SUPPLEMENTARY INFORMATION

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Appendix A

Table A1. Survey with open-ended questions.

Items	Statements
1	What do you think green chemistry might be?
2	What is the first principle of green chemistry?
3	Does the chemical industry bring benefits to society? Justify your answer.
4	Does the chemical industry bring harm to society? Justify your answer.
5	What is the importance of proper water treatment?
6	What could I do to learn more and learn better?

Appendix B

Table A2. Survey with closed-ended questions ("yes," "no," "maybe," or "I don't know").

Items	Statements
1	Have you ever heard the expression "green chemistry"?
2	Have you ever heard the expression "zero waste"?
3	Have you ever heard the expression "Sustainable Development Goals (SDGs)"?
4	Have you ever heard the expression "water footprint"?
5	In the past six months, has water been unavailable in your home even though all bills were paid?
6	Do you know what "drinking water" means?

Appendix C

Table A3. Survey assessment on a 5-point Likert scale.

Items	Statements
1	I try to put into practice what I have learned.
2	I enjoy reading reports or news published in newspapers, on television, on the internet, and in other media.
3	I enjoy participating in practical laboratory classes.

Appendix D

Table A4. Final assessment on a 5-point Likert scale.

Items	Statements
1	Participating in the classes enhanced my understanding of green chemistry.
2	Participating in the classes enhanced my understanding of organic chemistry.
3	Participating in the classes enhanced my understanding of aquatic chemistry.
4	Participating in the classes made me reflect on more conscious water use in my daily life.
5	Participating in the case study enhanced my argumentation skills.
6	Participating in the case study enhanced my scientific thinking.
7	Participating in the case study enhanced my ability to take a proactive role in addressing issues related

	to the distribution of drinking water in my region.
8	I believe that working in a group to solve the case helped me act with responsibility and citizenship, both individually and collectively.
9	I believe that working in a group to solve the case helped me express and share information and ideas and generate meanings that lead to mutual understanding.
10	I believe that clearly establishing the assessment criteria was essential for solving the case.
11	I believe that the professor’s role in organizing and evaluating the case was important.
12	I believe that the time allocated for solving the case was adequate.
13	I believe that the members of my team were important in solving the case.
14	I believe that the classes on green chemistry helped strengthen my socio-environmental awareness and responsible consumption at both local and global levels.
15	I believe that sustainable development is a mission that involves everyone.
16	I believe that participating in the project may help me on the National High School Exam (In Portuguese: Exame Nacional do Ensino Médio - ENEM).
17	I would like green chemistry to be discussed more in other subjects of my Technical Program.
18	I would like there to be more experiments in the Chemistry classes.
19	I would like Chemistry classes to include more discussion about human responsibility in sustainable development.
20	I would like to participate again in other case studies in other subjects of my Technical Program.

Appendix E

Table A5. Activities-evidence matrix describing the instructional sequence, learning objectives, and data used for analysis.

Sessions	Instructional activities and chemistry content	Learning objectives	Evidence collected	Analytical approach
1	Presentation of research procedures; administration of the pre-test; introduction of the case study on water scarcity in Sousa, Brazil; formation of five student teams to discuss initial hypotheses about the causes of the problem.	Introduce the socio-environmental problem and stimulate initial reflection on sustainability and green chemistry issues.	Pre-test responses; initial group discussions.	Descriptive statistics of questionnaire responses; identification of initial conceptions.
2	Lessons on the history of green chemistry and its 12 principles, defined by Paul T. Anastas and John C. Warner (2000), and a review of basic chemical concepts (transformations, reactions, chemical equations, and the Law of Conservation of Mass). Group discussion of preliminary case study solutions and resolution of questions related to green chemistry. These questions were taken from the Brazilian National High School Examination (ENEM; Portuguese: Exame Nacional do Ensino Médio).	Introduce the principles of green chemistry and relate them to environmental issues, while examining how core chemistry concepts included in the curriculum align with green chemistry.	Students’ responses and group discussions during the activities.	Qualitative examination of emerging arguments and conceptual references, as well as assessment of the correctness of students’ responses to ENEM questions related to green chemistry.
3	Lessons on hydrocarbon reactions (combustion, addition, substitution, and cracking) integrated with the 12 Principles of green chemistry and their environmental implications. Instruction included the use of reaction videos and three-dimensional models to illustrate the molecular structures involved in these reactions.	Relate organic reaction mechanisms to sustainable chemical practices.	Classroom observations focusing on students’ participation and engagement with the levels of chemical representation proposed by Peter G. Mahaffy (macroscopic, submicroscopic, symbolic, and environmental).	Qualitative analysis of classroom observations to examine students’ engagement with different levels of chemical representation and to identify conceptual references in their reasoning.
4	Review of previously covered content; lesson on key water treatment processes (coagulation, flocculation, sedimentation, filtration, and disinfection); and introduction to	Develop scientific argumentation using the Toulmin model and apply chemical knowledge of	Students’ oral arguments and written responses developed during the discussion of the case	Analysis of argumentative structure and the evidence used in students’ reasoning, with attention to

	Toulmin's argumentation model to support students' development of structured scientific arguments, followed by discussion of case study solutions using this argumentation framework.	water treatment processes to analyze the problem of water scarcity.	study on water scarcity.	how claims were supported and justified during the discussion of the case study.
5	Reading of the text "Green Reactions" (available at https://revistapesquisa.fapesp.br/reacoes-verdes/; text in Portuguese); lesson on green chemistry metrics, with emphasis on the environmental factor (E-factor) as a tool to evaluate waste generation in chemical processes; educational activity "Which Industry Am I?", in which students applied the E-factor to estimate waste generation in simulated production processes and relate the results to different industrial sectors; and discussion of case study solutions.	Evaluate industrial chemical processes from a sustainability perspective by applying green chemistry metrics, particularly the E-factor, to analyze waste generation.	Students' participation and accuracy of responses during the "Which Industry Am I?" activity, along with group discussions and written responses produced during the analysis of the case study.	Qualitative analysis of students' participation, responses, and reasoning, with identification of environmental, scientific, and social dimensions in their arguments.
6	Review of previously covered content; presentation and guided discussion of case study solutions, including students' presentations of their proposed solutions; introduction to laboratory safety standards, including best practices for the safe handling of chemicals; and an overview of the "Green Chemistry Thematic Environment" (site available in Portuguese: https://quimidexambiental.ufsc.br/ambiente-tematico-virtual/); emphasizing its role in promoting sustainable laboratory practices and the integration of green chemistry principles into experimental work.	Develop students' ability to propose and present case study solutions, apply green chemistry principles, and understand laboratory safety, while reflecting on responsible chemical practices and sustainability through the "Green Chemistry Thematic Environment."	Five final written texts produced and presented by the students, segmented into Units of Analysis (UAs), each defined as a statement ending with a period or semicolon. The UAs captured the structure and extent of students' written output for subsequent quantitative and qualitative evaluation.	Quantitative analysis involved counting the number of UAs in each text, without qualitative judgment of content at this stage. For the qualitative dimension, each UA was classified according to the type of evidence (personal or authoritative) and thematic domain (scientific, social, environmental, commercial, political, economic, cultural, health-related, or ethical).
7	Reading of an investigative text on the Bento Rodrigues disaster in Brazil, detailing the collapse of a mining tailings dam and its social, environmental, and economic impacts; execution of a green chemistry-inspired experimental activity to detect Fe^{3+} ions in water using a low-cost and environmentally safe salicylate reagent, based on the methodology proposed by Ventapane and Santos (2021). The procedure involved oxidation of Fe^{2+} to Fe^{3+} via a Fenton-type reaction, preparation of the salicylate reagent through alkaline hydrolysis of acetylsalicylic acid, and formation of a violet Fe^{3+}-salicylate complex (Trinder reaction) for colorimetric detection, emphasizing low chemical waste and sustainable experimental practices; and administration of a post-test.	Understand the impacts of chemical disasters, apply green chemistry principles in experiments, detect Fe^{3+} ions in water using safe reagents, and practice sustainable chemical methods.	Students' responses on the post-test.	Analysis of post-test responses using descriptive statistics and Likert-scale data to assess participants' perceptions of the methodological pathways and the general issues addressed.

References

Anastas, P. T.; Warner, J. C. Green Chemistry; Oxford University PressOxford: New York, 2000.

Ventapane, A. L. de S.; Santos, P. M. L. dos. Aplicação de Princípios de Química Verde Em Experimentos Didáticos: Um Reagente de Baixo Custo e Ambientalmente Seguro Para Detecção de Íons Ferro Em Água. Quim. Nova 2021, 43 (2), 201–205.