Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

Environmental education as a tool for awareness and evaluation of proper solid waste management.

Francisco Ícaro Carvalho Aderaldo
Master's degree in Renewable Energies, IFCE, Brasil.
Icaroaderaldo16@gmail.com

Tiago de Abreu Lima
Master's degree in Renewable Energies, IFCE, Brasil.
Tiagoabreu.engamb@gmail.com

Pedro Ítalo Carvalho Aderaldo
PhD student in Physical Geography, UNICAMP, Brasil.
pedroitaloo@hotmail.com

Franklin Aragão Gondim
Professor PhD in Biochemistry, IFCE, Brasil.
aragaofg@yahoo.com.br

Periódico Eletrônico "Fórum Ambiental da Alta Paulista"
Electronic Journal "Environmental Forum of Alta Paulista"

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

ABSTRACT
The proper management of solid waste remains a challenge that requires attention not only from specific sectors but from society as a whole. Environmental education, as a crucial mechanism for disseminating knowledge about environmental issues, emerges as a fundamental tool to promote collective awareness. This study aimed to deliver environmental education lectures to analyze students' level of knowledge and awareness regarding the general theme of waste. Two presentations were conducted for a total of 45 students, followed by a questionnaire at the end of each lecture. Notably, 90% of the students answered questions 05 and 06 correctly, while 100% answered question 07 correctly. It was observed that 80% of the students answered questions 08 correctly, 90% answered question 09 correctly, and 100% answered question 10 correctly. Additionally, 90% answered questions 11 and 13 correctly. Although 40% of the students demonstrated knowledge about reusing waste in the cultivation of plant species, only 60% admitted to having engaged in any waste reuse practices. In conclusion, the students exhibit a high level of knowledge and awareness regarding topics associated with solid waste. Furthermore, the effectiveness of environmental education was evident as a valuable tool in disseminating knowledge on the subject and assessing environmental consciousness within the academic community.

KEYWORDS: Environment. Awareness. Sustainability.

1 INTRODUCTION

In various spheres of productive activities, the generation of waste is an unavoidable reality, demanding constant attention for proper treatment and management. These solid and semi-solid waste materials originate from diverse sources, including industrial, domestic, commercial, and agricultural sectors (ABNT, 2004). In response to this environmentally crucial issue in Brazil, the Federal Law 12.305/2010 was enacted, establishing the National Solid Waste Policy (PNRS). This legislation provides essential instruments, goals, objectives, guidelines, and actions for significant advancements in addressing the environmental, social, and economic challenges related to solid waste in the country (BRASIL, 2010).

Despite these efforts, the effective management of solid waste remains a challenge, requiring attention not only from specific sectors but from society as a whole (ALBANO *et al.*, 2018). Many Brazilian cities face considerable challenges due to high waste generation and a lack of environmental education on viable alternatives for the proper disposal of this material, resulting in significant problems for the population and the environment (FRANCESCHI *et al.*, 2017).

Globally, the environmental consequences resulting from inadequate solid waste management are extensive, including the spread of disease-transmitting vectors, pollution of natural resources (water, soil, and atmosphere), landscape degradation, environmental imbalance, and the economic devaluation of the country (PELIZER *et al.*, 2007).

It is evident that the lack of appropriate disposal sites for solid waste persists as a challenge for Brazilian municipalities, as per current legislation, these spaces must meet social, economic, and environmental criteria (SAMIZAVA *et al.*, 2008).

In the Brazilian context, Law No. 9,795/1999 establishes the National Environmental Education Policy and addresses other relevant issues (BRASIL, 1999). This legislation plays a fundamental role in the country's environmental context by introducing principles, objectives, concepts, and assignments that guide the implementation of environmental education at all levels of education, both formal and non-formal. This legal framework represents a significant contribution to the construction and consolidation of educational practices focused on environmental awareness in Brazil. To underscore the importance of environmental education,

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

Law No. 14,393, dated July 4, 2022, amends Law No. 9,795, dated April 27, 1999, which establishes the National Environmental Education Policy, to institute the June Green Campaign (BRASIL, 2022). Among various provisions for the Public Power, the Federal Constitution of 1988 mentions:

> I - preserve and restore essential ecological processes and provide ecological management of species and ecosystems;
> II - preserve the diversity and integrity of the country's genetic heritage and supervise entities dedicated to research and manipulation of genetic material;
> III - define, in all units of the Federation, territorial spaces and their components to be specially protected, with alteration and suppression permitted only by law, prohibiting any use that compromises the integrity of the attributes that justify their protection;
> IV - require, in accordance with the law, for the installation of work or activity potentially causing significant degradation of the environment, a prior environmental impact study, which will be publicized;
> V - control the production, commercialization and use of techniques, methods and substances that pose a risk to life, quality of life and the environment;
> VI - promote environmental education at all levels of education and public awareness of environmental preservation (Brazil, 1988, chapter VI, art. 225).

Furthermore, according to art. 5th of Law No. 12,305, of August 2, 2010, the National Solid Waste Policy is part of the National Environmental Policy and articulates with the National Environmental Education Policy (BRASIL, 2010).

Therefore, to achieve appropriate waste management, it is imperative to implement environmental education strategies to raise awareness among the entire population. Klering *et al*. (2012) state that work on individual perception of the environment allows identifying the precise ways in which environmental education must be applied to play its fundamental role in the face of environmental adversities.

Given this context, it is believed that lectures on environmental education represent an effective approach to transmitting knowledge on the subject, contributing to the development of the listening public through the understanding of their duties and appropriate practices in relation to the correct management of solid waste.

2 OBJECTIVES

Based on the aforementioned, this study aimed to conduct environmental education lectures and subsequently assess the level of knowledge and awareness among a specific group of higher education students regarding the comprehensive theme of solid waste, with a focus on the issues arising from improper waste management.

3 METHODOLOGY

In this study, the Systematic Literature Review (SLR) was adopted as the methodology for literature review. The search for articles related to the central theme of the research, including terms such as environmental education, solid waste, and environmental impacts, was conducted on the Google Scholar and Scielo platforms. Selection criteria considered the year of

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

publication, obtained results, and the publication source, prioritizing works in international journals and events.

To meet the proposed objectives, the basic research method was employed to clarify the environmental impacts resulting from improper disposal of solid waste and explore how environmental education can become a crucial tool in addressing this challenge. The research was based on theoretical aspects, utilizing books, articles, and academic papers relevant to the topic.

The adopted approach was qualitative, involving a critical analysis of the data collected during the lectures. Inductive methods were applied to examine the issues associated with improper solid waste management and define how environmental education can effectively combat these impacts.

Environmental education lectures were conducted in the classroom of the Federal Institute of Education, Science and Technology of Ceará (IFCE), Campus Maracanaú, in February 2022. The environmental and sanitary engineer was responsible for the presentation, directed to a total of 45 students enrolled in the second semester of undergraduate programs in environmental and sanitary engineering, as well as chemistry. The space used was provided by the professor responsible for the environmental education course, mandatory for both programs.

Both lectures were conducted in person, with a four-hour duration each. The roundtable format was adopted to promote dialogue between the speaker and the audience, allowing questions during the presentation. The content focused on environmental education, highlighting issues related to the improper management of solid waste.

At the end of each lecture, students were asked to respond to a questionnaire provided through a link sent to their institutional emails and presented in the classroom via a QR code. The form, developed on the Google Forms platform, included four open-ended personal/introductory questions and ten objective questions related to the themes covered in the lectures (as per Table 1).

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

Table 1 - Questionnaire Applied After the Lecture

Question 01	What is your full name?
Question 02	What is your educational institution?
Question 03	Which course are you a student?
Question 04	Which semester are you a student?
Question 05	For dry recyclable materials, there is international standardization in the identification, by color, of collection containers. What type of waste is the red color for?
Question 06	What is the correct way to separate waste?
Question 07	What is selective collection?
Question 08	We know that soil can be polluted in different ways, one of which is through the accumulation of solid waste. Among the problems below, select the only one that is not related to the deposition of waste in the soil.
Question 09	Water pollution is a serious problem. Analyze the alternatives below and select the one that does not indicate a way to reduce the pollution of water resources.
Question 10	What are the objectives of the National Solid Waste Policy?
Question11	Did you already know about any form of waste reuse presented in this lecture?
Question 12	Did you know that it is possible to reuse waste to grow plant species?
Question 13	What is recycling?
Question14	Have you ever reused any type of waste?

Source: Author, 2022.

The data from students' responses were tabulated using Microsoft Excel software. Subsequently, a descriptive analysis, as proposed by Gil (2002), was conducted to understand the impacts of the lectures on students and assess the level of knowledge they had regarding the subject.

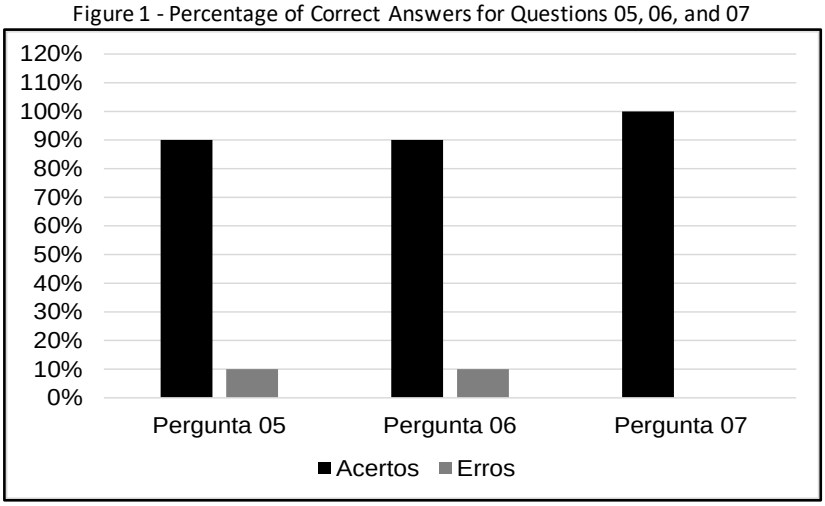
4 RESULTS

The results evidenced by the quantitative analysis of the questionnaire reveal that students already possessed fundamental knowledge about the relevance of environmental education as a tool for awareness, as well as about environmental issues associated with solid waste.

Questions 05, 06, and 07 address different methods of segregation and separation that can be employed in solid waste management, highlighting selective collection as an example. These inquiries allowed assessing students' understanding of the objectives of selective collection, the internationally recognized color-coding of waste bins, and the proper way to separate materials. Notably, 90% of students answered questions 05 and 06 correctly, while 100% got question 07 right (Figure 1).

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

Figure 1 - Percentage of Correct Answers for Questions 05, 06, and 07



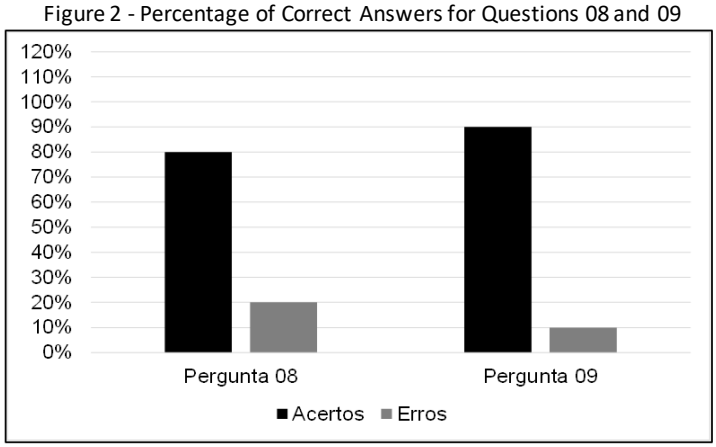
Source: Author, 2022.

As highlighted by Zaneti (1997), recycling and reuse processes form the basis for reducing environmental impact, mitigating both waste accumulation and the depletion of natural resources. Proper waste separation plays a crucial role, enabling the recycling of materials. Initially, it is feasible to categorize waste into four main groups: organic, recyclable, non-recyclable, and hazardous.

Accurate waste separation is vital to prevent numerous environmental problems. According to Zanatta (2017), environmental pollution can have various origins, and society has not fully internalized the importance of the environment for its survival, progressing slowly in terms of caring for nature. There is a need for broader dissemination, encouraging public participation in the selective collection process, and instructing on the correct separation of waste, thus facilitating the stages of treatment and final disposal.

Questions 08 and 09 address the various types of pollution resulting from improper disposal of solid waste, such as soil degradation and water contamination. These questions allowed assessing students' knowledge of the negative impacts caused by waste and the measures to be taken to minimize these effects on the environment. It is observed that 80% of students answered question 08 correctly, while 90% got question 09 right (Figure 2).

Figure 2 - Percentage of Correct Answers for Questions 08 and 09



Source: Author, 2022.

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

The various environmental impacts resulting from various forms of improper solid waste disposal pose significant risks to human health and the environment. The disposal of these wastes in the soil, such as in landfills, for example, is a significant source of exposure to various toxic substances, harming society's well-being and degrading the environment (GOUVEIA, 2012).

According to Milaré (2007), the classification of polluting modalities can be grouped into three major categories: first, by the affected environmental component (air, soil, water); second, by the nature of the pollutant (chemical, thermal, noise, radioactive, etc.); and third, by the polluting activity (industrial, agricultural, mineral, etc.).

The use of environmental education as a means to reduce pollution caused by waste is identified in campaigns, lectures, classes, and seminars on the subject. Soares *et al*. (2007) emphasize that environmental education can play a crucial role in minimizing the impacts generated by waste.

Higuchi and Maroti (2014) note that over the years, environmental education has predominantly taken place in the school environment, and several reasons support this scenario. As stated by Ramos (2001), environmental education can be considered "an active part of an intellectual process, constantly in the service of communication, understanding, and problem-solving, as well as the construction of new meanings and connections for life.

Question 10 addresses the objectives of the National Solid Waste Policy, allowing the analysis of students' knowledge about the guidelines governing waste management. Notably, 100% of the students answered question 10 correctly.

In the legislative history of Brazil, the National Solid Waste Policy was a milestone as the first law entirely dedicated to the issue of solid waste. Created with the purpose of establishing guidelines for waste management, the PNRS must be applied in conjunction with other Brazilian environmental regulations.

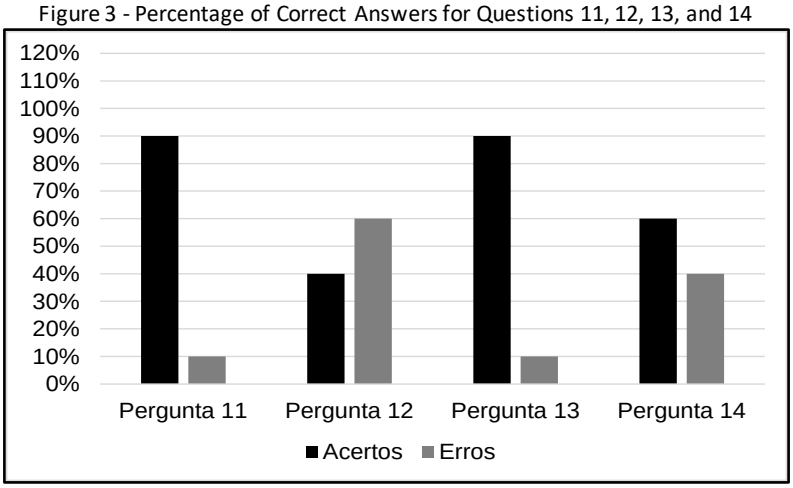
As established by the National Solid Waste Policy (PNRS) of 2010, individuals or legal entities of public or private law that, directly or indirectly, are responsible for the generation of solid waste, as well as those who develop actions related to the integrated management or management of these wastes, are subject to compliance with this policy (BRAZIL, 2010).

Environmental education plays a crucial role in solid waste management, having the potential to transform society's perception of the environment. By providing a critical view to the population, environmental education has the power to turn old habits into environmentally friendly and socially viable practices. According to Mendonça (2010), environmental education can be considered a viable interdisciplinary tool, empowering and sensitizing the population to the environmental problems faced by humanity.

Questions 11, 12, 13, and 14 address the concepts of recycling and the types of reuse of solid waste, such as the reuse for the formation of organic compounds used as fertilizers in vegetable cultivation. These questions allowed analyzing whether students had practical understanding of material reuse and the various types of recycling. It was observed that 90% of students answered questions 11 and 13 correctly, while 40% had knowledge about the reuse of waste in the cultivation of plant species (Question 12). Additionally, only 60% of students claimed to have engaged in some type of waste reuse (Question 14) (Figure 3).

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

Figure 3 - Percentage of Correct Answers for Questions 11, 12, 13, and 14



Source: Author, 2022.

Recycling emerges as an economic procedure that enables low-cost and environmentally friendly production processes. An illustrative example is plastic, where the production of 1 ton consumes 7,000 kWh of energy and emits 5,313.96 kg of CO2 (PEREIRA, 1999). In contrast, the recycling process only requires the equivalent of 137 kWh to recycle the same amount of plastic waste, resulting in a savings of 6,863 kWh compared to production from raw materials (MESQUITA, 2021).

According to Gutberlet (1998), participatory environmental education plays a significant role in strengthening citizenship in the pursuit of sustainability. It provides specific knowledge on topics such as waste reuse and expands awareness of the local socio-environmental situation, transforming the individual into a responsible and active agent in the community.

With the increased involvement of the academic population, environmental education on proper waste management will bring benefits to both students and society at large. This will contribute to the development of critical thinking and greater awareness of the importance of environmental preservation. This is a crucial point, as students, as thinking and informed agents, have the potential to revolutionize society through small behavioral changes, promoting a better quality of life and reducing environmental impacts.

5 CONCLUSION

It is concluded that lectures on environmental education have proven to be an effective tool in disseminating knowledge on the subject, as evidenced by a significant increase in questionnaire scores after exposure to the covered content. Participants, higher education students, demonstrated an average of eighty percent accuracy in their answers, reflecting a notable level of knowledge and awareness regarding themes related to proper solid waste management.

It is noteworthy that, even among this academic audience more familiar with the field, there was less accuracy when addressing topics that required a deeper understanding, such as the reuse of waste in the cultivation of plant species. Therefore, the ongoing need to encourage

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

environmental education is emphasized. Even in an academic setting, regularly conducting lectures and classes dedicated to this topic is crucial for obtaining more comprehensive results and improving participants' understanding. Persistence in this daily effort proves essential for strengthening knowledge and environmental awareness, even among an audience already familiar with the subject.

6 BIBLIOGRAPHICAL REFERENCES

ABNT. **NBR 10004**. Rio de Janeiro: Associação Brasileira de Normas Técnicas, 2004. Available in: https://analiticaqmcresiduos.paginas.ufsc.br/files/2014/07/Nbr-10004-2004-Classificacao-De-Residuos-Solidos.pdf. Access at: April 5, 2023.

ALBANO, L. B.; SCOTON, E. J.; BATTISTELLE, R. A. G. Diagnóstico dos resíduos sólidos urbanos no brasil após a Política nacional dos resíduos sólidos a partir de dados do SNIS. *In*: 1º CONGRESSO SUL-AMERICANO DE RESÍDUOS SÓLIDOS E SUSTENTABILIDADE, 2018, Gramado/RS. **Annals** [...]. Gramado: ExpoGramado, 2018.

BIDONE, F. R. A.; POVINELLI, J. **Conceitos básicos de resíduos sólidos**. São Carlos: EESC/USP, 1999.

BOSCOV, M. E. G. **Geotecnia ambiental**. São Paulo: Oficina de textos, 2008.

BRASIL. [Constituição (1988)]. **Constituição da República Federativa do Brasil.** Brasília, DF: Presidência da República, [2016]. Available in: https://www.planalto.gov.br/ccivil_03/Constituicao/Constituicao.htm#art225. Accessed on: January 8, 2023.

BRASIL. **Lei nº 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: Presidência da República, [1999]. Available in: https://www.planalto.gov.br/ccivil_03/leis/l9795.htm. Accessed on: January 10, 2023.

BRASIL. **Lei nº 12.305, de 02 de agosto de 2010**. Institui a Política Nacional de Resíduos Sólidos; altera a Lei n. 9.605, de 12 de fevereiro de 1998; e dá outras providências. Brasília: Presidência da República, [2010]. Available in: https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm. Accessed on: January 10, 2023.

BRASIL. **Lei nº 14.393, de 04 de julho de 2022**. Altera a Lei nº 9.795, de 27 de abril de 1999, que dispõe sobre a Política Nacional de Educação Ambiental, para instituir a Campanha Junho Verde. Brasília: Presidência da República, [2022]. Available in: https://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2022/Lei/L14393.htm#art2. Accessed on: January 11, 2023.

FRANCESCHI, F. R. A.; SANTIAGO, C. D.; LIMA, T. D.; PUGLIESI, E. Panorama dos resíduos sólidos no Brasil: uma discussão sobre a evolução dos dados no período 2003–2014, **Revista DAE,** p. 62-68, 2017. Available in: https://doi.editoracubo.com.br/10.4322/dae.2016.028. Accessed on: January 15, 2023.

ZANATTA, P. Gestão Ambiental e o Desenvolvimento Sustentável, **Revista Gestão e Sustentabilidade Ambiental**, Florianópolis, v.6, n.3, p. 296-312, 2017.

GOUVEIA, N. Resíduos sólidos urbanos: impactos socioambientais e perspectiva de manejo sustentável com inclusão social, **Ciência & saúde coletiva,** ABRASCO, Rio de Janeiro, n.17, p. 1503-1510, 2012. Available in: https://www.scielo.br/j/csc/a/y5kTpqkqyY9Dq8VhGs7NWwG/abstract/?lang=pt#. Accessed on: February 2, 2023.

GUTBERLET, J. **Desenvolvimento desigual: impasses para a sustentabilidade**. Konrad-Adenauer-Stiftung: Centro de Estudos São Paulo, 1998.

HIGUCHI, M. I. G.; MAROTI, P. S. Espacialidades e socialidades da educação ambiental além dos muros da escola, **Revista Pesquisa em Educação Ambiental**, v.9, n.1, p.95-109, 2014.

KLERING, L. R.; KRUEL, A. J.; STRANZ, E. Os pequenos municípios do Brasil–uma análise a partir de índices de gestão. **Análise - Revista de Administração da PUCRS,** Porto Alegre, v.23, n.1, p. 31-44, 2012.

ISSN 1980-0827 – Volume 20, Number 2, Year 2024

MENDONÇA, F. Dimensões regionais das mudanças climáticas globais e educação ambiental: Alguns aspectos da região Sul do Brasil. *In:* 12º ENCONTRO DE GEÓGRAFOS DA AMÉRICA LATINA – EGAL, 2012, Montevideu/Uruguai. **Anaals** [...]. Montevideu/Uruguai, 2012.

MESQUITA, J. L. C. **A reciclagem de resíduos sólidos como ferramenta para redução da emissão de gases tóxicos do efeito estufa:** estudo de caso em Cooperativas de reciclagem do Distrito Federal. 28 f. Trabalho de conclusão de curso (Bacharelado em Saúde Coletiva), Universidade de Brasília, Brasília, 2021.

MILARÉ, É. **Direito do ambiente: doutrina, jurisprudência, glossário**. São Paulo: Editora Revista dos Tribunais, 2007.

PELIZER, L. H.; PONTIERI, M. H.; DE OLIVEIRA MORAES, I. Utilização de resíduos agro-industriais em processos biotecnológicos como perspectiva de redução do impacto ambiental, **Revista de Gestão Tecnológica e Inovação**, Santiago, Chile, v.1, p.118–127, 2007. Available in: https://www.jotmi.org/index.php/GT/article/view/art41. Accessed on: January 28, 2023.

PEREIRA, N. J. T. **Quanto vale nosso lixo.** Viçosa: IEF/UNICEF, 1999.

RAMOS, E. C. Educação ambiental: origem e perspectivas, **Educar em Revista**, UFPR, Curitiba, n.18, p.201-218, 2001.

SAMIZAVA, T. M.; KAIDA, R. H.; IMAI, N. N.; NUNES, J. O. R. SIG aplicado à escolha de áreas potenciais para instalação de aterros sanitários no município de Presidente Prudente-SP, **Revista Brasileira de Cartografia**, UFU, Uberlândia, v.60, n.1, 2008. Available in: https://seer.ufu.br/index.php/revistabrasileiracartografia/article/view/44882. Accessed on: January 26, 2023.

SOARES, L. D. C.; SALGUEIRO, A. A.; GAZINEU, M. H. P. Educação ambiental aplicada aos resíduos sólidos na cidade de Olinda, Pernambuco–um estudo de caso, **Revista Ciências & Tecnologia**, v. 1, n. 1, p. 1-9, 2017.

TENÓRIO, J. A. S.; ESPINOSA, D. C. R. Controle ambiental de resíduos. *In*: TENÓRIO, J. A. S.; ESPINOSA, D. C. R (org.) **Curso de gestão ambiental.** Barueri: Manole, 2004.

ZANETI, I. C. B. B. **Além do lixo–reciclar: um processo de transformação.** Brasília: Terra Una, 1997.