



Educação & Formação  
ISSN: 2448-3583  
Universidade Estadual do Ceará

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Aprender Ciências por meio de textos de divulgação científica: estratégias contributivas  
para professores em formação sobre a construção de conceitos ambientais  
Educação & Formação, vol. 7, no. 1, e8944, 2022  
Universidade Estadual do Ceará

DOI: <https://doi.org/10.25053/redufor.v7.e8944>

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## Learning Sciences through scientific awareness texts: contributory strategies for teachers in training on the construction of environmental concepts

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### Abstract

This research aimed to understand how the use of scientific texts can contribute to the understanding of concepts related to the environmental area in the teaching of Biology to high school students. The qualitative, descriptive, and participatory research took place in a state school located in Natal, Rio Grande do Norte, with two groups divided into an intervention group and a participatory observation group. The results show that the intervention group presented a greater amount of basic ecological concepts and inserted them into an environmental problem, with more property and better reasoning than what was observed in the responses of the participatory observation group, meaning that there was greater construction of knowledge. Thus, the use of well-defined reading strategies and the direct participation of the teacher facilitated and encouraged the discussion of the scientific popularization text in the classes, enabling a meaningful, diversified, and dynamic learning process.

### Keywords

meaningful learning; teaching Science and Biology; scientific literacy; constructivism.

### Aprender Ciências por meio de textos de divulgação científica: estratégias contributivas para professores em formação sobre a construção de conceitos ambientais

### Resumo

O objetivo desta pesquisa foi compreender de que forma a utilização de um texto científico pode contribuir para o entendimento de conceitos relacionados com a área ambiental no ensino de Biologia para estudantes do ensino médio. A pesquisa qualitativa, descritiva e participante ocorreu em uma escola estadual na cidade de Natal, Rio Grande do Norte, em duas turmas, divididas em um grupo de intervenção e outro de observação participativa. Os resultados mostram que o grupo de intervenção apresentou maior quantidade de conceitos ecológicos básicos e inseridos em uma problemática ambiental, com mais propriedade e melhor fundamentação do que o testemunhado nas respostas do grupo de observação participativa, significando que houve maior construção de conhecimento. Assim, o uso de estratégias bem definidas de leitura e a participação direta do professor facilitaram e incentivaram a discussão do texto de divulgação científica nas aulas, possibilitando uma aprendizagem significativa, diversificada e dinâmica.

### Palavras-chave

aprendizagem significativa; ensino de Ciências e Biologia; alfabetização científica; construtivismo.

## **Aprender Ciencias a través de textos de comunicación científica: estrategias contributivas para docentes en formación sobre la construcción de conceptos ambientales**

### **Resumen**

El objetivo de esta investigación fue comprender cómo el uso de un texto científico puede contribuir a la comprensión de conceptos relacionados con el área ambiental en la enseñanza de la Biología a estudiantes de secundaria. La investigación cualitativa, descriptiva y participante ocurrió en una escuela estatal de la ciudad de Natal, Rio Grande do Norte, en dos clases, divididas en un grupo de intervención y un grupo de observación participativa. Los resultados muestran que el grupo de intervención presentó mayor cantidad de conceptos ecológicos básicos e insertos en un problema ambiental, con más propiedad y mejor razonamiento que lo observado en las respuestas del grupo de observación participativa, es decir, hubo mayor construcción de conocimiento. Así, el uso de estrategias de lectura bien definidas y la participación directa del docente facilitaron y fomentaron la discusión del texto de divulgación científica en las clases, posibilitando un aprendizaje significativo, diversificado y dinámico.

### **Palabras clave**

aprendizaje significativo; enseñanza de Ciencias y Biología; alfabetización científica; constructivismo.

## **1 Introduction**

Science teaching has been changing concerning the strategies used by the teachers in the classroom, in the perspective of allowing pedagogical actions which give new meanings to the students' learning processes, including more constructivist practices. According to Garcia (2003), the introduction of pedagogical innovations has been recurrent in promoting reforms to improve teaching. Within this perspective, it is possible to highlight reading and writing as teaching strategies in Sciences classes, since reading establishes relations and creates conceptual systems with which we elaborate thoughts.

Reading and writing in the school environment are linked to communication activities, dissemination of results, and establishment of norms, which will only occur if the teacher in charge is aware of the social dimension that involves his profession (MARANGONI, 2008). At this juncture, the practice of reading and writing is inseparable from the teaching and learning process. Besides that, texts that are not strictly school texts circulate beyond the school walls and can enable the establishment of

relationships between science, the educational environment, and the real world (OLIVERAS; BARGALLÓ; SANMARTÍ, 2012).

Inserted on the current context of Education, it is necessary to understand which methodologies and strategies can be used by teachers to incite in students the pleasure of reading, especially reading scientific awareness texts. In this way, learning with criticality is favored in teaching contexts, leading students to scientific literacy.

Through reading and writing in Sciences and Biology classes, for example, students can be encouraged to do readings that substantiate important concepts about ecology, environmental preservation, the environment, among others, starting to understand relevant aspects of the area and being able to link those topics to the environment where they live. However, teachers should be warned about the need to create a reading habit, acquire new knowledge, compare their point of view with other students', and, thus, generate solid arguments, as these are essential in textual production.

Concerning the area of Nature Sciences, the Common National Curricular Base (BNCC) for High School has a skill, listed as the third, linked to the specific competence, which aims:

[...] interpret scientific texts that deal with themes of the Natural Sciences, available in different media, considering the presentation of data, both in text form and in equations, graphs and/or tables, the consistency of arguments and the coherence of conclusions, aiming to build strategies for selecting reliable sources of information. (BRASIL, 2018, p. 559).

This means, according to Delabio *et al.* (2021), that using different ways of understanding Science and its configuration of development is of utter importance and, in this case, according to the authors, may be helped by using several scientific materials.

In this context, this study aimed to understand how the use of a scientific texts text may contribute to the comprehension of scientific concepts related to the environmental area in Biology teaching for High School students.

## 2 Methodology

The research, described as qualitative, descriptive, and participant, was done in a state school in Natal, Rio Grande do Norte, in two classes in the 3<sup>rd</sup> year of High School. The approached topics followed the proposed curriculum for the 3<sup>rd</sup> year, as well as the sequence from their schoolbook to be studied in the fourth bimester. The topics included themes such as ecology, environmental conservation, environmental education, environment, and others.

The students were divided into two groups: group 1 (Class A), named intervention class, which had as the beginning of its activities the use of problematizations aiming to promote cognitive conflicts and generating debates around the themes to be studied with the use of scientific texts; and group 2 (Class B), named participatory observation class, which also had access to the problematization issue, but the dynamics of its classes prioritized expository aspects in the presentation of the contents.

During the research period, the observations and data collection were made by the main investigator of this study. Thus, we analyzed the influence of scientific texts on reading habits and how this practice might help the students' written productions concerning conceptual concepts. It was also possible to analyze how the reading habit in Biology classes reflects on the written production.

In the intervention class, the content was exposed through scientific texts while the same content was exposed through the traditional method (expositive classes) in the participatory observation class, following a methodology normally used in the development of bimestrial activities. The methodologic stages applied in both classes are shown in Table 1.

**Table 1** – Stages of the research development on the intervention and participatory observation classes

Stages	Class A – Intervention	Class B – Participant observation
1st	Characterization of a scientific texts	Content introduction – expository lesson
2nd	Presentation of the chosen text Explanation of the Critic framework	Fundamental concepts for Ecology study
3rd	Reading the text: on the verge of a new extinction; initial question	Species extinction and conservation in ecosystems (expository lesson)
4th	Presentation of the situation-problem	Presentation of the problematizing situation
5th	Text production	Text production

**Source:** Produced by the authors.

As the facilitator strategy for the moment of reading the text on the intervention class, the research based on the *Claim framework; Role of the claimant; Information backing the claim; Testing; Independent testing; Cause proposed* (CRITIC), used in Bartz's works (2002), with adaptations that aimed a better comprehension from the students. The execution of the proposed steps started in the fourth bimester of the school year, when, at first, after defining the text to be studied, we exposed the scientific text to be used in the future classes aiming to characterize the reading genre (scientific text). The goal was also to introduce the structure that identifies and guides the production of this type of text, how they are produced, and its purpose.

In this perspective, we proposed, from a visual introduction, a previous analysis of the text to be read, recognizing the importance of some living creatures for the environment. After that, we introduced the text "On the verge of a new extinction?" (KUGLER, 2014).

After that, we discussed some topics, such as the importance of the spider as a predator of small insects and the perception of species responsible for the dissemination of seed in the environment. In this phase which preceded the reading of the text, we asked students to answer the question: "Why should we care about the disappearance of animal species?".

The reading of the text happened collectively, with emphasis on the questions suggested by the students, prioritizing the objectives to be achieved. Then, the students had an individual reading contact, having, for this goal, the guidance of the CRITIC framework with the appropriate adjustments of terms and questioning, as suggested by Oliveras, Bargalló, and Sanmartí (2012).

In some moments, we established a dialogue with the text or with the students, aiming to guide their perception so the goals already defined for this activity could be achieved. There was also a concern to clarify words or terms that the students presented as "unfamiliar", which generated the production of a glossary as an activity to be made after reading the text.

After those stages, we made a moment of socialization of the answers to the questions suggested by CRITIC, and the students opened a discussion about the concepts, themes, and situations presented in the text. This stage was followed by asking the group to produce a justification for the following question:



The backland is represented by the caatinga, the driest region in the Northeast. There we find cacti, mandacarus, xique-xiques, and facheiros, in addition to maniçoba, which produces latex, marmeleiro, and umbuzeiro. Because it remains green, despite the drought, and conserves water reserves in its roots, Euclides da Cunha defined the umbuzeiro, as the "sacred tree of the caatinga" in his book "Os sertões" ("Rebellion in the Backlands"). What consequences would the extinction of all caatinga vegetation have for this important biome?

In Class B, on the other hand, we discussed the same theme, showing the students a foundation on the issue of extinction and the consequent conservation of species. This group had access to the same information regarding the theme studied by Class A, but in the form of lectures, and no textual resources were proposed. Thus, the classes were taught by the researcher teacher, considering the proposed curriculum for the bimester, in accordance with the themes also discussed in Class A.

At the end of the teaching unit for the bimester, we asked the students of this group to produce an answer to the same question presented in Class A. Thus, we intended to analyze, from the answers given, to what extent the reading of the scientific texts could interfere and define a better quality in the answers of students and if questions and analysis that appeared during the discussions were supported by the texts read.

Since this research worked with human beings, the participants signed a Free and Informed Consent Form, which makes clear the free and spontaneous will to participate in the research. Still regarding ethical issues, this research is part of a larger study that was submitted to the Ethics Council of the Federal University of Rio Grande do Norte (UFRN), through the Plataforma Brasil, being analyzed and approved with Report No. 5,327,250 and Certificate of Ethics Appreciation Presentation No. 54129421.2.0000.5537, in accordance with the Resolution of the National Health Council No. 466/2012.

### 3 Results and discussion

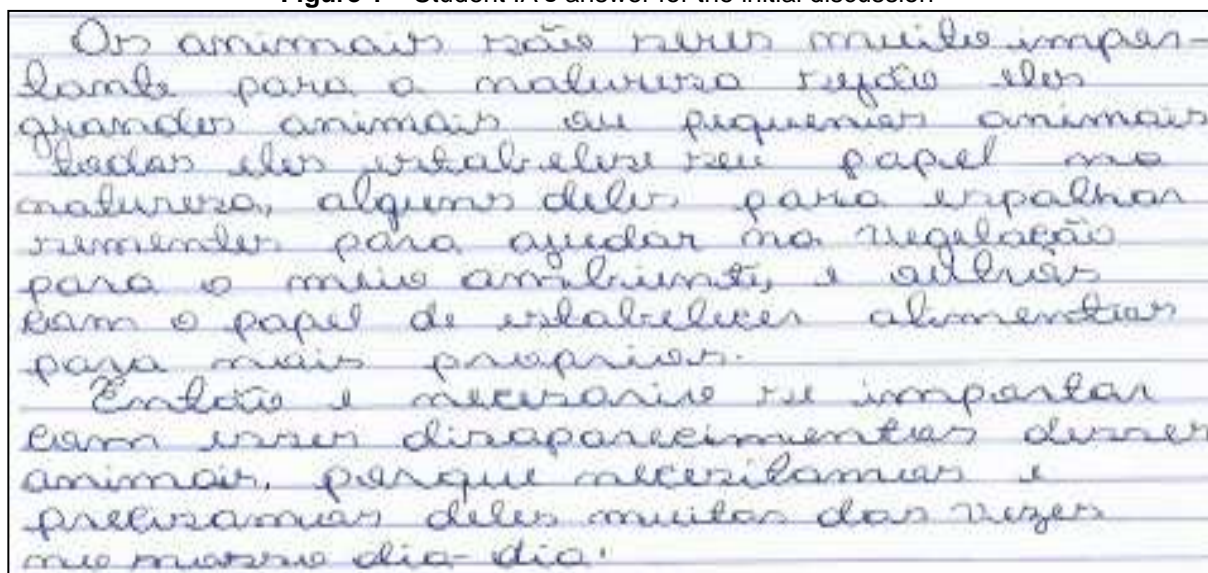
We now present the results obtained in the sequence of activities performed with the intervention class according to the chronological order of the activities, which were: the phase that precedes the reading of the text, the moment of reading the scientific text, and the post-reading phase.

### 3.1 Pre-reading moment: preliminary phase

Oliveras, Bargalló, and Sanmartí (2012) consider important for the use of texts in the classroom the use of activities that help contextualize reading. In addition, they consider that cooperative learning, from the discussions provided during the reading, fosters the increase of higher-order skills, such as: criticizing, analyzing, judging, and improving problem-solving strategies.

In this sense, we selected one question included in the chosen text which started the initial discussion: "Why should we care about the disappearance of animal species?". The analysis of 38 answers obtained from this question revealed that students understand the importance of animals as collaborators of the environment, an answer highlighted by 36.8% of the participants. The main example of this collaboration was the possibility that these animals participate as disseminators of seeds and pollen, as observed in the answer presented by student IA (Figure 1).

Figure 1 – Student IA's answer for the initial discussion<sup>1</sup>



Source: Research data.

The analysis allows concluding that, in this case, besides the condition of animals which help "disseminate seeds", the student refers to "big animals or small

<sup>1</sup> Translated: "The animals are very important beings to nature, being big animals or small animals, they all have a role in nature, some of them to disseminate seeds to help the vegetation of the environment and others with the role to establish food for more proper. So it is necessary to care about those disappearances of those animals because we need them most of the times in our daily lives".

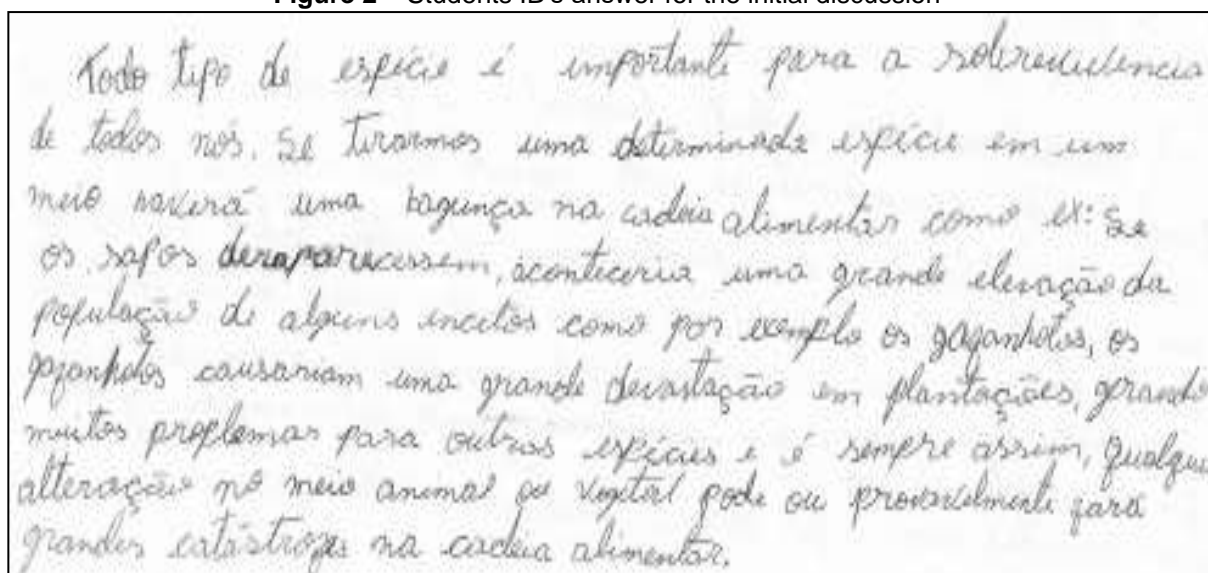


*animals*", which represents an important aspect, since students normally refer to large size animals only. Another highlighted aspect refers to the food link relations that could be established among animals, which reminds us of the concept of the food chain, without highlighting the need to *"care about those disappearances of those animals because we need them most of the times in our daily lives"*.

According to Duarte, Calixto, and Ferreira (2022), scientific dissemination has a fundamental rule for the wide use of scientific information in the process of teaching and learning Sciences. However, it is understood that the teachers need to have access to processes and/or training actions for this, in other words, they need to know and feel safe to use those resources in the classroom. Therefore, they may provide meaningful learning moments for their students, similar to the ones shown in the students' speeches in this research, which shows their perceptions about the environment from the used scientific text.

Other students mention as a reason for animal preservation the imbalance of the food chain, as expressed in the answer by student IB (Figure 2).

**Figure 2** – Students IB's answer for the initial discussion<sup>2</sup>



**Source:** Research data.

<sup>2</sup> Translated: "All types of species are important for our survival. If we remove a certain species of an environment, there will be a mess on the food chain. For example: if frogs disappeared, there will be a huge elevation of the population of some insects such as grasshoppers. The grasshoppers would cause a huge devastation in plantations, causing many problems for other species and it is always like this, any change on the animal or plant environment may or will probably make huge catastrophes on the food chain".

Analyzing the given answer, it is possible to understand that “*there will be a mess*” refers to an imbalance that, in this case, implies the decrease and increase of animal and plant populations. Besides that, the sentence “*causing many problems for other species*” shows this student’s perception of the importance of keeping the unit on food chains, under the risk of causing “*problems for other species*”.

After reading the answers provided by the students, we proposed a conclusive debate during which it was possible to observe the following aspects: a) students were able to easily understand the concept of the food chain; and b) students were able to recognize the importance of a living being in relation with another, understanding that each specie has an important biological role on the environment it lives. Thus, it was possible to understand that the scientific text may contribute to bringing aspects of the specific language of science closer to the student's everyday life, making the school content more meaningful and enabling the necessary generalizations that are required in the process of conceptual meaning (COLPO; WENZEL, 2021).

The analysis of the answers written by the students allowed noticing a clear understanding of the effects that the removal of one of the species involved in a food chain may cause on the imbalance of this community. It was also possible to observe the students’ perception concerning the numerical change (increase and decrease) in the populations, as well as the recognition of the importance of animals as seed disseminators.

In this sense, Gauthier, Bissonnette, and Bocquillon (2021) argue that, in aiming to develop critical thinking in their students, the teacher should not only seek to acquire declarative knowledge in a field of knowledge but also teach them to critique, i.e., demonstrate a procedural knowledge. Such knowledge can be achieved through strategies that put students in front of problems, from which they need to think and elaborate hypotheses, as occurred in this study. This allows the awakening of critical thinking and, consequently, stimulates the student to formulate valid opinions to solve the proposed problem.

### **3.2 During the reading: use of the CRITIC**

The CRITIC framework was used during the reading of the scientific text as a facilitator support in the overall reading comprehension. For this research, we made

some adjustments in the terminologies in order to help the execution of this stage. Thus, the questionnaire was worked on in the intervention class, and the records of 23 collaborating students were analyzed.

Data shows that, from the answers given by the students who filled the CRITIC framework about the ecological questions shown in the text (Consignment Phase – main points), 73,9% of the students identified the extinction process as the main issue presented by the author of the text. In the questionnaire phase, when we asked about who wrote the text and what motivated the writing (Rol phase of the CRITIC), the main aspects indicated by the students were: informing about the dangers of extinction, indicating the importance of the balance of the food chain, restricting hunting and deforestation, and recovering the species.

Therefore, it was possible to observe that students were able to clearly communicate the author's purpose in writing the text. Besides that, it is worth highlighting the coherence of the interpretation of this purpose with the previously analyzed question, since the extinction issue was highlighted by most of the students (39,1% of the participants).

When asked about what the author expected in face of the mentioned problem (Ideas phase in CRITIC), it was possible to see that the impression captured by the students was that the author of the text points out as the readers' main expectation the creation of an awareness about the ecological facts related to the preservation of species, followed by the concern about their extinction.

Thus, it was possible to infer that, from information disseminated in scientific texts and through their constant use, especially in science classes, the popularization of Science should occur, awakening citizens' sustainable practices in the use of natural resources that surround them. Therefore, it is possible to have a better understanding of the man-nature relationship (FERNANDES; SILVA; ARAÚJO, 2020).

The two final analyses, which refer to the final phases of the CRITIC framework (Information and Conclusion) were answered very limited, including only information from the text (clear copies of parts of the text). Students did not show, in those items, their own ideas and possibilities concerning how to test the hypothesis or analyze arguments. Thus, the answers given, in general, consider or understand that

the arguments and scientific evidence, which justify a hypothesis, were presented by the author, scientists, or entities mentioned in the text itself.

### **3.3 Text production: the post-reading moment**

After the introduction of the topics worked in both classes, from different methodological strategies, the students were asked a final question as a way of marking the results. Thus, the construction of the answers of the participants who used the scientific text and the reading strategies (intervention class) was compared to those who did not provide such activities.

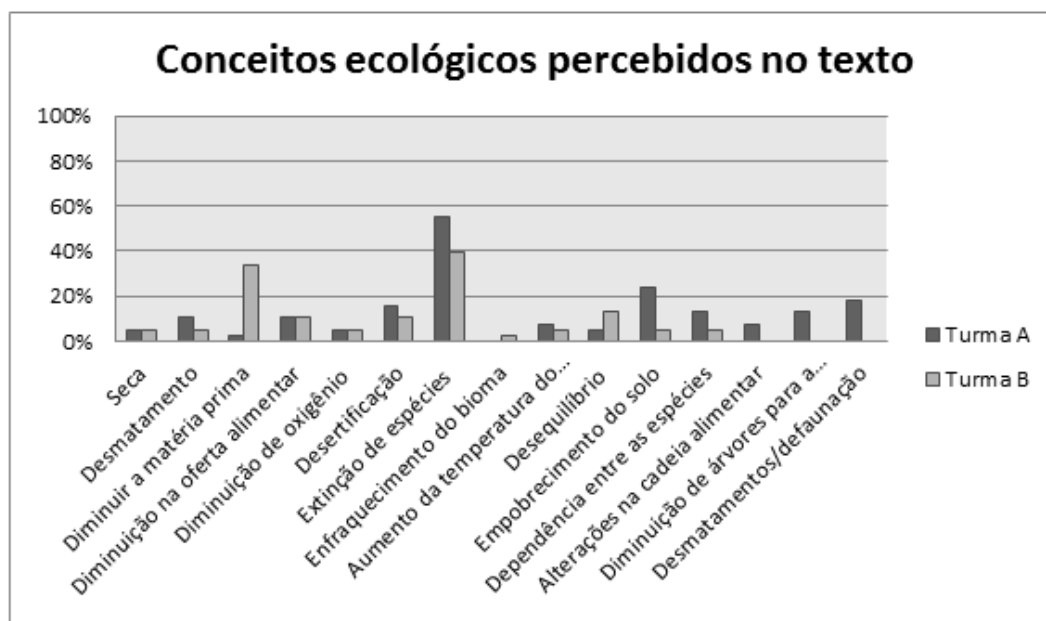
This research stage was done in both classes and the results were analyzed and compared concerning the textual construction of the answers presented. For the analysis of the answers given to the questionnaire answered by the students, the criteria of textual cohesion and coherence, the description of biological concepts discussed during the classes, and the contextualization of the discussions held throughout the bimester were considered.

Data revealed that in Class A (the intervention group) the number of information presented concerning what consequences of the extinction of certain plant species in the caatinga biome could cause was much higher than in class B (the participant observation group). Data also evidenced that the students of the intervention group mentioned, besides the expected themes, other important issues such as the consequences of the degradation of the terrestrial biomes in their entirety and its effects on planet Earth.

With these results, it is argued that, in the process of teaching and learning in the area of Natural Sciences, we must consider the need for the use of the specific language of scientific concepts during classes, so that it is understood by students, considering, for example, that students do not yet know the terms with the meanings assigned to them historically (COLPO; WENZEL, 2021). Thus, science papers can help the teacher to achieve this balance between the use of scientific texts in classes and the necessary language for the students' understanding.

It was also possible to verify that some expressions were used exclusively by the students who had access to the scientific text, indicating that they developed a better grounding and argumentation capacity for the topic in question, as shown in Figure 3.

**Figure 3** – Ecological concepts mentioned by Classes A and B

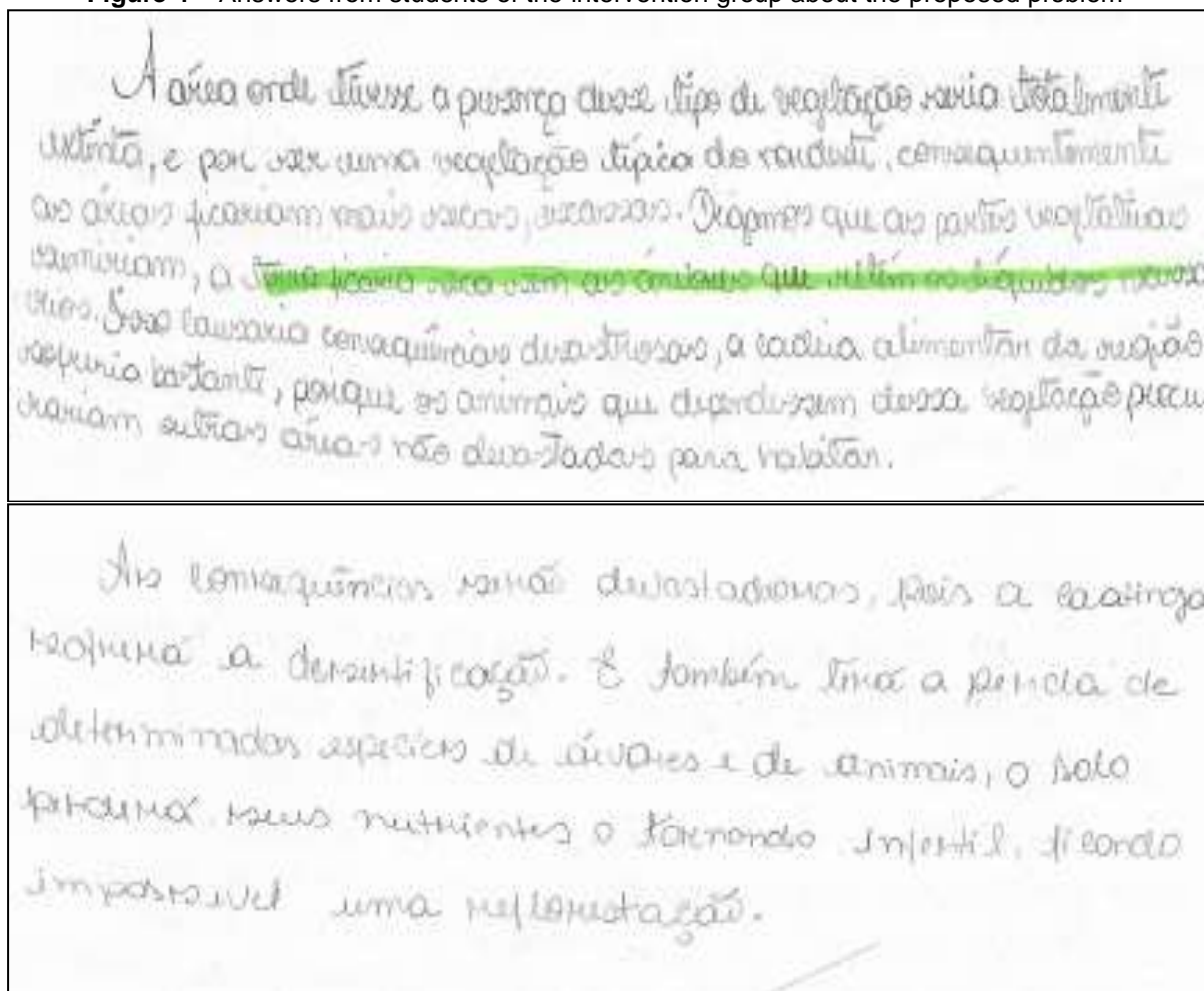


Source: Research data.

It is possible to observe with those answers that students were very interested in the reading from the moment the topic was previously problematized, which favored the initial interest. The awakening of the students' curiosity, aiming to find in the text the answers or directions for the mentioned problems, was reached with the incitement of the problem launched before the reading. This learning, according to Sanmartí (2020), provides students with meaning and a sense of the need to want to connect with reading, that is, it brings the learner closer to reading with the aim of building their learning.

The written production of Class A (intervention group) presented a greater amount of basic ecological concepts, inserted in an environmental problem, with more property and a better foundation in relation to the answers of Class B (participant observation group). This shows that there was a greater construction of knowledge from the scientific texts, proving to be an efficient resource for learning, as can be seen in the answers in Figure 4.



**Figure 4** – Answers from students of the intervention group about the proposed problem<sup>3</sup>

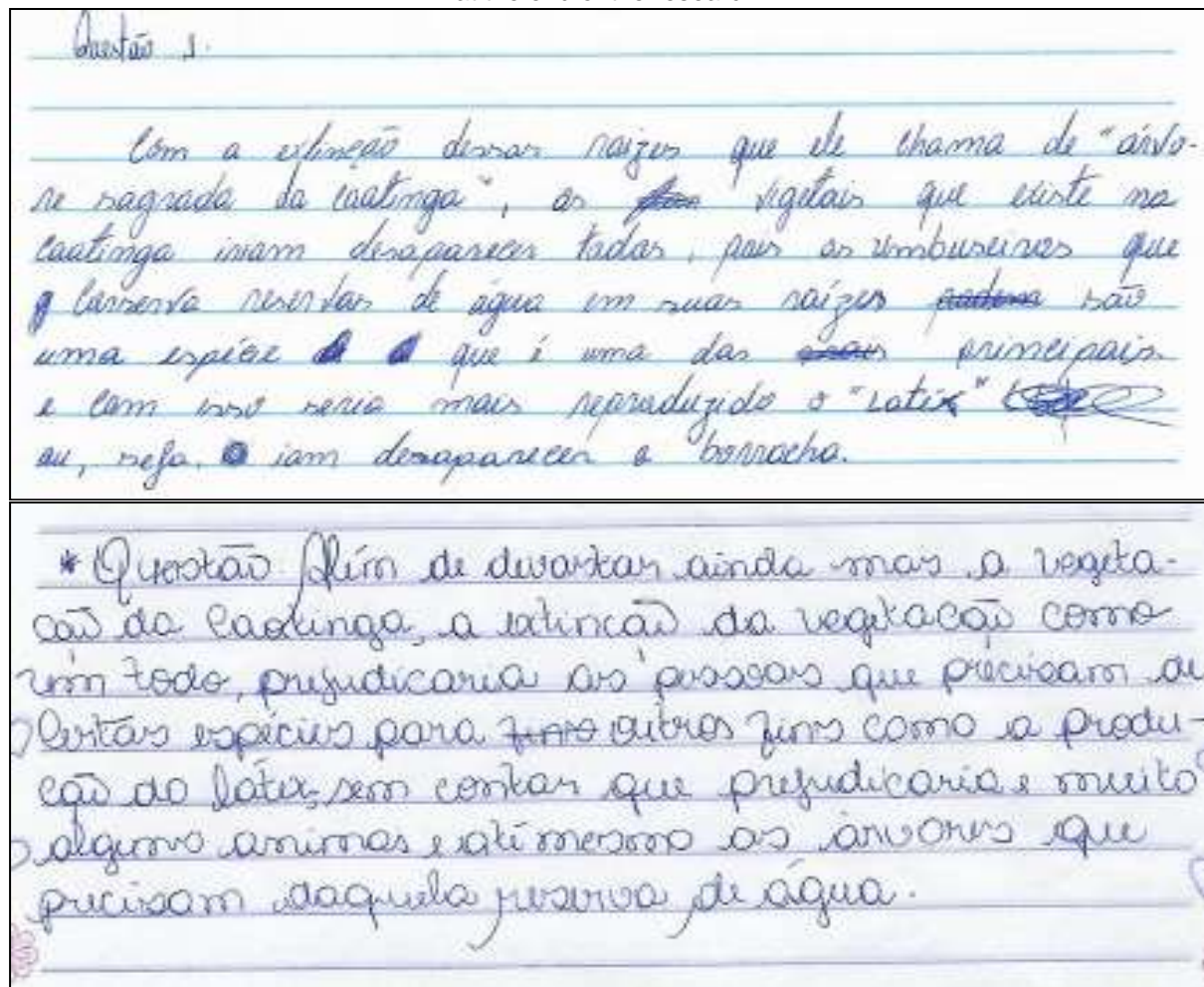
Source: Research data.

Among the answers given by the students of class B (participant observation group), it was possible to notice a concern with the decrease of raw material from the caatinga, linking this decrease to the lack of material for the production of consumer goods. However, little was said about the protection, preservation, causes, and consequences of the extinction of a species (Figure 5), as presented in the work of Fernandes, Silva, and Araújo (2020), which, when checking the understanding of students about the functioning of ecosystems, showed that the answers were influenced

<sup>3</sup> Translated: "The area where this type of vegetation is located would be totally extinct and, due to being a typical vegetation of the Northeast, consequently the areas would become dryer, scarce. If we consider the vegetation would disappear, the land would become dry without the trees which retain the necessary liquids. This would cause disastrous consequences; the food chain of the region would suffer a lot because the animals that depend on that vegetation would seek other non-devastated areas to inhabit"; "The consequences will be devastating, because caatinga will suffer desertification. And there will also have a loss of certain species of trees and animals, the soil will lose its nutrients turning it infertile and making reforestation impossible".

by the environmental perception of the subject in their daily lives and by little knowledge about ecology and relationships between living beings and the environment.

**Figure 5** – Answer from a student from the participant observation class about the questionnaire released at the end of the research<sup>4</sup>



Source: Research data.

With the analyses, it was possible to verify, in general, that changes in the food chain, reduction of trees to produce photosynthesis, deforestation and reduction of fauna were terms that appeared only in the answers of Class A (intervention group), which indicates a greater concern for ecological issues and expression of reading maturity gained from the proposed reading. The answers presented by the students of Class B

<sup>4</sup> Translated: "Question 1: With the extinction of the roots he calls the "sacred tree of the caatinga", the plants from the caring would all disappear, since the umbuzeiros which contain water reserves in its roots are one of the most important species and, with that, it will be more reproduced the "latex", in other words, the rubber would disappear"; "Question: Besides devastating even more the vegetation of caatinga, the extinction of the vegetation as a whole would harm people who need certain species for other goals, such as latex production, and it would also harm some animals and even the trees which need that water reserve".

(participant observation group) were limited to the information provided by the question shown to the students, without expanding other possibilities of hypotheses, criticisms, and positions toward the presented problem.

Delgado-Mendez, Dias-Trindade, and Moreira (2021) highlight that education is a process that has been accepted and defended as a right for all human beings and, through it, it is possible to prepare individuals to face the realities that make their respective nations or communities, contributing to the economic, social and environmental development. Thus, using scientific texts is a teacher's contribution to the formation of students in the face of the need that they have before the lack of safe, understandable, and practical information before the realities experienced by each individual.

## 5 Closing remarks

The performed reading and the use of well-defined strategies with the direct participation of the teacher facilitated and encouraged the discussion of the scientific text in class. It is believed that just asking for a reading without the definition and clarity of strategies, or leaving the student "alone", will hardly enable the student to accomplish what was requested from them.

In general, the students from the intervention group considered the reading easy to understand and were able to draw several conclusions from what was read, for example, the relationship between the extinction of animals and the damage that can be linked to the human species. Concerning sustainability, they highlighted the action of the lion tamarin as a seed disperser and the importance of these animals in protecting water sources.

The proposed rereading and discussion moments collaborated to a reflection of the themes presented in the text, a situation that would not have been favorable if the students had read the text alone or if they had not used the scientific text, as in the case of the participant observation group. The suggested activities (like the glossary) favored moments of debate and textual analysis in the large group, as well as in individualized moments, providing a more systematized and collaborative work.

In this context, it was possible to have significant, diverse, and dynamic learning, favored by a constructivist methodology. At the end of the proposed stages, a significant amount of learning was perceived of the concepts previously proposed for study in that period, namely: food chain, ecological niche, and habitat, as well as a better understanding of the meaning of words and terms that were suggested in the text, such as deforestation, defaunation, and seed dispersal.

Following the points suggested in CRITIC, the research participants were able to guide their reading, and the first use of this resource was a factor to be analyzed. It should also be considered that the Information segment (scientific arguments and proofs) was not worked on, due to the lack of emphasis on scientific methodology.

Among the difficulties perceived during the classes, it is worth highlighting the students' lack of knowledge about the characteristics of a scientific text, a fact that required the researchers to prepare a summary table to be presented to them, enabling the grounding of the theories involved in this knowledge.

Another factor also observed concerns the lack of interest on the part of the students for the moment of reading, which implied the search for alternatives that would motivate them for this moment. The alternative defined was to work the content in a more objective way, based on the questions asked, seeking, with this, the integration and involvement of students with the text.

Thus, the strategies used in this study, such as the CRITIC framework and the scientific texts, proved to be valid resources for the learning process of environmental concepts and can work as possibilities for deepening the theme in the practice of practicing teachers or even for science teachers in training, in order to motivate them to diversify their methodological strategies in the classroom efficiently.

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**Responsible editor:** Lia Machado Fiuza Fialho

**Ad hoc experts:** Gustavo Flórez-Mojica and José Airton de Freitas Pontes Junior

### How to cite this article (ABNT):

ALMEIDA, Sandra Luiza Sousa Santos de; ARAÚJO, Magnólia Fernandes Florêncio de; SILVA, Natanael Charles da. Learning Sciences through scientific awareness texts: contributory strategies for teachers in training on the construction of environmental concepts. *Educ. Form.*, Fortaleza, v. 7, e8944, 2022. Available at: <https://revistas.uece.br/index.php/redufor/article/view/e8944>

*Educ. Form.*, Fortaleza, v. 7, e8944, 2022

DOI: <https://doi.org/10.25053/redufor.v7.e8944>

<https://revistas.uece.br/index.php/redufor/index>

ISSN: 2448-3583



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Received on October 5, 2022.

Accepted on December 9, 2022.

Published on February 7, 2023.