ISSN:1984-2295

Revista Brasileira de Geografia Física

Homepage:https://periodicos.ufpe.br/revistas/rbgfe

Uma xxperiência de educação climática na comunidade do Morro Santa Terezinha na cidade de Fortaleza no estado do Ceará (Brasil)

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Artigo recebido em 11/06/2024 e aceito em 23/07/2024

R E S U M O

O estudo apresenta a avaliação de um processo de ensino-aprendizagem em educação climática através de metodologias ativas, além de apresentar a percepção dos estudantes dos anos finais do ensino fundamental sobre os efeitos da variabilidade do clima e sobre a ocorrência de desastres naturais na região onde vivem no Morro Santa Terezinha em Fortaleza/CE. Assim, foi aplicado um questionário para diagnosticar o nível de conhecimento desses estudantes, cujos resultados subsidiaram as discussões dos conteúdos nos encontros pedagógicos, nas palestras e nas análises das informações climáticas obtidas no Instituto Nacional de Meteorologia e na Fundação Cearense de Meteorologia e Recursos Hídricos, além das informações sobre as ocorrências de desastres naturais obtidas na Coordenação Municipal de Proteção e Defesa Civil. Esta metodologia proporcionou aos estudantes associar o conhecimento científico a realidade climática observada na região em estudo e favoreceu a aprendizagem significativa e o protagonismo, como preconizado na Base Nacional Comum Curricular (BNCC), além da elaboração e da publicação de um folheto educativo que foi distribuído na comunidade escolar. Dessa forma, concluiu-se que o trabalho cumpriu os objetivos de motivar e despertar o interesse dos estudantes e da comunidade escolar sobre educação climática e preservação ambiental.

Palavras-chave: Ambiente. Educação climática. Desastres naturais.

A Climate education cxperience in the community of Morro Santa Terezinha in the city of Fortaleza in the state of Ceará (Brazil)

A B S T R A C T

The study presents the evaluation of a teaching-learning process in climate education through active methodologies, as well as the perception of students in the final years of elementary school about the effects of climate variability and the occurrence of natural disasters in the region where they live in Morro Santa Terezinha in Fortaleza/CE. Thus, a questionnaire was applied to diagnose the level of knowledge of these students, the results of which supported discussions of the content in pedagogical meetings, lectures and analysis of climate information obtained from the National Institute of Meteorology and the Ceará Foundation of Meteorology and Water Resources, as well as information on the occurrence of natural disasters obtained from the Municipal Coordination of Protection and Civil Defense. This methodology enabled the students to associate scientific knowledge with the climatic reality observed in the region under study and fostered meaningful learning and protagonism, as recommended in the National Common Curriculum Base, in addition to the preparation and publication of an educational leaflet that was distributed in the school community. It was therefore concluded that the work met the objectives of motivating and arousing the interest of students and the school community in climate education and environmental preservation.

Keywords: Environment. Climate education. Natural disasters.

Introduction

Discussions on climate and its variability, including climate change, which are taught in primary and secondary school geography classes are of great importance for students to understand the formation of atmospheric phenomena, known as meteorological phenomena, as well as to understand the concept of climate and the climate variability that occurs naturally in the regions where they live, and to understand the relationship between this variability and the natural disasters

that occur in these regions. Thus, discussions of this content can help students to take part in a teaching-learning process in climate education.

Several studies found in the literature agree that knowledge about meteorological variables, as well as an understanding of the climate variability of a given region, i.e. a teaching-learning process that provides climate education, is relevant to citizen education and can help individuals to become agents of transformation in communities, especially in areas with a high incidence of natural disasters (Steinke and Silva, 2019; Fernandes; Silva, Júnior, 2020; Allocca and Filaho, 2021).

As well as enabling discussions on current issues, such as greenhouse gas emission scenarios contained in the atmospheric composition, this content provides knowledge of regional and local climate variability. In this way, it can encourage students to acquire specific knowledge about the climate variability observed in their environment, favouring an understanding of various spatial and temporal quantities, as well as the dynamics of natural disasters that occur in the regions where they live (Araújo; Pontes, Silva, 2021; Silva et al., 2021; Souza et al., 2024).

Also, according to these authors, it is important to apply new pedagogical possibilities in classes where content on climate, climate variability and climate change is taught, above all through active methodologies (lectures, workshops, exhibitions, field classes, among others) which aim to motivate reflection and research in the school environment and which, in addition to awakening creativity, value students' prior knowledge and protagonism.

In this context, it is worth mentioning that guidelines on the delivery of this content can be found in the National Common Curriculum Base (BNCC) and in the Ceará Reference Curriculum Document (DCRC), a document that guides curricular practices in Ceará's public schools and complements the guidelines contained in the BNCC. Thus, these documents state that the study of these contents should serve as a guideline for teaching work in the classroom, and that the methodologies applied in the presentation and discussions of these contents should consider the context of the realities and daily lives of students in their communities (Costa and Wollmann, 2017; Torres et al., 2020; Reis, 2022).

In relation to the potential of using active methodologies to understand climate variability and the relationship between this variability and the occurrence of natural disasters, Silva et al. (2019) present and discuss the results of a study carried out in the Ilha Dourada region in Fortaleza, which is an area of social vulnerability and at risk of flooding and landslides.

The authors carried out climate education work in a public-school environment in the region, involving students and their families, with seminars on climatology and on civil protection and defense actions in the region under study. They concluded that this teaching-learning process played a fundamental role in enabling people to understand the relationship between variations in the local climate and the occurrence of natural disasters that affect their lives as a community.

In view of the above, the importance of teaching this content in primary school is evident, but it is a fact that Brazilian schools still do not have the curricular obligation of a teaching-learning process that provides skills and competences in climate education, despite the fact that the content to be taught in this educational process is confused with the content that is taught in environmental education, which is a guiding theme in the official documents that govern Brazilian education, contained in the BNCC and the DCRC.

In addition, the studies cited above also indicate that the inclusion and strengthening of climate education practices allied to environmental education in schools, in a contextualized way and according to the reality of the students, could contribute to student participation and protagonism, as well as raising awareness of the preservation of the environment in which they live in their communities.

In this way, the aim of this work is not only to present the perception of primary school students in a public school about the effects of climate variability and possible changes on the environment in which they live, but also to evaluate a climate education process that uses active methodology promoted in the community of Morro Santa Terezinha in Fortaleza/CE.

Methodology

The area under study is known as Morro Santa Terezinha, located in the coastal region of Fortaleza/CE, and corresponds to the neighbourhoods of Vicente Pinzon (50,182

inhabitants) and Cais do Porto (24,674 inhabitants). These neighborhoods have a low HDI (0.3315 and 0.2236) and a total area of 5.86 km² (IPLANFOR, 2023), as shown in Figure 1.

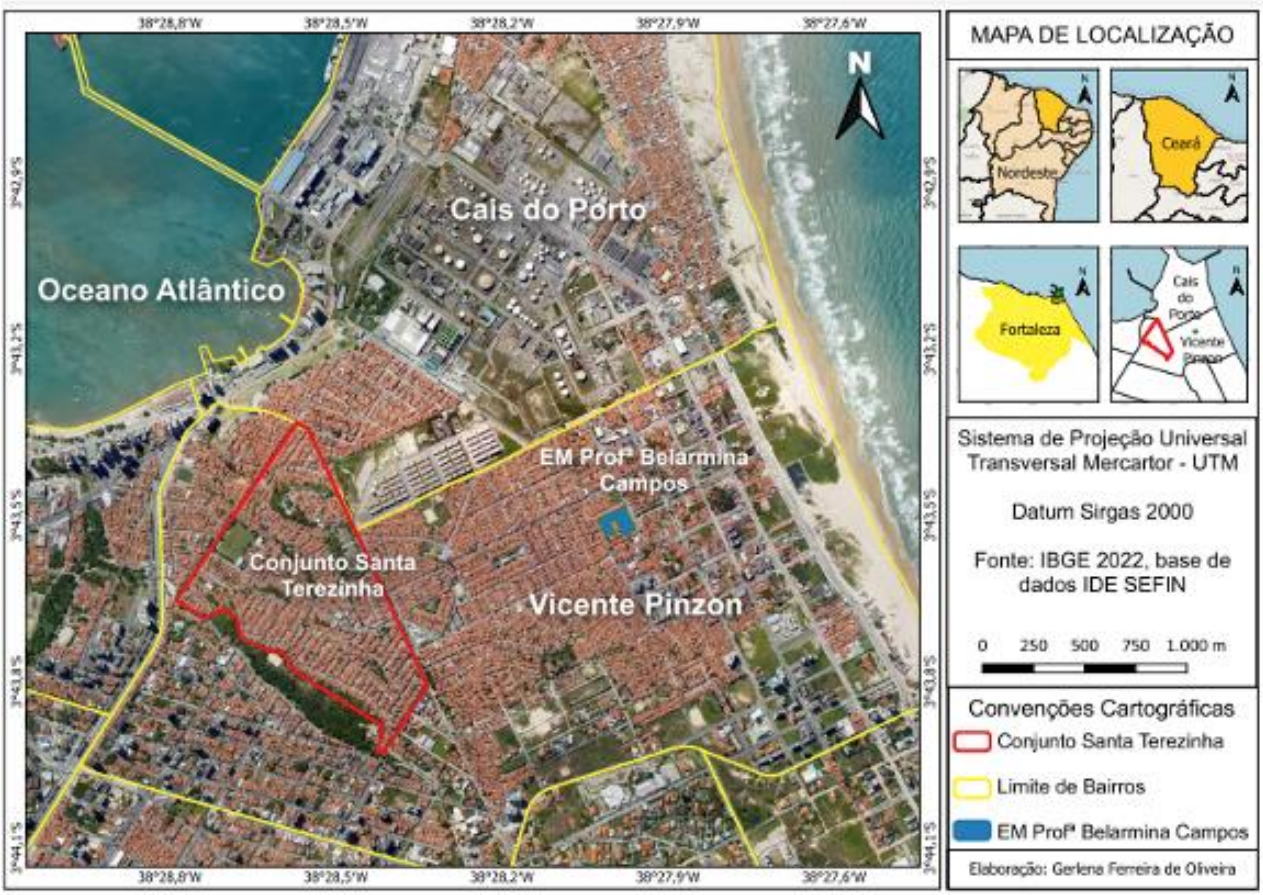


Figure 1. Location map of the study area.

The region of Morro Santa Terezinha has historical and cultural value for the city of Fortaleza/CE. Since the 1980s, it has been home to housing estates for residents relocated from beach areas in the eastern part of the city, and irregular construction of houses has been observed on the slopes of the hill, a practice that intensifies environmental problems and is associated with the occurrence of natural disasters in the region, as shown in Figure 2.

Figure 2. Area with irregular occupation on the slopes and environmental pollution by solid waste in Morro de Santa Terezinha - Fortaleza/CE.

The highest levels of risk of landslides, mudslides, floods, and mudslides occur during the region's rainy season, between February and May each year, and are aggravated by disorderly urban

occupation and solid waste disposed of inappropriately by the population in the streets and in the culverts intended for water drainage.

Thus, due to its social, historical, and cultural importance, this region was selected for this study, which was carried out in a municipal public school in Fortaleza/CE, the Escola Municipal Professora Belarmina Campos (highlighted in Figure 1), which caters for 520 students enrolled in the final years of primary school, distributed in the morning and afternoon shifts.

Most of these students live in the area around the school and are members of low-income families, enrolled in the Federal Government's single registry (CadÚnico), data that corroborates the low HDI of the neighborhood and the region. The sample of participants in the research is made up of 70 students who are regularly enrolled in two classes in the seventh year of the final years of primary school, corresponding to 13.46% of the students enrolled in the final years of primary school.

It should be noted that the collection of data through the participation of students in this research was authorized by the Term of Authorization for Academic Research issued by the Municipal Department of Education of Fortaleza/CE (Process P146774/2023).

The methodology applied in the exploratory study consisted of two stages. Firstly, a structured questionnaire was administered with the aim of diagnosing the level of knowledge about the study, described in the table below (Table 1).

Table 1. Questionnaire content. Source: Authors, 2024.

Questions	Objective
Have you observed any climate variability in your region?	To obtain a diagnosis and assessment of knowledge about the climate variability observed in the region under study. Thus, to assess whether the participants can identify the rainy season, the period of highest air temperature, the second half of the year, and the intensification of winds between September and November of each year. In addition, to obtain information on the means of information on climate change, the occurrence of natural disasters and the civil protection and defense actions carried out in the Morro de Santa Terezinha community.
What is the rainy season in the region?	
What period sees the highest air temperatures in the region?	
What period sees the strongest winds in the region?	
Do you have any knowledge or information about climate change?	
Are you aware of any natural disasters in the region?	
Do you know about civil protection and defense actions in the region?	

The second stage involved educational meetings, lectures with professionals from the fields of Meteorology and Civil Protection and Defense, and analysis of climatological data and records of natural disasters in the region.

Ten educational meetings were held, each lasting 1 hour and 50 minutes. The following table (Table 2) describes the content and activities carried out at each of these meetings.

Table 2. Description of the activities carried out during the pedagogical meetings. Source: Authors, 2024.

Meeting	Contents and Activities Carried Out
1	Presentation of the research objectives and timetable. The aim was to make them aware of the study and their participation. In addition, a structured questionnaire was administered with the aim of investigating the prior knowledge of the students taking part in the research. This questionnaire was made up of twenty-four objective questions to be answered without consultation and to guarantee the reliability of the research into the tacit knowledge of these students.
2	The concepts of weather (meteorological weather) and climate were discussed, as well as the main elements and factors that influence them. The aim of this meeting was to differentiate between the concepts and terms, as well as to use them appropriately in everyday life, in addition to arousing interest in observing the environment and its meteorological conditions. For a better understanding of the content, real everyday situations were discussed, including examples of issues related to weather

	forecasting, as well as videos (channel with science), slides and activities with educational games to consolidate knowledge.
3	The climate variables were presented. In the search for greater understanding on the part of the students, it was necessary to distinguish climate variability from climate change. From this perspective, special emphasis was placed on the rainfall that occurs on the coast of Fortaleza/CE, where the area under study is located, as well as average air temperatures and the temporal behavior of local winds. With the aim of awakening the perception of these variables, discussion and questioning tools were used, making it possible to connect theory with experience, providing the perception of the monthly variability of atmospheric weather variables.
4	In the fourth meeting, in addition to the previous subject, they were introduced to the instruments used to measure atmospheric variables, such as thermometers, rain gauges, anemometers and windsocks, using slides showing images of these meteorological instruments. The students also carried out a research activity on FUNCEME's electronic portal to obtain and verify historical data on rainfall and average air temperature observed over the last 10 years in the region under study.
5	the effects of climate variability were discussed, especially heavy rainfall, which can lead to natural disasters. Slides were presented with the concepts, types, consequences, and ways of preventing disasters, with emphasis on caring for the environment and proper waste disposal, contextualized from the local reality. Teamwork was carried out to compare meteorological data (FUNCEME) with what was reported in the press about the risk of landslides, relating it to the participants' experiences. At the end of the fifth meeting, 14 teams were formed by affinity, with the aim of expressing their perceptions of everything that had been presented so far (Figure 2). They were given a pre-prepared educational leaflet with the topics they had studied so that they could write down the knowledge they had acquired.
6 to 8	lectures were given by professionals with specific knowledge of the subjects discussed in the teaching-learning process, with the aim of broadening the students' knowledge and arousing their interest and curiosity in understanding the environment, and thus making them aware of the importance of understanding the environmental issues involved in the community in which they live, so that they feel co-responsible and consequently make behavioral changes.
9	Production of the information material began at the fifth meeting. The result of this activity was used to produce an educational leaflet that was distributed to the school community, containing information on the content researched and discussed, with an emphasis on ways of preventing risks and changing behavior, especially in relation to waste disposal in the community in which they live.
10	Meeting to evaluate the methodology applied in the study, the last stage of the research concerning the processes of obtaining data, sensitizing the students, and producing information material. The structured questionnaire was then reapplied, also without consultation, to compare the skills and competences acquired during the teaching-learning process.

Lectures on climate variability and meteorological phenomena were given by meteorologists, kindly provided by FUNCEME, and on the occurrence of urban heat islands and the concept and actions of civil protection and defense, by officers from the Ceará State Military Fire Brigade (Figure 3).

Figure 3. Lectures and team activities.

In these activities, the lecturers presented the conceptualizations and experiences necessary to understand the content presented and discussed in the educational meetings, bringing theory closer to the students' reality. As a result, the students felt motivated to carry out their research and produce an educational leaflet, proposed by the participants during the educational meetings.

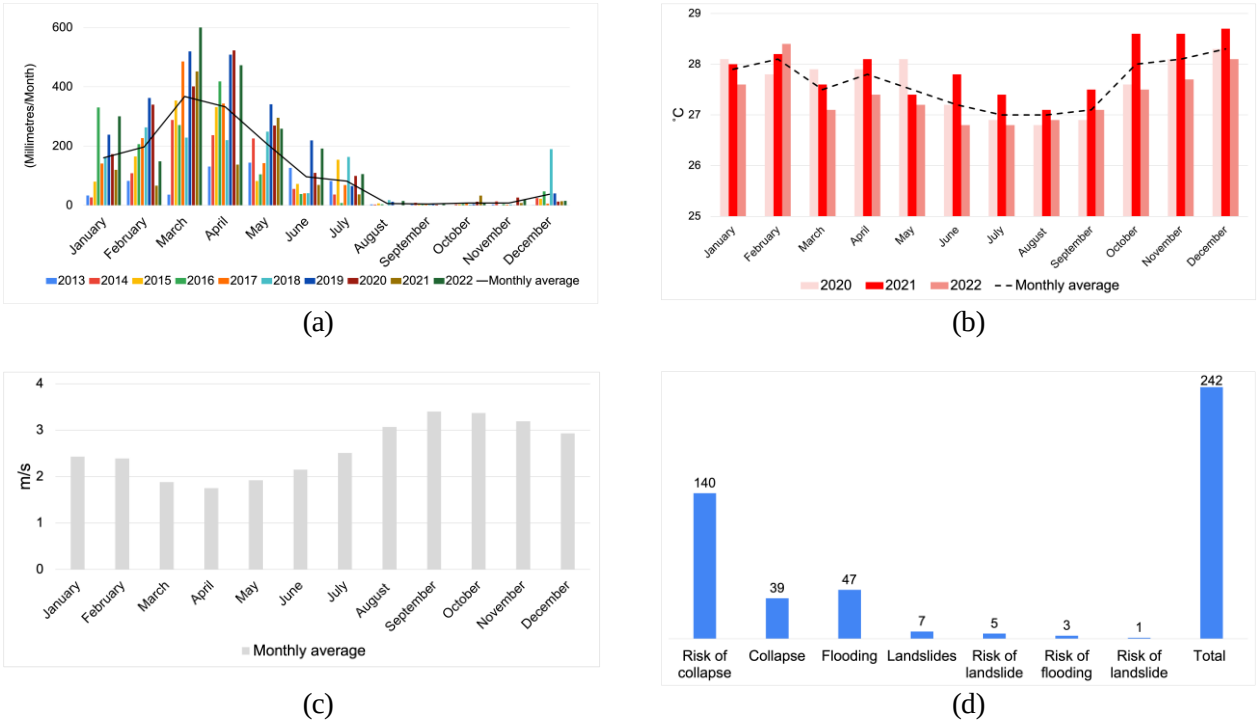


Figure 4. Climatological variables: (a) Rainfall, (b) Average air temperature, (c) Average wind speed. (d) Records of natural disaster occurrences. Sources: INMET (2024) - FUNCEME (2024).

In addition, the students carried out two searches of climatological databases, one on the electronic portal of the Ceará Foundation for Meteorology and Water Resources (FUNCEME) and the other on the electronic portal of the National Institute of Meteorology (INMET), as well as analyzing information on occurrence records and actions to prevent natural disasters in the study area obtained from the Municipal Civil Protection and Defense Coordination (COPDC), shown in Figure 4. To evaluate the climate education process proposed as an educational methodology in this study, the questionnaire from the first stage was applied again. This made it possible to compare the answers obtained before and after the proposed method was applied.

Results and discussions

Below are the initial (diagnostic) and final (evaluation) results obtained from the answers to the questionnaire applied in this study, and the respective discussions. These responses reflect the knowledge, skills and competences worked on with the students in the teaching-learning process proposed as a scientific research methodology in this study.

In the answers obtained from the first application of the questionnaire, in relation to the climate variability observed in the region under study, 64.3 per cent of the participants were unable to give an opinion because they didn't know what it was about, and a further 30 per cent of these students said they didn't observe climate variability in this region (Figure 5).

When the questionnaire was reapplied after the educational intervention, in relation to the climate variability observed in the region, 65.7% of the participants said they recognized the variability of the region's climate. It can therefore be said that after applying the methodology proposed in the study, most students acquired knowledge about climate variability (Figure5).

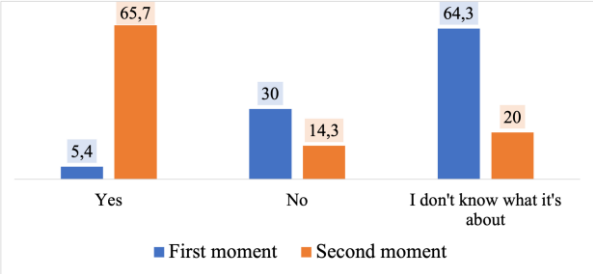


Figure 5. Answers obtained (climate variability).

When looking at the climatological variables (rainfall, average air temperature and wind speed), 35.7% of the participants initially said that rainfall is concentrated in the period from January to June, 25.7% said that this period is from January to April and 22.9% from February to May. Considering that the rainy season in the region is from February to May, but that pre-season and post-season rains are observed in the months of January and June, respectively, especially in the coastal region of Fortaleza/CE, these concepts were worked on with the students and, thus, it was observed that in the second application 67.1% were able to identify the period when rainfall is observed in the region (Figure 6).

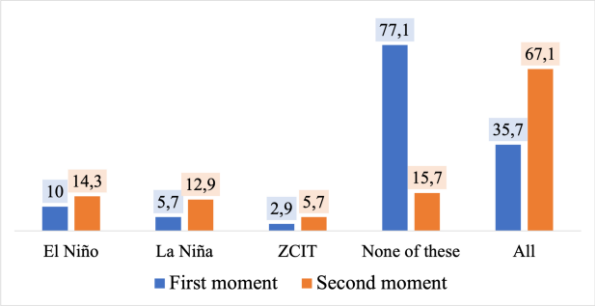


Figure 6. Answers obtained (rainy season).

About the variability of the average air temperature, 40% of the students initially considered the period from May to August to be the period with the highest values. It is believed that this sample of students was motivated by the association with the period of intensification of the trade winds in the region, when there is a reduction in the sensation of heat. After the work carried out, 58.6% of the students considered the average air temperature to be higher in the period from September to December, now correctly (Figure 7).

About wind variability, initially only 25.7% of the students were able to identify that the period of wind intensification in the region is between September and December, in the second half of the year. After working with the climatological data and the discussions held in the lectures, the correctness rate for this question was 62.9%, an increase of 37.2% compared to the same answer in the first application of the questionnaire (Figure 8).

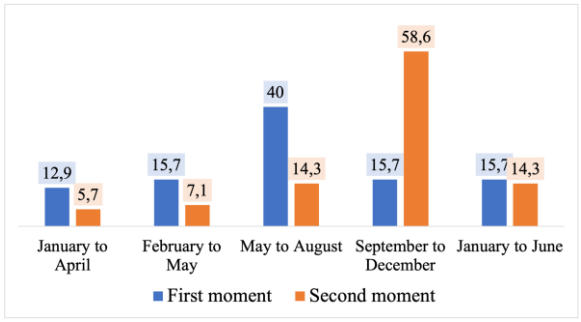


Figure 7. Responses obtained (air temperature).

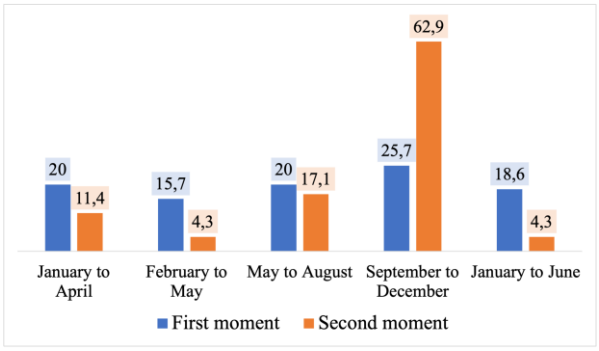


Figure 8. Answers obtained (winds).

The results obtained and described above show that the climate education work carried out using an active methodology, considering the characteristics of the climate observed in the region under study, provided advances in the students' understanding, agreeing with the conclusions of the studies (Araújo; Pontes, Silva, 2021; Silva et al., 2021; Souza et al., 2024) and with Aires, Pereira, and Farias (2024).

In addition, we investigated whether the students had any knowledge or information about climate change, and by what means of communication they were acquiring this information. Most students, before (58.6%) and after (72.9%) the method applied in this study, said they had information, and that this information was acquired at school (Figure 9). This reiterates the importance of teaching this content in the classroom and/or in projects that work on environmental education and climate education practices.

About identifying natural disasters that occur

in the region, initially only 18.6% of the participating students answered that they had observed floods, landslides and/or landslides in the region under study. After the lectures with experts in civil defense and protection, this rate increased to 67.1% of the participants, who are now able to identify which of the natural disasters classified by civil defense occur in the community where they live, a region classified as socially vulnerable (Figure 10).

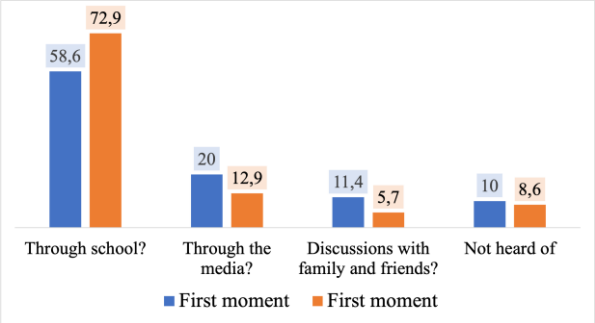


Figure 9. Answers obtained (climate change).

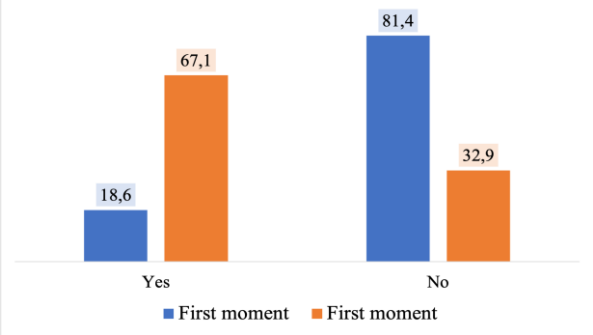


Figure 10. Answers obtained (natural disasters).

Regarding knowledge of civil protection and defense actions carried out in the community, 35.7% of the students initially said they were aware of these actions through the media and 34.3% of the total number of students said they were aware of these actions through discussions with family and/or friends. Only 8.6 per cent said they discussed these actions at school. After the talks given at school by experts in civil protection and defense, this rate increased to 72.9% (Figure 11).

In this context, it is important to note that after the climate education teaching-learning process, the number of students who said they had never heard of civil protection and defense actions fell to 8.5%. This shows that the pedagogical meetings held enabled students to understand natural disasters and civil protection and defense actions, in line with the conclusions described by Silva et al. (2019).

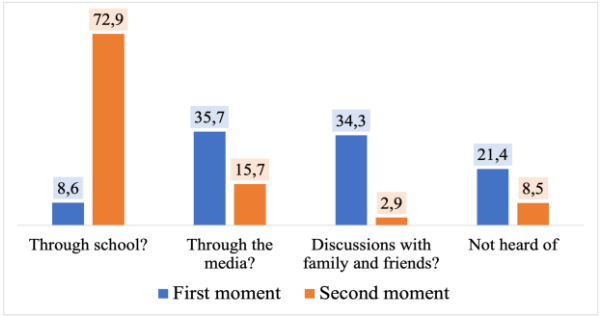


Figure 11. Answers obtained (civil defence actions).

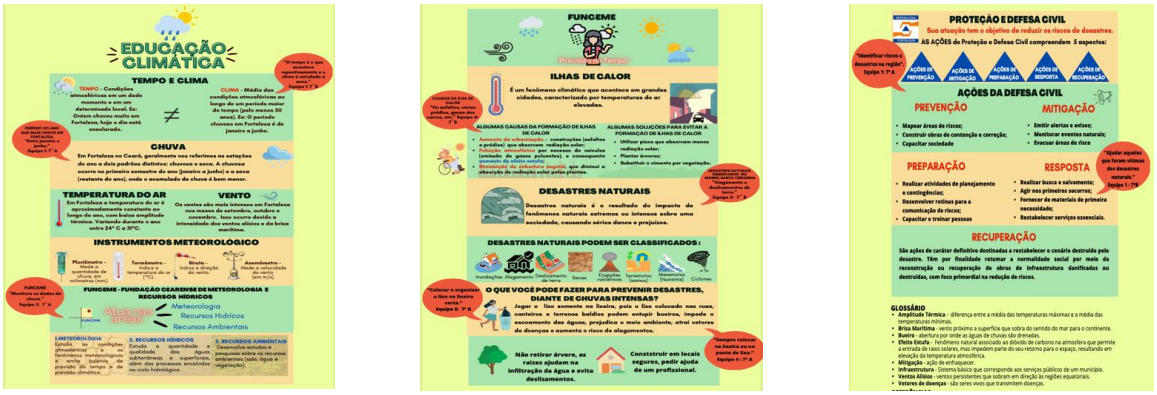
Table 3 shows the sample statistics (sample mean of the proportions, sample standard deviation and standard error of the sample distribution of the means) for the seven questions shown in the results of this study.

In addition, because of the methodology applied in this study, an educational leaflet was produced, based on the learning, skills and abilities acquired by the participating students during the discussions at the pedagogical meetings, with the analysis of climatological information, and with the discussions on climate variability and on natural disasters and civil protection and defence actions. Figure 12 shows part of this educational leaflet, which was printed and distributed to the school community.

It should be noted that the results obtained with the methodology applied in this study agree with the discussions and conclusions found in studies published in the literature (Souza, 2022; Marques; Rios, Alves, 2022; Aires; Pereira, Farias, 2024), which highlight the near invisibility of environmental education and climate education activities in schools, particularly activities involving knowledge of climate variability (climatology) in school routines. Even though this content is included as a guideline in the official documents that govern Brazilian education and enables students to become aware of and sensitive to environmental preservation.

Table 3. Sample Statistics (P_1 and P_2 represent the first and second moments).

Question 1	P_1	P_2	Mean	Standard Deviation	Standard Error
Yes	5.7	65.7	35.7	42.4	5.1
No	30	14.3	22.2	11.1	1.3
I don't know what it's about	64.3	20	42.2	31.3	3.7
Question 2					
El Niño	10	14.3	12.2	3.0	0.4
La Niña	5.7	12.9	9.3	5.1	0.6
ZCIT	2.9	5.7	4.3	2.0	0.2
None of these	77.1	15.7	46.4	43.4	5.2
All	35.7	67.1	51.4	22.2	2.7
Question 03					
January to April	25.7	8.6	17.2	12.1	1.4
February to May	22.9	11.4	17.2	8.1	1.0
May to August	10	2.9	6.5	5.0	0.6
September to December	5.7	10	7.9	3.0	0.4
January to June	35.7	67.1	51.4	22.2	2.7
Question 3					
January to April	12.9	5.7	9.3	5.1	0.6
February to May	15.7	7.1	11.4	6.1	0.7
May to August	40	14.3	27.2	18.2	2.2
September to December	15.7	58.6	37.2	30.3	3.6
January to June	15.7	14.3	15.0	1.0	0.1
Question 4					
January to April	20	11.4	15.7	6.1	0.7
February to May	15.7	4.3	10.0	8.1	1.0
May to August	20	17.1	18.6	2.1	0.2
September to December	25.7	62.9	44.3	26.3	3.1
January to June	18.6	4.3	11.5	10.1	1.2
Question 5					
Through school?	58.6	72.8	65.7	10.0	1.2
Through the media?	20	12.9	16.5	5.0	0.6
Discussions with family and friends?	11.4	5.7	8.6	4.0	0.5
Not heard of	10	8.6	9.3	1.0	0.1
Question 6					
Yes	18.6	67.1	42.9	34.3	4.1
No	81.4	32.9	57.2	34.3	4.1
Question 7					
Through school?	8.6	72.9	40.8	45.5	5.4
Through the media?	35.7	15.7	25.7	14.1	1.7
Discussions with family and friends?	34.3	2.9	18.6	22.2	2.7
Not heard of	21.4	8.5	15.0	9.1	1.1



(a) (b) (c)

Figure 12. Educational leaflet produced by participating students.

Conclusions

Firstly, it can be concluded that the hypothesis raised in this study was validated and that the objective was achieved by observing the interest and engagement of all the participating students in the proposed activities (pedagogical meetings, analyses of climatological data, lectures, and production of didactic material), reaffirming the pedagogical and motivational possibilities of applying climate education in schools, as described in the studies.

It was also observed that the students were motivated to seek out the knowledge necessary to understand regional climate variability and the effects of this variability on the environment in which they live in the community, and, with this, they developed the capacity to learn the content in a participatory manner and in association with the local reality.

Further evidence of the pedagogical possibilities of this process was the knowledge and skills acquired by the students after analyzing the answers obtained from the questionnaire, before and after applying the proposed methodology.

In addition, it was also observed that the participating students showed the ability to carry out teamwork, and among the various activities proposed, the written production stands out, which helped to consolidate knowledge of the content and served as the basis for drawing up the educational leaflet distributed in the school community.

Finally, the hypothesis of the need to carry out climate education work to also awaken students' perception of environmental preservation in the final years of primary school was confirmed, as indicated by the studies cited in the literature review and in the discussion of the results.

Acknowledgements

The authors would like to thank the National Institute of Meteorology (INMET) and the Ceará Meteorology Foundation (FUNCEME) for providing the climatological data, as well as the Municipal Coordination of Protection and Civil Defense (COPDC) of Fortaleza/CE.

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