, the responsibility of companies and political agents is minimized, concealing socio-environmental conflicts and maintaining social inequality (Layrargues, 2009).

Guimarães (2011, 2020) emphasizes that environmental education that overlooks the social context lacks political strength, which hampers civic engagement. Teachers, despite their genuine concern for the environment, frequently resort to non-transformative practices. This is often due to insufficient training or the pressures of an educational system that does not adequately prioritize the complexities of socio-environmental issues.

## **METHODOLOGICAL APPROACH**

The integrative review, chosen for its breadth and comprehensiveness, aims to systematically synthesize and analyze scientific knowledge on a given topic, contributing to a deeper understanding of the issue under investigation and providing new insights and reflections (Botelho; Cunha; Macedo, 2011; Cooper, 1982). This methodological approach consists of five stages: formulation of the research problem, data collection, evaluation of the collected results, analysis and interpretation of the data, and presentation of the results (Cooper, 1982).

To formulate the research question, the “PCC” strategy (Araújo, 2020) was used, in which “P” refers to the population to be studied (students); the first “C” refers to the concept—what is the central issue to be examined (teaching about solid waste); and the second “C” refers to the context—what are the characteristics of this population (basic education students). Thus, the research question was: How has the topic of solid waste been addressed in Brazilian basic education over the last five years?

For data collection, five search sources were consulted: the CAPES Journal Portal, the CAPES Theses and Dissertations Catalog (T&D), the Brazilian Digital Library of T&D, and the proceedings of the National Meeting on Research in Science Education (ENPEC) and the National Education Congress (CONEDU). The following keywords were used: “garbage,” “solid waste,” “education,” “teaching,” and “school.” The search strategy was constructed using Boolean operators as follows: (garbage OR solid waste) AND (education OR teaching OR school). To broaden the scope of the search and include articles presented at scientific events or published in non-indexed journals, searches using the same terms were conducted on Google Scholar. However, after analyzing the first ten pages of results, a low level of accuracy and a lack of new relevant studies were found, resulting in the decision not to continue using this database.

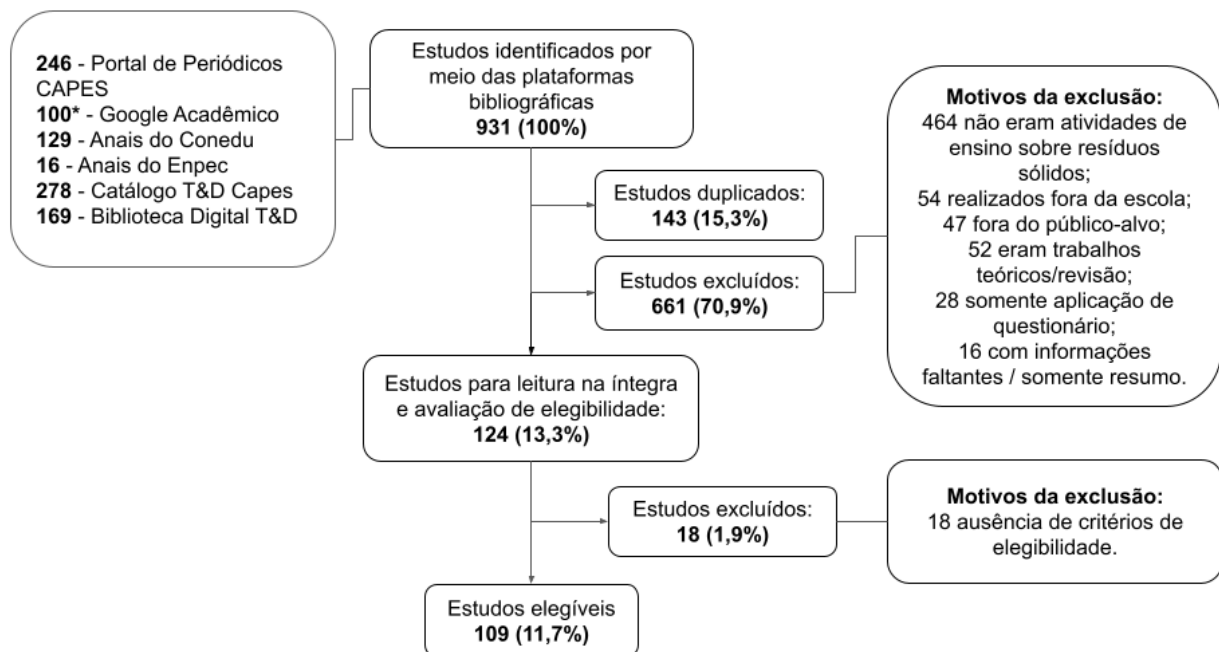
Publications in Portuguese, including articles, theses, dissertations, and complete papers published electronically in conference proceedings related to solid waste education, were deemed eligible for inclusion in this review. The selection encompassed various segments of basic education, including early childhood education, elementary education, high school, youth and adult education (EJA), as well as technical and vocational education, across both public and private institutions. This review was conducted in 2023 and covered the period from 2018 to 2022 in order to incorporate papers published on the topic over the preceding five years. Documents not pertaining to the acronym "PCC," meaning those outside the scope of the research proposal, were excluded. Additionally, publications that were not available for online access were also omitted from this review.

From the selected studies, information regarding type and year of publication, geographic distribution, basic education segment, type of school, and practices developed were classified, categorized by teaching modalities and themes. To classify teaching modalities, the categories proposed by Krasilchik (2004) for biology teaching were adopted: lecture, discussion, practical class, demonstration, excursion, individualized instruction, simulation, and project. To categorize the themes, the thematic analysis proposed by Braun and Clarke (2006) was used as a basis.

## RESULTS AND DISCUSSION

A total of 931 potentially eligible studies were identified and, from reading the abstract and full text, 109 publications were included in this integrative review (Figure 1).

Figure 1 – Eligibility flowchart of studies evaluated in the integrative review on teaching about solid waste.



246- CAPES Journal Portal  
100\*-Google Scholar

129- CONEDU Annals

16- ENPEC Annals

278- CAPES T&D Catalog

169- T&D Digital Library

Studies identified through bibliographic platforms: 931 (100%)

Duplicate studies: 143 (15.3%)

Excluded studies: 661 (70.9%)

Studies for full reading and eligibility assessment: 124 (13.3%)

Excluded studies: 18 (1.9%)

Eligible studies: 109 (11.7%)

Reasons for exclusion: 464 were not teaching activities on solid waste; 54 conducted outside of school; 47 outside the target audience; 52 were theoretical/review works; 28 were questionnaire applications only; 16 missing information/summary only.

Reasons for exclusion: 18 lack of eligibility criteria

Source: The authors (2025).

\* Results for Google Scholar: 16,700 publications identified, but only the first 100 were evaluated for relevance. T&D – Theses and Dissertations; Capes – Coordination for the Improvement of Higher Education Personnel; Enpec – National Meeting on Research in Science Education; Conedu – National Congress of Education.

The selected works, as well as information on authorship, year, region, type of publication, and study participants, are presented in chronological order in Table 1.

Table 1 – Works identified in the integrative review on teaching about solid waste between 2018 and 2022 (N=109).

#	AUTHORS	REGION	TYPE OF PUBLICATION	STUDY PARTICIPANTS
1	Alves; Araújo, 2018.	N	AE	5th-year Elementary students.
2	Alves; Cavalcanti; Neto, 2018.	NE	P	10 2nd-year High school students.
3	Andrade, 2018.	NE	D	172 students from Elementary to High school, between 6 and 19 years old, 1 manager, and the Secretary of Public Works and Urban Planning.
4	Bellini, 2018.	S	D	96 students from 4 classes of the 2nd year of High School.
5	Bravo <i>et al.</i> , 2018.	SE	P	297 students from 11 High School classes and staff.
6	Da Silva; Intorne, 2018.	SE	AE	25 High School students, aged between 13 and 22.
7	Da Silva; Correia; Teles, 2018.	NE	AE	Students from 1 class of the 3rd year of Elementary school.
8	De Araújo, 2018.	NE	AE	40 7th-grade Middle school students.
9	Dos Santos <i>et al.</i> , 2018.	S	P	School community.
10	Duarte; Silva; Da Silva, 2018.	NE	AE	62 students of 2 classes of the 9th year of High School.
11	Figueirêdo <i>et al.</i> , 2018.	NE	AE	11 5th-semester students from the Proeja night program.
12	Gomes; Medina, 2018.	S	P	94 students from the 6th and 7th years of Middle School.
13	Lima <i>et al.</i> , 2018.	NE	AE	4th-year Elementary students.
14	Martins; Carvalho; Couto, 2018.	CO	AE	Students from 5 classes of the 5th year of Elementary school.
15	Mendonça; Schmitz; Andrade, 2018.	S	P	Not specified.
16	Monteiro, 2018.	SE	D	26 9th-grade High School students.
17	Nascimento; Nazário, 2018.	NE	AE	36 6th-grade Middle school students.
18	Pereira; Guimarães, 2018.	NE	AE	7th-grade Middle school students.
19	Pinto, 2018.	S	D	81 students; 3 classes of 6th grade of Middle school.

20	Santos <i>et al.</i> , 2018.	NE	AE	33 5th-year Elementary students.
21	Sêca; De Araújo; Da Silva, 2018.	NE	AE	37 Elementary students.
22	Silva; Martins, 2018.	NE	AE	45 EJA students: 4th period (7th year of Middle school), 5th period (9th year of High school) and 2nd year of Elementary.
23	Siqueira; Arrial, 2018.	S	P	18 1 <sup>st</sup> -year Elementary students, aged between 6 and 7.
24	Valle; Utta, 2018.	NE	P	2nd year Elementary students.
25	Almeida; Duarte; Hidalgo, 2019.	S	P	All Elementary, Middle and high School classes.
26	Araújo <i>et al.</i> , 2019.	NE	AE	School community, Middle school.
27	Barbosa <i>et al.</i> , 2019.	N	P	Students from 2nd to 5th grade of the Elementary school, school teachers, school management.
28	Bezerra; Oliveira; Nascimento, 2019.	NE	AE	10 students from 9th grade to 3rd grade of High school.
29	Bitencourte; Rodriguez, 2019.	S	P	1 class of students from nursery II, aged 1 to 2 years old, in Early Childhood Education.
30	Cembranel; Francischett; Rodrigues, 2019.	S	P	147 students from 1st to 5th grade and 25 families from an Elementary school.
31	Costa, 2019.	SE	D	22 students from a class on the technical course in Administration.
32	Da Rocha; Santos; Pitanga, 2019.	NE	P	19 3rd-year Middle school students.
33	Da Silva; Silva; Amado, 2019.	SE	AE	4th-year Elementary students.
34	De Albuquerque <i>et al.</i> , 2019.	NE	AE	10 9th-grade High school students.
35	Dos Reis <i>et al.</i> , 2019.	SE	P	25 2nd-year High school students.
36	Dos Santos; Martins, 2019.	NE	AE	Two classes of 3rd-year High school, between 15 and 20 years old.
37	Ferreira <i>et al.</i> , 2019.	NE	AE	20 students from 1st to 3rd year of Elementary school.
38	Friede; Reis; Avelar, 2019.	SE	P	7th-grade Elementary students.
39	Larsen; Weinschutz; Kolicheski, 2019.	Sul	P	6 classes, 3rd year of High school technician in Environment.
40	Martins, 2019.	NE	P	Students from 3 High school classes, from 1st to 3rd year.
41	Medeiros <i>et al.</i> , 2019.	NE	AE	33 1st year High school students.
42	Mendes <i>et al.</i> , 2019.	NE	AE	1st year High school students.
43	Mesquita, 2019.	SE	D	25 2nd year High school students, aged 14 to 17.
44	Moreira; Márquez; Araújo, 2019.	SE	P	35 students from an 8th-grade Middle school class.
45	Nicoletti, 2019.	S	AE	52 students from 2 6th-grade Middle school classes.
46	Oliveira; Costa; Pimenta, 2019.	CO	AE	9th-grade High school students.
47	Pedrozo, 2019.	S	D	10 students from the Chemistry Technician School, between 18 and 42 years old.
48	Raupp; Cunha, 2019.	CO	P	22 5th-year Elementary students, aged between 9 and 12.
49	Rodrigues; Kindel, 2019.	S	P	7th-grade Middle school students.
50	Rosini <i>et al.</i> , 2019.	S	P	219 High school students, aged between 14 and 20.
51	Santos; Medeiros, 2019.	NE	P	79 students from 3 9th-grade High school classes.
52	Santos, L. S. O. <i>et al.</i> , 2019.	NE	P	Not explained.

53	Santos, M. F. S. <i>et al.</i> , 2019.	NE	AE	15 students from the 8th and 9th grades of Middle school, 5 parents, the principal, and 3 teachers.
54	Santos, 2019.	N	D	83 8th and 9th-grade High school students from three schools.
55	Silva; Richetti, 2018.	SE	P	15 5th-year Elementary students.
56	Silva <i>et al.</i> , 2019.	N	AE	3rd-year Elementary students.
57	Silva, 2019.	NE	AE	6 8th-grade Middle school students.
58	Simonato, 2019.	N	D	27 students from a 3rd-year High school class.
59	Souza <i>et al.</i> , 2019.	NE	AE	A 9th-grade Middle school class and 22 teachers.
60	Torezin <i>et al.</i> , 2019.	S	AE	A 7th-grade Middle school class.
61	Andrade, 2020.	NE	D	30 students from a 6th-grade Middle school class.
62	Angelis, 2020.	SE	D	Elementary and Middle school students.
63	Angieski <i>et al.</i> , 2020.	S	P	High school students.
64	Barcellos; Copetti; Pastorio, 2020.	S	P	Students from 4th to 9th grade, faculty, and school staff.
65	Behling <i>et al.</i> , 2020.	S	P	100 Elementary and Middle school students, aged between 6 and 14.
66	Campos, 2020.	N	D	100 students from four classes of the 2nd year of High school, between 15 and 19 years old.
67	Da Silva; Da Silva, 2019.	NE	AE	Students from 2 classes of the 7th year of Middle school.
68	De Sousa; Moreno, 2020.	NE	P	19 6th-grade Middle school students.
69	Do Nascimento; Alves, 2020.	N	P	40 students from two 2nd-year High school classes.
70	Freitas, 2021.	NE	D	73 8th-grade Middle school students, aged 13 to 18.
71	Karat; Giraldo; Cassiani, 2020.	S	P	High school students.
72	Marques; Xavier, 2020.	S	P	20 6th-grade Middle school students.
73	Mothé <i>et al.</i> , 2020.	SE	P	120 9th-grade High school students.
74	Nunes <i>et al.</i> , 2020.	S	P	15 5th-year Elementary students.
75	Oliveira; Araújo; Aquino, 2020.	NE	P	Students from 1 class of the 2nd year of High school.
76	Paiva, 2020.	NE	D	35 2nd-year high school students, aged 15 to 16.
77	Santos, 2020.	S	D	9 teachers and 31 students from a 1st year of High school class.
78	Silva, A. V. <i>et al.</i> , 2020.	CO	P	50 students from two 5th-year classes and 5 staff members.
79	Silva, D. Z. P. <i>et al.</i> , 2020.	NE	P	42 7th-grade Middle school students, aged 10 to 13, from 3 public schools.
80	Sousa, 2020.	SE	D	4th year of Elementary school, between 9 and 11 years old.
81	Souza <i>et al.</i> , 2020.	SE	P	1st and 2 <sup>nd</sup> -year High school students.
82	Tertuliano, 2020.	S	D	26 students from a 5th-grade EF class.
83	Alves, 2021.	SE	AE	5th-year Elementary students.
84	Costa <i>et al.</i> , 2021.	NE	P	15 4th-year Elementary students.
85	Da Silva; Guerra, 2021.	SE	AE	60 students from three 6th-grade EF classes.
86	De Bortoli; Castaman, 2021.	Sul	P	High school students.
87	Figueiroa, 2021.	NE	D	40 2nd year students, 15 to 17 years old
88	Fontes, 2021.	NE	D	12 students of the subsequent technical High school in Sanitation.
89	Gomes; Scheibler; Filho, 2021.	NE	AE	22 final year EJA students, at night, between 22 and 60 years old.

90	Lima; Sousa; Dantas, 2021.	NE	AE	24 7th-grade Middle school students.
91	Santos; Lima, 2021.	NE	P	4 Professors and 10 students of the subsequent technical High school in Logistics.
92	Silva; Duda, 2021.	NE	AE	9th-grade Middle school students.
93	Souza, 2021.	SE	D	65 students from three classes of 5-year-olds.
94	Stedile; Carmadelo; Cioato, 2021.	S	P	268 students from 1st to 5th year of Elementary school, 80 guardians and 10 teachers, 378 students from EI to 5th year of EF, and 41 guardians.
95	Borges; Da Silva; Silva, 2022.	NE	AE	Guardians of Early Childhood Education students.
96	Castione, 2022.	S	D	2 students from the 8th and 9th grade of Middle school.
97	Da Silva; Lima, 2022.	NE	AE	30 1st year High school students.
98	Diniz; Calefi, 2022.	SE	P	6 students from the technical High school in Sugar, Alcohol, and Food, and 3 from the degree in Chemistry.
99	Do Nascimento, 2022.	SE	D	19 students from the 1st to 3rd year of High school, aged 16 to 18.
100	Friedrich, 2022.	S	D	8 students from a 6th-grade elementary school class, ages 11 to 17.
101	Garcia; Miranda; Costa, 2022.	NE	P	9th-grade elementary school students.
102	Gonçalves; Roth, 2022.	S	P	200 students from 6th to 9th grade elementary school.
103	Gonçalves; Novello; Junior, 2022.	S	P	68 students from two 6th-grade elementary school classes.
104	Lima; Brabo, 2022.	N	P	6 7th-grade elementary school students.
105	Lima, 2022.	NE	D	56 3rd-year high school students majoring in computer science and 5 course teachers.
106	Lopes <i>et al.</i> , 2022.	NE	AE	17 8th- and 9th-grade elementary school students, ages 16 to 46.
107	Oliveira, 2022.	CO	D	4th-grade elementary school students.
108	Pedro, 2022.	S	D	263 6th- to 3rd-grade elementary school students.
109	Rodrigues, 2022.	N	D	10 2nd-year high school students and 3rd-year EJA students, ages 18 to 40.

Source: The authors (2025).

\* EJA – Youth and Adult Education; EM – High School; EF – Elementary School; EI – Early Childhood Education; N – North; NE – Northeast; S – South; SE – Southeast; CO – Midwest; D – Dissertation; AE – Conference Annals; and P – Journals. Note: The numbers in the first column of the table are a reference for reading Table 2.

## Characterization of studies

Regarding the type of publication, 41% of the studies were published in journals, 34% in conference annals, and 25% were master's dissertations. No doctoral theses on teaching solid waste in basic education were identified. Regarding geographic distribution, almost half of the studies (42%) were concentrated in the Northeast region of the country, followed by the South (27%). The Central-West region presented only two publications (2%). Most conference annals (73%) were published in the Northeast.

The studies were carried out across various segments of basic education, with a significant majority occurring in elementary schools (60%). This is consistent with Amaral's (2022) state-of-the-art research, which found that 74% of the identified studies also took place within this segment. In contrast, studies focusing on early childhood education and youth and adult education were notably

underrepresented, comprising only 4% (5 out of 109) in each area. The scarcity of research addressing environmental education, particularly regarding solid waste in early childhood settings, was also highlighted in international studies (Davis, 2009; Jørgensen, Madsen, Læssø, 2017). Concerning secondary education, 44% of the studies were conducted at this level, with 18% occurring in technical or vocational programs.

Most of the schools where these teaching experiences took place were public (84%). Among those that reported the type of school (78/92), 50% were state, 37% municipal, 10% federal, and 3% took place in military or civic-military schools.

### **Development of teaching activities on solid waste**

In terms of teaching activities, the majority (90%) were one-time events, averaging 3.13 months in duration, and involved students from one or more classes (74%). Ongoing activities were present in 24 studies, particularly those that engaged the school community, with 8 out of 10 studies exhibiting this characteristic. Only 10% of the studies referenced previous environmental education or selective waste collection initiatives. According to the PNRS (Brasil, 2010), state plans should establish integrated solutions for selective waste collection and proper waste disposal across various areas of the city, including schools; however, this is still not the case in most of the institutions examined. The lack of essential infrastructure for waste management highlights a situation of neglect, especially noticeable in socially vulnerable areas, which further contributes to the persistence of socio-environmental injustices (G1 Globo, 2022; Rodrigues, 2021).

In terms of authorship of educational initiatives, a significant majority (88%) were carried out by researchers external to the school, with only five studies conducted in collaboration with a teacher from the institution. While the data does not provide specific statistical analyses, the dominance of ad hoc practices and research conducted by outsiders often leads to fragmented approaches that may not align with the realities of the school. Therefore, it is recommended that research in educational settings actively involve teachers and coordinators, promoting the development of contextualized practices that can be effectively integrated into the school's daily operations.

More than half of the activities (55%) were carried out through workshops held outside the classroom, including two during recess. Among the activities, 45% were developed across school subjects, both disciplinary and interdisciplinary, covering the following areas: science (21 studies); chemistry (14); geography (8); mathematics (5); arts (5); Portuguese (4); physics (2); history (1); sociology (1); English (1); life project and entrepreneurship (1); environmental health (1); and environmental analysis (1). Historically, environmental education has generally been related to the disciplines of geography and science, as it is an area that began through the confluence of the environmental and educational fields, and which developed a predominantly conservationist and naturalist character during its initial phase in Brazil (Kawasaki; Carvalho, 2009; Layrargues; Lima, 2014). Despite this, this review highlights the effort to introduce new approaches to environmental education into educational spaces.

Only 32 of the 109 studies conducted some form of evaluation after educational activities, and none assessed the impact of these actions. Impact assessment can provide important data and evidence for critical reflection on adopted practices, fostering continuous adjustments and improvements (IDIS, 2023) and thus ensuring that education is relevant and capable of generating positive changes in the school environment in the medium and long term.

### **Didactic modalities**

The teaching experiences on solid waste developed in the analyzed studies were diverse, mostly involving lectures (79 works), practical classes (49 works), and projects (46 works), which occurred in isolation or in combination. Lectures, workshops, and group work were also strategies adopted in teaching about solid waste in the systematic review by Lutif, Oliveira, and Gonçalves (2023) and in the multicenter study in European schools by Lee et al. (2022).

Lectures were combined with one or more teaching methods. The most common approaches in practical classes were the reuse of waste to create objects and toys, and the holding of selective waste collection workshops. In Amaral's (2022) review, more than half of the researchers (55.5%) proposed activities involving the reuse of various solid waste to create objects. However, these practices had a

technical bias, without deepening the discussion and questioning the socioeconomic and cultural causes of the problem, nor the collective responsibility for waste management.

The projects focused on textual and visual creations, as well as the development of prototypes and photographic records. Among these, 19 investigative practices were developed based on the collection and analysis of household, school, and compost waste, in addition to interviews with the school community and the development of a junior enterprise.

Field trips represented a minority of activities, appearing in only nine studies. They involved visits to improper waste disposal sites, environmental protection areas, and museums. The lower incidence of field trips compared to other educational activities was also observed in the review by Lutfi, Oliveira, and Gonçalves (2023), in which only 7% of activities were extracurricular. This contrasts with international studies, in which field trips were more frequent (Lee et al., 2022).

From the perspective of critical environmental education, fieldwork allows students to leave the school environment and experience socio-environmental problems in their real-world contexts. By visiting different areas of a city, for example, it is possible to observe differences in environmental impacts, encouraging students to question and analyze the underlying causes of the problems encountered and seek possible solutions. Therefore, fieldwork can contribute to a contextualized discussion of environmental issues experienced by the school community and how to solve these problems (Freire, 2021).

### Main topics covered

Braun and Clarke (2006) used thematic analysis as a reference to categorize the themes. The central themes identified were solid waste management and consumption. The distribution of these publications according to these themes, as well as the frequency of each of them and their respective subthemes, is found in Table 2.

Table 2 – Topics covered in works on teaching solid waste in Brazilian basic education between 2018 and 2022.

<b>THEMES</b>	<b>PUBLICATIONS*</b>	<b>FREQUENCY OF THEMES</b>
<b>SOLID WASTE MANAGEMENT</b>		82
Selective collection	2, 3, 4, 5, 9, 10, 16, 17, 19, 20, 21, 22, 25, 28, 29, 33, 34, 36, 37, 38, 39, 50, 52, 55, 56, 58, 59, 67, 70, 72, 74, 82, 84, 85, 86, 89, 92, 93, 94, 96, 97, 100, 102, 103, 104, 107, 108.	47
Reuse	7, 8, 15, 18, 23, 29, 30, 34, 36, 40, 45, 48, 52, 53, 58, 59, 61, 62, 65, 69, 72, 79, 80, 82, 83, 84, 86, 90, 95, 96, 97, 101.	32
Recycling of dry and organic waste	3, 5, 6, 8, 12, 15, 16, 24, 27, 42, 44, 53, 57, 60, 68, 71, 72, 73, 76, 78, 80, 81, 86, 92, 93, 96, 100, 106, 107.	29
<b>CONSUMPTION</b>		31
Conscious consumption	16, 21, 22, 28, 31, 32, 35, 37, 43, 47, 48, 58, 66, 70, 72, 79, 82, 84, 90, 91, 96, 97, 99, 105, 108, 109.	26
Consumerism	2, 13, 32, 64, 71, 88, 98.	7

Source: The authors (2025).

\* For publication identification, see Table 1.

### Theme 1: Solid waste management

Waste management was addressed in the majority (75%) of the studies analyzed in this review. In assessments before educational activities, students lacked knowledge of appropriate waste management practices. In Andrade's (2018) study of 142 elementary, middle, and high school students, only 25% of participants reported frequently using school trash cans to dispose of waste, with much of this waste discarded on the floor. Furthermore, 74% of students reported not separating waste at home.

In Bravo et al.'s (2018) study, most 297 students (90%) reported being unaware of selective waste collection and not separating waste for recycling (78%), even though there was a voluntary waste drop-off point in the city.

The limited knowledge of children and adolescents regarding waste management practices can largely be attributed to insufficient discussion and daily engagement with the topic. This gap may stem from difficulties in comprehending how to address such issues, or simply a lack of interest in them. To foster active citizenship among students, it is essential to develop practices that are contextualized within their realities. Guimarães (2011) and Loureiro and Layrargues (2013) emphasize that for environmental education to be deemed “critical,” it must promote discussions on complex issues and explore their political, historical, and cultural dimensions, thereby enhancing students' engagement with the subject matter. Additionally, employing active methodologies, such as inquiry-based learning (Sasseron, 2015) and problem-based learning (Lopes et al., 2019), can effectively encourage students' active participation in educational practices.

### Selective collection

The 47 selective collection practices were developed through lectures, practical classes, and projects in different segments of basic education (Table 2). The approaches varied from more technical classes focused on creating selective collectors for waste identification to approaches that involved the school community.

Among the practices related to selective waste collection, 41% were approached predominantly technically. Bitencourte and Rodriguez (2019), for example, developed practical classes with early childhood education, in which children painted selective waste collection bins and identified where to dispose of each type of waste based on the bins' colors. The authors believe that acquiring knowledge about proper waste disposal by students, even at a young age, has the potential to spread within the family environment. On the other hand, Cembranel, Francischett, and Rodrigues (2019) conducted lectures on selective waste collection and reuse with 147 students from grades 1 to 5. The researchers found that, even after the educational practices, no changes in waste separation were observed in these students' homes. The tendency to approach waste management from a technical perspective has also been identified in international studies, such as the multicenter study in European schools by Lee et al. (2022), in which the authors emphasize the need for adequate school infrastructure to engage students in selective collection practices.

In Brazil, this challenge is even more acute. As noted by Guimarães et al. (2012), environmental education in Brazilian schools still faces structural challenges that may limit its potential for social transformation. In general, projects are developed through ad hoc activities, with little systematization or teacher participation. This fragmentation is related to a lack of support from school administration and a shortage of material and human resources. Despite this, initiatives such as the “Zero Waste Schools” project have stood out for their potential to integrate waste management into the school environment, aiming to transform students and staff into agents of change in their homes and communities, promoting citizenship education (Mendonça, Schmitz, Andrade et al., 2018; Barros, 2024).

Studies involving selective collection initiatives within the school community were scarce, as noted by Lutfi, Oliveira, and Gonçalves (2023). On the other hand, a significant example is the work of Larsen, Weinschutz, and Kolicheski (2019), who created a voluntary oil drop-off point through the initiative of third-year technical high school students. In nine months, 550 liters of oil were collected, 60 of which were used to produce handmade soap, which was donated to the participating community. The authors observed that the students guided their learning and promoted good oil management practices within the school community. Rosini et al. (2019) organized an oil and electronic waste collection event with 219 high school students, with support from the local government. During this event, 903.5 kilos of cooking oil and 10,355 kilos of waste were collected, which helped students understand how to contribute to waste management in their own reality and collectively.

The government's negligence in providing infrastructure for selective waste collection in municipalities hinders proper waste management, even when the population is willing to separate their waste. This can contribute to the occurrence of educational practices with a pragmatic bias, focused on technical issues of waste management. Much of the selective waste collection and recycling in Brazil is

carried out by waste pickers or groups of waste pickers who often lack employment benefits (Layrargues, 2002). According to the PNRS (Brasil, 2010), the government must provide infrastructure, establish partnerships, and compensate waste pickers for their services. Furthermore, it is important that the government, in partnership with schools, businesses, and the media, promote ongoing actions focused on environmental education and teaching about solid waste, addressing both waste disposal and the socio-environmental implications of negligent disposal, as recommended by the National Environmental Education Policy (Brasil, 1999).

Environmental educators must advocate for educational practices related to solid waste management that address political, social, cultural, and economic dimensions. They should also propose contextualized strategies to challenge the perception that waste is solely an individual issue (Guimarães, 2004; Layrargues, 2002). Tackling waste production presents a structural challenge that requires collective recognition and discourse to press for short- and medium-term solutions from the government. It is essential for professionals in this field to realize that socio-environmental issues cannot be resolved merely by imparting ecologically sound knowledge, as suggested by traditional conservationist and pragmatic approaches. Instead, a collective responsibility for addressing these socio-environmental challenges must be acknowledged, as emphasized by critical environmental education (Guimarães 2004; Layrargues; Torres, 2022; Logarezzi, 2004; Reis, 2019). Active social participation and the promotion of citizenship are vital for the successful implementation of any public policy, including the effective execution of the PNRS (Reis; Matos; Silva, 2018).

## Reuse

Among the teaching experiences on waste management, 29% of the studies addressed the reuse of materials through lectures and practical lessons, especially in elementary school (Table 2). This topic was explored through the creation of objects and practices related to entrepreneurship.

Waste reuse activities were developed as the core activity. Costa et al. (2021) performed a play about selective waste collection and best practices, as well as a workshop on making toys such as checkers and table football, activities that, according to the authors, stimulated students' imagination and critical thinking. In workshops on creating games with waste collected by fifth-grade students, Raupp and Cunha (2019) found that practices like these contribute to a playful and fun reflection on environmental protection.

Entrepreneurial practices were also developed, such as the reuse workshops discussed in the work of Mendonça, Schmitz, and Andrade (2018). Resulting in the production of wallets and pencil cases made from milk cartons, eco-friendly notebooks, earrings, and necklaces to be sold at a fair, the initiative raised R\$80 and, according to the researchers, engaged students in reducing material waste. Similarly, Martins (2019) held annual fairs with high school students to reuse objects, collecting books, clothes, shoes, furniture, and appliances to be sold affordably to the community. The students raised R\$5,000, which they used to finance travel and studies. The author noted the development of the students' critical thinking, as they recognized that waste could have different values for people, encouraging the problematization of disposal and the identification of new possibilities for reuse.

Addressing the redefinition of waste in schools can foster a more thoughtful approach to the production and disposal of materials. In the study by Jørgensen et al. (2018), conducted in Danish early childhood education settings, it was found that reusing waste materials associated with the arts enhances curiosity, ingenuity, and creativity among children, while also promoting their autonomy through active participation in toy creation. However, pursuing waste reuse practices without taking into account the broader issues of resource extraction and product manufacturing is a simplistic and pragmatic approach to this conversation. Engaging with the capitalist economic system, exploring the conflicts surrounding resource extraction, and reflecting on significant socio-environmental disasters, such as Chernobyl and the Cesium disaster in Goiânia, provide a more nuanced understanding of the topic. This, in turn, contributes to the development of critical environmental education initiatives (Guimarães, 2004; Layrargues; Lima, 2014).

Therefore, understanding waste as valuable helps us understand that goods are part of a production chain that involves the extraction of natural resources, such as water, oil, and other metals, to transform them into products. These resources are finite, and their extraction causes socio-

environmental injustices (Leonard, 2011). For example, the production of aluminum cans depends on bauxite extraction, which can lead to disasters like those in Mariana and Brumadinho in the state of Minas Gerais (Brasil, 2017; G1 Globo, 2023). Leonard (2011) notes that new industries are being built in preserved areas in Mozambique, Chile, and along the Amazon River in Brazil. To utilize these plants, more roads must be built, and once the plants are operational, more waste and greenhouse gases will be emitted (Leonard, 2011). Therefore, it is important that governments, industries, and companies work together to mitigate the impacts of new construction and not further compromise the health of the planet and the future of future generations.

### **Recycling of dry and organic waste**

Unlike reuse, recycling involves the physical, chemical, or biological alteration of solid waste to transform it into inputs or new products (Brasil, 2010). Both dry and organic waste can be recycled.

The topic of recycling was addressed in 26% of studies (Table 2), across different segments of basic education, through discussions and practical classes. The materials most frequently discussed in recycling studies were paper, oil, and organic waste. Paper recycling was developed through practical classes. Oil recycling involved the creation of voluntary collection points, collection competitions, and discussions.

According to Layrargues (2002), integrating recycling into educational practices creates an illusory and comforting effect on individuals, which can encourage excessive consumption of disposable items. Because these items are recyclable, they are often mistakenly viewed as environmentally friendly. In this scenario, recycling serves as a form of risk compensation, leading to the belief that it is a comprehensive solution to solid waste issues when, in reality, it is not. By presenting recycling as a viable answer, it can obscure criticism of consumerism and reinforce strategies for wealth accumulation, promoting the misguided notion that consumption is acceptable as long as products are environmentally friendly. As Leonard (2011) articulately states in *\*The Story of Stuff\**: "[...] is recycling an illusion that leads us to believe we are helping the planet, while simultaneously leaving industry free to continue spewing toxic and poorly designed things?" (p. 230). Consequently, it is crucial to reconsider the system of commodity production and to design products with responsibility in mind. Alongside efficient selective collection systems, this approach can help make recycling an effective practice in addressing these challenges.

Nine studies involved practices with organic waste through lectures and the creation of compost bins from a contextualized perspective. Rodrigues and Kindel (2019) conducted a study on waste degradation with 7th-grade middle school students, encouraging the understanding that organic waste and soil are not dirt, but promoters of life. In a chemical and biological analysis of compost bins with 19 6th-grade elementary school students, De Sousa and Moreno (2020) observed greater connection and engagement with organic waste management. This management prevents dry waste from spoiling in contact with organic waste, protects organic materials, and generates fertilizer for the soil. Promoting composting in different spaces can increase recycling rates in Brazil, where almost half of the waste produced (45%) is organic. Waste is often disposed of mixed, which impacts selective collection (Abrelpe, 2022).

### **Theme 2: Consumption**

Less frequently discussed than waste management, consumption was addressed in 28% of the studies analyzed in this review, primarily from the perspectives of conscious consumption and consumerism.

Among the educational initiatives focused on this topic, conscious consumption was examined in 26 out of the 31 identified studies (see Table 2), primarily through discussions and lectures. Rodrigues (2022) conducted discussion groups with 10 high school and adult education students, emphasizing the significance of transforming individual consumption habits to improve waste management. Additionally, in an educational program centered on responsible consumption with 73 eighth-grade students, Freitas (2021) underscored the importance of developing awareness campaigns aimed at reducing waste in schools.

On the other hand, studies addressing consumerism were scarce, with only seven articles addressing it. From the discussion of consumerism and its relationship to economic and housing issues, Fontes (2021) observed that technical high school students were able to critically reflect on how waste management depends on a change in societal attitudes. In the simulation of a school assembly conducted by Diniz and Calefi (2022), students represented various institutional actors, such as the campus administration, the solid waste committee, and the students' parents. The authors observed that the simulation helped students understand the problem in an integrated manner, encouraging the creation of solutions based on their school reality.

Conscious consumption is encouraged by official ecological discourse both in the SDGs—such as Goal 12 “Sustainable Consumption and Production” (UNPD, 2015) and by the United Nations Environment Programme (UNEP) and the Ministry of the Environment (UNEP, 2011; MMA, 2020). Conscious consumption implies giving preference to less toxic, exploitative, and polluting products (Layrargues, 2018; Leonard, 2011).

At the educational level, the National Common Curricular Base (BNCC) includes conscious consumption as a contemporary, cross-cutting theme, asserting that education “[...] is an effective means of developing the tools for conscious consumption at the individual level” (Brasil, 2022b, p. 27). However, an exclusive focus on individual consumption is insufficient to resolve the socio-environmental challenges associated with solid waste. The ongoing promotion of consumption, which is inherently unequal due to economic and resource disparities, constrains our choices. To effectively tackle the issue of waste within capitalist societies, educational practices must encompass the social, economic, and cultural dimensions of consumption (Guimarães, 2004; Silva; Loureiro, 2019). This necessitates a critical and comprehensive approach that underscores the responsibilities of all social agents involved in the production of goods and waste management, particularly industries and public authorities (Layrargues, 2011).

### **Study limitations**

Regarding the limitations of this integrative review, we observed that, despite the broad search for relevant data sources and the use of a clear and comprehensive strategy, not all studies on solid waste education conducted in Brazil between 2018 and 2022 may have been identified. Among the selected sources, Google Scholar presented the least standardized search strategy. Being a very comprehensive and sometimes imprecise repository, the search scope was limited to increase the specificity of the search. Therefore, we chose to read the first 10 pages of results, as the most relevant results are typically concentrated on these first pages. However, through this strategy, we cannot exclude the possibility that some publications relevant to the scope of the review were missed.

Regarding the annals of scientific events, those with published full articles were chosen to understand in more detail how the solid waste teaching strategy was developed. However, in this case, we may have missed some relevant studies published in abstract form, or even as full papers, at another event not selected for this review. Furthermore, it is known that many educational initiatives carried out in schools are not systematized in academic publications, which prevents their inclusion in publications such as this article. Final coursework (TCCs) was not included in the data sources, as no platforms were found that present these works in an organized format.

### **FINAL CONSIDERATIONS**

This integrative review sought to provide an overview of educational experiences on solid waste in Brazilian basic education published in recent years, using critical environmental education as a reference. The results revealed that, although the topic is present in schools, the most common approaches focused on how to properly separate waste for selective collection, how to recycle, and how to reuse materials for making games and toys.

Despite the significance of these initiatives, educational practices have often been perceived as isolated actions, focused solely on themselves, without fostering a broader discussion about the socioeconomic and political structures that drive waste production and disposal. These findings underscore the necessity of studies that integrate environmental education with other subjects within the

basic education curriculum. Topics such as waste economics, environmental justice, consumerism, and urban governance are relevant and can be incorporated into future teaching strategies regarding solid waste in schools.

We found that students generally lacked prior knowledge of waste management. This gap may be attributed to students' lack of interest in the topic or the impact of fragmented teaching. Furthermore, most studies conducted environmental education practices in a targeted manner, with one or more classes at the school, through presentations and practical lessons. Specific practices can contribute to the development of pragmatic environmental education, generally addressing technical and operational aspects, as discussed in this review.

Therefore, further research is recommended to evaluate improvements in the teaching and learning process on the topic of waste using active methodologies, such as inquiry-based learning and problem-based learning. These teaching approaches show promise because they allow students to actively participate, enabling them to build new knowledge by investigating real-life situations.

The limited number of studies concentrating on early childhood education and adult education (EJA) aligns with findings from international research. This emphasizes the necessity for environmental educators to design educational practices tailored to these groups. It is crucial to develop pedagogical strategies for environmental education related to solid waste in early childhood settings, fostering attitudes and values of respect for both the environment and individuals. This approach can help raise children's awareness about the significance of environmental issues from a young age. In the context of adult education (EJA), such strategies can facilitate the collective development of values, attitudes, and behaviors, encouraging the discussion of socio-environmental issues encountered in daily life.

This review revealed that the schools analyzed lack adequate infrastructure for waste management, demonstrating a failure to comply with the National Waste Management Guidelines (PNRS) in the school context. The results highlight the need for research to identify the main obstacles to implementing efficient waste management systems in educational institutions. Initiatives such as the "Zero Waste Schools" project can be examples of contributions in this field. Among the various challenges faced, the scarcity of financial resources to maintain the necessary infrastructure, the lack of support from city governments, the lack of technical training for education professionals, and the absence of a staff member or team responsible for coordinating these actions in the school environment stand out.

Based on the findings of this study, we aim to contribute to a broader dialogue on environmental education and the teaching of solid waste management in schools, while also encouraging research initiatives on this subject within educational institutions. By adopting a contextualized approach that reflects each community's unique circumstances and engaging the entire school community and its environment, we can foster equitable collaboration in decision-making processes related to waste management. This underscores the necessity of training education professionals to cultivate more critical and inclusive practices in schools, thereby advancing environmental justice. A critical approach to environmental education can serve as a strong foundation for transforming the teaching of solid waste management in educational settings.

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## DATA AVAILABILITY DECLARATION

The underlying content of the research text is found in the manuscript.

## AUTHORS' CONTRIBUTIONS

**Author 1** – Conception of the study, data collection, data analysis, writing, review, and editing of the manuscript.

**Author 2** – Conception of the study and revision of the manuscript.

**Author 3** – Conception and supervision of the study, editing, and review of the manuscript.

## DECLARATION OF CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this article.