

## Development of Environmental Awareness Aiming the Learning of Students in a Public School in Brazil through Evaluation Instruments

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**ABSTRACT** This paper aims to present the importance of working Environmental Education in schools, valuing collective work and the construction of new knowledge, seeking to develop teaching focused on integral student. Questions about the environmental impacts of plastic were addressed, involving the perception of the productive sequence of this material, environmental awareness for conscious consumption, and the proper destination of this waste. The work was carried out in a public school, with first-year high school students, integrating the disciplines of Biology and Chemistry. Questions on the topic were also applied at the beginning and end of this project. On average, the number of responses increased from the pre-test to the post-test. However, regarding the proper disposal of waste, the rate of correct answers in the post-test was less than 50 percent, indicating the need for more projects to try to overcome deficiencies in relation to the proposed theme.

### INTRODUCTION

Nowadays it is almost impossible to imagine everyday life without the use of plastic. There are several types of materials that are used only once. These materials are known as single-use plastics because soon after they are used, they are discarded. Examples of these products include straws, bags, cups, disposable cutlery, and product packaging in general. Even bringing numerous benefits to society, the use of plastic has been intrinsically contradictory due to the damage caused to the environment and human well-being.

According to Moore et al. (2001), plastic undergoes mechanical wear as a result of exposure to rain, UV rays, and temperature variations. This causes it to break into small pieces of different shapes and become particles called microplastics that are around 1 to 5 mm in size. This material often reaches the ocean through rivers that flow into the sea or through its irregular disposal in

the coastal region. Collignon et al. (2013) claim that studies in recent decades have shown that microplastics represent the main source of pollution in marine environments. In this way, the presence of microplastics is verified throughout all dimensions of the ocean, even in the abyssal zones.

This microplastic enters the food chain when a living organism is in search of its food and accidentally ingests the microplastic, causing a great imbalance and having the effect of bioaccumulating plastic in this organism until it reaches humans (Omoyajowo et al. 2022). Evidently, the environmental impacts of plastic involve several other aspects not addressed here (Reed and Chen 2022). A brief review on this topic can be found in Eduardo et al.'s (2020) work.

This is a contemporary theme and students who entered high school at a state public did not have access to this information, which can cause an important gap in student training.

In this context, we have the problem situation of the present research: How to develop the awareness of high school students about re-

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sponsible consumption and the proper disposal of plastic? To answer these study questions, this work aimed to develop in first-year high school students a perception of the plastic production chain, to promote environmental awareness for conscious consumption and proper disposal of this waste through the search for creative solutions and innovation.

Thus two first-year high school classes were selected to participate in the learning project “Plastic: Hero or villain?” As a pedagogical strategy an Active Methodology called Project-Based Learning (PBL) was used because it allows the social engagement of students, in addition to allowing them to develop the structuring stages of a research project.

A Biology teacher, a Philosophy teacher, and a Chemistry teacher participated in this project in guiding 62 students. The students developed their own projects that showed different stages of the plastic production chain or an innovative solution to solve the problem in question. The projects were presented at a special moment for the entire school and it was found that the result was quite satisfactory using project-based learning.

### Objectives

The objective of the study was promoting a discussion environment on the issue of plastic and its environmental impact through investigative classes that lead to the construction of knowledge about the interference of plastic waste in today’s society.

### Theoretical Foundation

In general, the curriculum documents brought the disciplines fragmented, which made it difficult for a long time to integrate a complex organization and a satisfactory approach to the objects of knowledge. As a way to break this fragmentation, in 2018, the main guiding document for Secondary Education in Brazilian education was approved, known as the National Common Curricular Base (BNCC - Base Nacional Comum Curricular), which aimed to standardize teaching in Brazil. The BNCC organized the curricular components into three major areas: Humanities Area (History, Geography, Sociology, and Philosophy), Languages and Codes Area (Portuguese Lan-

guage, Art, Physical Education, and English), and Natural Sciences Area (Biology, Physics, and Chemistry).

Each of the areas presents specific competencies that are developed interdisciplinary and unfolded into skills. However, it appears that the terms Environmental Education and the Environment appear only once in the entire text of the BNCC, which can be understood as the absence of this theme in the Curriculum. On the other hand, general competencies are presented, among them competence number 10, which says that the student must be able to:

“Act personally and collectively with autonomy, responsibility, flexibility, resilience, and determination, making decisions based on ethical, democratic, inclusive, sustainable, and solidary principles” (BRASIL 2017).

This attribution makes it possible to infer that environmental issues are implicit in this competence and it is up to the professor in the area to deepen and identify how these competencies relate to different objects of knowledge.

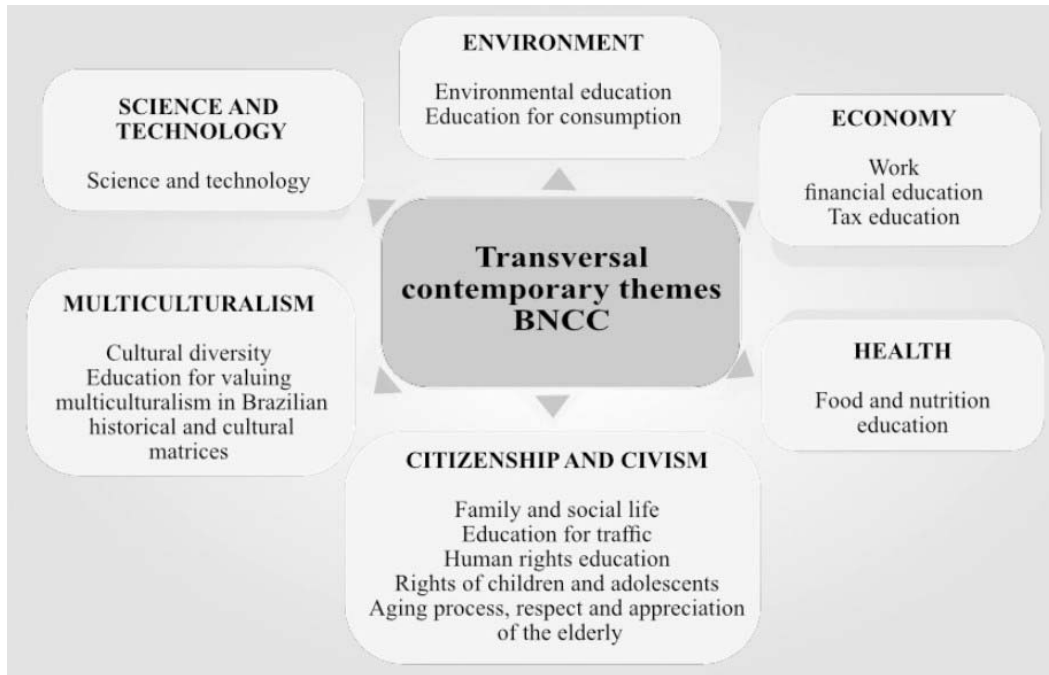
In addition, these skills show the need for integrated work, as it would not be possible to form an active citizen with an integral and complex environmental vision without a global perception of this theme.

In 2019, to make this work possible, the BNCC document Contemporary Transversal Themes (Temas Transversais Contemporâneos - TCTs) (BRASIL 2019) was prepared, which explained the connection between the different curricular components and suggested ways to establish connections with the situations experienced by students in their realities, contributing to contextualize and give contemporaneity to the objects of knowledge described in the BNCC. One of the topics presented in this document is related to the Environment and Conscious Consumption, as can be seen in Figure 1.

In view of this, the Environment theme can be worked on in any curricular component in an inter or transdisciplinary way.

Thus, it is important that teachers work with projects and motivating themes that support the training of students in an integral way, enabling a global and nonfragmented understanding of scientific knowledge.

Project-Based Learning (PBL) advocated by Bender (2022) can be characterized by the use of



**Fig. 1. Transversal contemporary themes BNCC: National Common Curricular Base**

*Source:* Adapted from Brasil 2019 (This figure was built using concepts from the BNCC, which is an official document in Brazil and open to use by teachers and researchers in the country).

authentic and realistic projects to teach different contents in the classroom and always starts with a problematic, task or motivating question. The involvement of this teaching approach allows for a cooperative way and the search for problem solutions, providing a challenging experience for both the student and the teacher.

The PBL method goes beyond teaching only the concept in the classroom, as it enables the learning of other skills such as cooperation, values, communication, argumentation, criticality, socialization of ideas and cooperativeness.

Lara et al. (2019) say that the action of teaching is interconnected with the action of learning and through this exchange, the construction of knowledge and practices is expanded and reconstructed. To rupture the practice of traditional teaching, PBL brings dialogue and makes the student be perceived through their ideas and desires, strengthening ties and allowing the construction of meanings and exchange of knowledge, aspects that are extremely relevant for the formation of environmental awareness.

Skills for group work with oral presentations and project management will be developed throughout the course without the need to have previous experience with projects. Thus, the teacher will have relevant participation as a facilitator and manager for them to develop the required skills (Markham et al. 2008).

According to Ribeiro (2008), the benefit of this method is not only for the student but also for the teacher. The teacher reflects on his teaching practice in the teaching approach, making him improve his knowledge and perceptions in relation to the teaching and learning process of his students.

Educational learning projects are activities planned and carried out by students under the guidance of the teacher, in which the student is the main actor in this whole process and the teacher is the mediator or advisor. This student-centered method encourages youth protagonism and autonomy, and as students face certain stages, the responsibilities assigned to them increase in

order to create solutions and stimulate their creativity in problem-solving.

Ribeiro (2008) reaffirms that education should not only be a preparation for life, it should accompany life itself, and go hand in hand with the experiences of students and their peers, thus collaborating with the strengthening of their relationships in the psychological sphere, of consciousness and knowledge.

In view of this, it is evident that the contemporary educational context currently faces several challenges. The method used in educational areas is not attractive, a practice still common in this field is the conservative paradigm. However, as our society is experiencing constant changes, it is necessary for educational areas to adapt and modify their teaching environments, allowing the student to be active, critical, autonomous, and protagonist.

Due to the urgency and changes in educational areas and the constant emergence of new technologies, the teaching and learning process must promote the construction of knowledge, practices, and cultures that, through teacher and student interaction, have the same trajectory and can follow the same path and direction (Hoffmann 2014).

In this way, although this student has a main role in the whole process, having responsibility and autonomy for its conduction, it is also necessary that they have an active voice and opportunity for decision-making so that the learning expectations are relevant and the objectives can be decided by them, even partially.

Thus, in this context, the work with PBL in Environmental Education brings an innovative method that allows the student to have greater contact with the object of study, stimulating reflections and active attitudes throughout the process, aiming at consistent learning in relation to the proposed content by the teacher. It also provides the interaction between teacher, student, and the object of study mediated by articulations of the teacher who also has the role of facilitator of this whole path. Valuing the prior knowledge of students and content articulation differ from traditional practice, which is based only on the transmission of knowledge without concern and evidence of what the student has actually learned, increasing their engagement throughout the process.

## MATERIAL AND METHODS

### Selection and Characterization of the School Unit

The development of this study was carried out in the second two months of 2019 in a public school in Vale do Paraíba, State of São Paulo, Brazil. The pedagogical proposal of this research is centered on a socio-interactionist perspective, valuing collective work and the construction of new knowledge, seeking to develop teaching aimed at the integral formation of the student and the stimulation of youth protagonism. The management team of the school has a dialogue with the entire community, which favored its integration and reference in the neighborhood for its performance and support for students. In this school, there is a computer room, a Natural Sciences laboratory, and a reading room that works in three periods (morning, afternoon, and evening).

Most students live in the suburb of the city, with a low-income socioeconomic situation. The researchers worked with students in the first year of high school in the discipline of Biology. For this study, two rooms in the 1<sup>st</sup> year of high school were considered in the morning and evening periods, totaling approximately 50 students. The choice of groups occurred due to the low performance in the bimonthly evaluations of the discipline, the lack of interest in lectures, and the low productivity in individual and collective activities.

### Method Used for the Development of Activities with Students

A method was selected that would encourage youth protagonism and student autonomy for the development of skills and competencies in the discipline. The methodology used was in line with the skills provided for in the curricular matrix of the State of São Paulo. The curricular matrix provides for the interdisciplinary junction of Biology and Chemistry disciplines, integrating the contents of both to enable greater understanding, as well as a comprehensive view of the area of Natural Sciences.

The method used in this research was Project-Based Learning (PBL), which aims at learning that is not passive, verbal, and theoretical and with the active participation of students (Oliveira 2006). The guiding question of this study was: "How to make the school an environment for experiencing

environmental values and mobilize high school students to act on the environmental impact caused by plastic in the environment?" This question made it possible to direct the project with the activities proposals to be developed and the reflection of students for decision-making, offering subsidies for the final result obtained.

### Collection, Analysis and Interpretation of Data

In the data collection for the development of activities, the pre-test was used as the first evaluative instrument consisting of 10 questions about plastic as described in Table A1 (Appendix A).

The results of the pre-test helped to define which topics would be addressed by the students. Each theme was developed by a team of students. Each team had autonomy in the preparation of its stand, which later had to be presented to the public in an objective way. The topics addressed by the groups were:

- ◆ Group 1: Decomposition time of materials in the environment
- ◆ Group 2: Origin of petroleum, its derivatives, and raw material of plastic
- ◆ Group 3: Kinds of plastics
- ◆ Group 4: Plastic in the food chain
- ◆ Group 5: Microplastics
- ◆ Group 6: The impact of plastic on the environment

During the research, the objective was to encourage the engagement of students in an interactive and collaborative way, developing autonomy and critical thinking through experience and investigation, using different teaching and learning strategies with focus on the protagonism of students and youthful autonomy. The students were motivated to formulate hypotheses, write texts, discuss and reflect. The objective was to develop understanding and critical sense of students in relation to the concepts worked on in Environmental Education, with an interdisciplinary approach through the integration of Biology and Chemistry disciplines.

For the evaluation of the works, a committee was composed of five teachers from different disciplines of the school unit and used the analytical rubric as a qualifying instrument. It was observed that some students were insecure in the presentation and others showed mastery of the topic and excellent oratory. However, all teams

participated effectively with the preparation of slides or posters aimed at meeting the objective of developing the work.

### Analytical Rubric

For individual and collective evaluation of presentations and group work, an analytical rubric was used considering the following items and respective scores:

- ◆ Knowledge of the subject (1.0)
- ◆ Representation of the worked issue (1.0)
- ◆ Survey of information relevant to the proposed subject (1.0)
- ◆ Thematic related to the perspectives presented (1.5)
- ◆ Artistic structure adequate to the proposal (0.5)
- ◆ Will the proposed plan result in significant future content? (1.0)
- ◆ Did the information gathered and presented serve to educate the viewer? (1.0)
- ◆ Does the plan value the prospects of the chosen content? (1.0)
- ◆ Is the presentation adequate to what was requested? (0.5)
- ◆ Did the presenters make eye contact and pique the curiosity of the audience? (0.5)
- ◆ Are multimedia, digital images, artwork, and other visual aids well-developed and appropriately included? (0.5)
- ◆ Was the presentation convincing and engaging? (0.5)

The final mention of each group was calculated by adding the score obtained in each of the items considered in the analytical rubric.

To observe the evolution of students and the efficiency of the chosen methodology, the average of the bimonthly conceptual evaluations of the 1<sup>st</sup> and 2<sup>nd</sup> bimonthly was compared for future comparison of the class average without using the PBL method and with the use of the PBL method.

## RESULTS AND DISCUSSION

### Pre-test Evaluation

At the beginning of the studies, a pre-test was applied to evaluate the prior knowledge of students through a survey on the proposed topic. In the application of the pre-test, the question-



naire was previously read, aiming at understanding by the students. Students were informed that, in case there was a lack of knowledge of some questions, they should answer what they understood about the subject and avoid not answering the essay questions.

The Biology teacher applied the pre-test with an average duration of 50 minutes to complete the questionnaire. Some questions are considered in this section. Throughout the process, it is noted that the questions in which the students had difficulties were about the consumption of plastic in food, with a significant number of students answered negatively. Firstly, for the question “Do you think it’s possible that plastic is consumed in our food?”, 62 students answered this question, being that 17 percent answered “yes”, 52 percent “no” and 31 percent “don’t know”.

In the question of the pre-test related to the generation of diseases in living beings by plastic (Question: Do you think plastic can cause disease to living beings?), it was observed that, although the students did not have depth in this subject, they were aware that, in general, the problems related to this material would include disease and death of animals (62% answered “yes”). Through this question, it was possible to observe that this subject is little discussed in the classroom and that the contents addressed did not make the students reflect on the consequences of using these materials.

The question regarding plastic as a cause of disease addresses a topic publicized in the media, which links the problem of using plastic straws with the death of marine animals, especially sea turtles. However, the incorrect answers of some of the students showed that there was no correct understanding of the statement of the question.

The students were asked about the main problem arising from plastic and they answered that it would be the death of several animals and even the extinction of some species. It was possible to observe that the campaigns about garbage in the oceans and the death of sea turtles publicized in the media were successful in influencing the responses of students. The students reported on the use of the straw, but at no point did they mention knowledge about the aggravating factors of these actions for the human species. It was found that this knowledge of students was built mainly through media campaigns. However,

problems in relation to what happens in the food chain and the bioaccumulation of harmful materials in human food are still a topic to be studied in depth with material for dissemination and awareness of students.

Table 1 shows the varied responses of students related to the issue of problems arising from the use of plastic and its consequences for the environment and the lives of living beings. The analyzed data were important to outline the proposed project activities through this survey.

**Table 1: Response of students in the pre-test on the problem arising from the use of plastic**

(Total responses: 62)

<i>What is the problem with the use of plastic?</i>	
<i>Option</i>	<i>%</i>
Death and extinction	61
Flooding	33
Water pollution	28
Soil pollution	17
Others	21

The analysis of the pre-test responses made it possible to record the prior knowledge evidenced by the students in relation to the object of study. This step was fundamental to point out which paths should be followed in the next stages of this study. It was observed that most of the students raised important questions about the object of analysis, arousing a lot of curiosity and providing a favorable environment for new discoveries.

### **Evaluation of the Analytical Rubric**

The activities developed by the students were analyzed by the evaluating teachers. The results of this analysis are shown in Table 2, considering the average among the five professors.

According to Scallon (2017), it is recommended that the construction of descriptive scales, such as those that allow for evaluating performance or competence, be carried out by groups of job evaluators. In this context, the author alleges that an evaluator could not ensure that the judgment tool was well understood. According to the analysis of the results obtained in Table 1, progress was observed in the evaluation of the proposed items, even with the consideration of different scores for the indicators. In this study,

**Table 2: Analytical rubric of the evaluation of works by the committee of professors**

Indicators	Student groups						Mean $\pm$ Standard deviation
	1	2	3	4	5	6	
Knowledge of the subject (1.0)	0.8	0.8	0.8	1	0.5	1	0.81 $\pm$ 0.18
Representation of the problem in question (1.0)	0.9	0.7	1	1	0.5	0.5	0.76 $\pm$ 0.23
Gathering information relevant to the proposed subject (1.0)	1	0.8	1	0.8	0.9	1	0.91 $\pm$ 0.09
Themes related to the perspectives presented (1.5)	1.3	1	1	0.9	0.9	1.2	1.05 $\pm$ 0.16
Artistic structure adequate to the proposal (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5 $\pm$ 0.0
Will the proposed plan result in significant future content? (1.0)	1	1	1	1	1	1	1 $\pm$ 0.0
Did the information gathered and presented serve to educate the viewer? (1.0)	1	1	1	1	1	1	1 $\pm$ 0.0
Does the plan value the prospects of the chosen content? (1.0)	1	1	1	1	1	1	1 $\pm$ 0.0
Is the presentation adequate to what was requested? (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5 $\pm$ 0.0
Did the presenters make eye contact and pique the curiosity of audience? (0.5)	0.4	0.3	0.5	0.3	0.5	0.5	0.41 $\pm$ 0.09
Are multimedia, digital images, artwork and other visual aids well developed and appropriately included? (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5 $\pm$ 0.0
Was the presentation convincing and engaging? (0.5)	0.5	0.5	0.5	0.5	0.5	0.5	0.5 $\pm$ 0.0
Final Mention	9.4	8.6	9.8	9	8.3	9.2	9.05 $\pm$ 0.54

progress in learning was considered, for example, the relevance of the criteria in which there was relevance between indicators related to knowledge (knowledge), to know-to-do (data processing), and know-to-be (group attitude) of students during presentations of work in the classroom.

### Post-test Evaluation

At the end of the project, a post-test containing six questions was applied to measure student learning and verify whether the project objective was achieved. Questions related to the topic studied were included with the objective of matching the pre-test and post-test with the intention of observing the advances in knowledge acquired throughout the project and identifying learning difficulties. It is noteworthy that the questions that were worked on in the pre-test and post-test were similar and not identical, modifying the enunciation and/or the format of the questions.

In item 1 of the post-test, which explains the following question: "What is the raw material for the manufacture of petroleum?", it was verified that in the pre-test this question obtained 45.2 percent of correct answers, with 34 students answering incorrectly by marking cellulose, latex, and

leather as possible raw materials for plastic. From this analysis, it was verified that with the application of the post-test that all the answers were answered correctly, demonstrating an advance of 54.8 percent when compared to the pre-test. Based on these results, the researchers had an indicator that students had gained an understanding of the subject addressed.

In question 2, when asked again about the decomposition time of plastic in nature, the students were more unanimous in their answers. In the pre-test, 41.9 percent of correct answers were obtained in this question, noting that this learning skill was not previously developed with this group and in the post-test, it obtained 87 percent of correct answers, expressing an advance of 45.1 percent. This fact elucidates on the part of the students a more comprehensive understanding of plastics having a high durability in nature and with regard to their bio-accumulation. However, the study also showed only an expectation of reality, as there are several types of plastics and each one takes a different time to degrade. Table 3 presents the comparison between the pre-test and post-test questions, demonstrating the advances in this teaching and learning process.

In summary, the results presented from the comparative data between the pre-test and post-test demonstrate an advance in the knowledge of students with skills that go beyond the school curriculum. The pre-test average was 42.7 percent and the post-test average was 81.9 percent, highlighting the evolution of student learning and demonstrating the importance of an innovative teaching methodology. In a first analysis, this average would indicate a considerable increase in student learning. This improvement in learning is true for some of the evaluated topics, which reached 100 percent correct answers in the post-test, as in relation to the question involving the different types of plastic. Note that in the question in which the problems brought by plastic to today's society were addressed, the rate of correct answers increased from 16.1 percent in the pre-test to 82.6 percent in the post-test. These percentages suggest that students did not initially have knowledge about the consequences of plastic in a broader context, such as global warming, marine and soil pollution, and risks to human health caused by the manufacturing process that were addressed in the classroom through seminar discussions and activities. The improvement in student learning was also observed in relation to plastic decomposition, with an increase

from 41.9 percent in the pre-test to 87.0 percent in the post-test. However, in the question that addressed the final destination of the plastic, the number of correct answers went from 30.6 percent to only 47.8 percent. It was observed that the percentage of correct answers in the post-test remained low, possibly due to the complexity of the subject for the students. In this item, the fate of plastic in landfills was discussed, as well as its irregular disposal without treatment in open-air dumps.

Thus, although in general, the data in Table 3 suggest that there were important improvements in learning, it is important to be aware of topics that students had difficulty discussing, requiring the intervention of the teacher to complete the proposed activities in the classroom.

### CONCLUSION

The data obtained in this study are articulated with the objectives exposed in this paper, with the selection of several evaluation instruments such as the pre-test, the analytical rubric, and the post-test for an assertive and punctual analysis of the results obtained.

The analysis of the evaluative instruments showed that the students acquired new knowl-

**Table 3: Summary analysis of pre-test and post-test result**

<i>Learning objective</i>	<i>Guiding question</i>	<i>Pre-test% of correct answers</i>	<i>Post-test % of correct answers</i>
Stimulate the perception of the plastic production chain and promote environmental awareness for conscious consumption and proper disposal of this waste through the search for creative and innovative solutions.	What is the raw material for the manufacture of petroleum?	45.2	100
Know the specificities of different types of plastics and relate them to decomposition processes;	What is the decomposition time of plastic?	41.9	87.0
Analyze the impacts caused by plastic on society, on food chains and on the health of living beings;	What are the consequential problems of plastic for today's society? (Soil pollution item)	16.1	82.6
Know the specificities of different types of plastics and relate them to decomposition processes;	Are all plastics the identical?	77.4	100
Stimulate the search for sustainable solutions and alternatives to the use of plastic.	What is the most important attitude to reduce the use of plastic?	45.2	73.9
Analyze the impacts caused by plastic on society, on food chains and on the health of living beings.	What is the final destination (route) of plastic?	30.6	47.8



edge and there was a change of attitude in the school context, especially in low-achieving students. Consequently, these students performed better in formal school evaluation, with greater autonomy in the study and youth protagonism.

On average, the number of responses increased from 42.7 percent in the pre-test to 81.9 percent in the post-test. However, the interpretation of this result deserves caution. For some topics, the improvement of students was really significant going from 16.1 percent to 82.6 percent, as observed in relation to soil pollution. However, regarding the proper disposal of waste, even after the development of the project, less than half of the students (47.8%) were able to answer this question correctly. Such results indicate the need for more projects to try to overcome deficiencies in relation to the proposed theme.

### RECOMMENDATIONS

The researchers believe that with the idea proposed here, other professors/researchers may be able to carry out similar research, as for example focusing on “metals”, and “oils” among others.

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### REFERENCES

- Bender WN 2022. *Project-Based Learning: Differentiated Education for the 21<sup>st</sup> Century*. 1<sup>st</sup> Edition. Rodrigues, M. G. S. H. F. S., Translator; Penso: Porto Alegre.
- BRASIL 2017. Common National Curriculum Base. Ministry of Education, 2017. From <[http://basenacionalcomum.mec.gov.br/images/BNCC\\_EI\\_EF\\_110518\\_versaofinal\\_site.pdf](http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518_versaofinal_site.pdf)> (Retrieved on 25 April 2021).
- BRASIL 2019. Contemporary transversal themes at the BNCC. Practical proposals for implementation; Ministry of Education: Brasília. From <[http://basenacionalcomum.mec.gov.br/images/implementacao/guia\\_pratico\\_temas\\_contemporaneos.pdf](http://basenacionalcomum.mec.gov.br/images/implementacao/guia_pratico_temas_contemporaneos.pdf)> (Retrieved on 15 May 2021).
- Collignon Amandine, Hecq Jean-Henri, Jousseume Mathieu, Goffart Anne 2014. *Zooplankton Biovolume Time Series at Station STARESO (Bay of Calvi, Corsica)* in 2013. <https://doi.org/10.1594/PANGAEA.832969>.
- Eduardo LA, de P, Garcia RV, Romão EC, Napoleão DAS 2020. Analysis of the impact of plastic on the theme of environmental education for application in Brazilian Public Schools. *Int J Innov Educ Res*, 8(6): 78-89. <https://doi.org/10.31686/ijer.vol8.iss6.2378>.
- Hoffmann J 2014. Evaluate to Promote: The Arrows of the Way. 15<sup>th</sup> Edition. Mediation: Porto Alegre. From <<http://conferenciainfante.mec.gov.br/images/conteudo/iv-cnijma/diretrizes.pdf>> (Retrieved on 28 May 2021).
- Lara EM de O, Lima VV, Mendes JD, Ribeiro ECO, Padilha R de QO 2019. The teacher in active methodologies and the nuances between teaching and learning: challenges and possibilities. *Interface (Botucatu)*, 23: e180393. <http://dx.doi.org/10.1590/interface.180393>.
- Markham T, Larmer J, Ravitz J, Bueno D, Sena GJ 2008. *Project-Based Learning Guide for Elementary and Secondary School Teachers*. 2<sup>nd</sup> Edition. Artmed: Porto Alegre, RS.
- Moore CJ, Moore SL, Leecaster MK, Weisberg SB 2001. A comparison of plastic and plankton in the North Pacific Central Gyre. *Marine Pollution Bulletin*, 42(12): 1297-1300. [https://doi.org/10.1016/S0025-326X\(01\)00114-X](https://doi.org/10.1016/S0025-326X(01)00114-X).
- Oliveira CL 2006. *Meaning and Contributions of Affectivity, in the Context of Project Methodology, in Basic Education - Chapter 2*. Dissertação, Mestrado. Belo Horizonte: Centro Federal de CEFET - Educação Tecnológica.
- Omoyajowo K, Raimi M, Waleola T, Odipe O, Ogunyebi A 2022. Public awareness, knowledge, attitude and perception on microplastics pollution around Lagos Lagoon. *Ecological Safety and Balanced Use of Resources*, 2(24): 35-46. [https://doi.org/10.31471/2415-3184-2021-2\(24\)-35-46](https://doi.org/10.31471/2415-3184-2021-2(24)-35-46).
- Ribeiro LRC 2008. Problem-Based Learning (PBL) in engineering education. *Revista de Ensino de Engenharia*, 7(2): 23-32.
- Reed MR, Chen WT 2022. Plastics crash course: A website for teaching plastics recycling and microplastics prevention through infographics. *Recycling* 7: 65. <https://doi.org/10.3390/recycling7050065>
- Scallon G 2017. *Learning Assessment in a Competency Approach*. PUCPRES: Curitiba.

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**APPENDIX A****Table A1: Initial analysis with the introduction of the pre-test**

<i>Number</i>	<i>Question</i>
(1)	Where do we find plastic in our daily lives?
(2)	What is the best way to reduce plastic use? a) <input type="checkbox"/> Reducing consumption b) <input type="checkbox"/> Recycling the materials c) <input type="checkbox"/> Reusing the materials d) <input type="checkbox"/> Others
(3)	What waste do you consider most harmful to the environment and living beings? a) <input type="checkbox"/> Glass b) <input type="checkbox"/> Plastic c) <input type="checkbox"/> Paper d) <input type="checkbox"/> Metal
(4)	Are all plastics identical? a) <input type="checkbox"/> Yes b) <input type="checkbox"/> No c) <input type="checkbox"/> I don't know
(5)	What is the raw material for obtaining plastic? a) <input type="checkbox"/> Cellulose b) <input type="checkbox"/> Latex c) <input type="checkbox"/> Petroleum d) <input type="checkbox"/> Leather
(6)	What is the average time for plastic to decompose? a) <input type="checkbox"/> 2 years b) <input type="checkbox"/> 20 years c) <input type="checkbox"/> 200 years d) <input type="checkbox"/> 2000 a years
(7)	Do you think it is possible for plastic to be consumed in our food? a) <input type="checkbox"/> Yes b) <input type="checkbox"/> No c) <input type="checkbox"/> I don't know
(8)	Do you think that plastic can cause diseases to living beings? a) <input type="checkbox"/> Yes b) <input type="checkbox"/> No c) <input type="checkbox"/> I don't know
(9)	You are walking down the street and suddenly you drop a candy wrapper on the floor. What is the route taken by the package and what is its final destination?
(10)	What is the environmental problem arising from the use of plastic?