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Planetary Health Education: Exploring Students' Perceptions of Climate Change in a School in Southern Amazonas

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Abstract: The Brazilian Legal Amazon, crucial for ecosystem services such as biodiversity, carbon sequestration, and climate regulation, has declined over time in its capacity to absorb carbon dioxide. In response, global policies are being developed to mitigate climate change, which has emerged as a central issue in the planetary health approach. The objective of this study was to investigate how elementary school students in a rural school in the Southern Amazonas state perceive climate change and understand its implications for the health of the planet. Understanding the phenomenon's complexity, we conducted research with students from riverside communities in the Southern Amazon region. The data were analyzed using relative, absolute and percentage frequency tables, with a Fisher's test applied at a 5% significance level. A significant finding was the predominant difficulty students had in accurately conceptualizing climate change, highlighting notable gaps in their understanding of these wide-ranging issues. In the context of the global climate crisis we are experiencing, the integration of concepts related to climate change in basic education becomes indispensable. This study emphasizes not only the existing knowledge gap but also the urgency of educational approaches that prepare children and young people for the challenges of mitigation, adaptation, and understanding the complexities of climate change and its planetary implications.

Keywords: basic education; planetary health; climate action; children and adolescents



Citation: de Melo, P.R.H.; Alves, P.V.; Bourscheidt, V.; de Camargo, T.S. Planetary Health Education: Exploring Students' Perceptions of Climate Change in a School in Southern Amazonas. *Challenges* **2024**, *15*, 31. <https://doi.org/10.3390/challe15020031>

Academic Editors: Susan Prescott, Jemilah Mahmood, Marie Studer, Elil Renganathan, Fatimah Ahamad, Menaka Ganeson and David Webb

Received: 17 March 2024

Revised: 28 May 2024

Accepted: 29 May 2024

Published: 5 June 2024



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1. Introduction

Climate change (CC) is an environmental challenge with a significant impact on society and global health. Researchers, politicians, and world leaders are focusing on strategies aimed at mitigating the harmful effects of global warming from climate change. The climate crisis represents the need for a rapid transformation across society to avoid a major catastrophe, as its impacts pose a threat to life on Earth [1].

Children and young people wield significant power in the face of the global challenges of climate change, as they will feel its impacts more strongly or benefit if changes occur in the way we live on the planet [2]. In this context, it is crucial to involve them in this debate so that they become more aware of the impacts of climate change on their lives and the health of the planet.

Education is fundamental to mitigating and adapting to the planetary climate crisis, seeking a healthy and just future for all [3,4], as adequate knowledge about the consequences of climate change is crucial for decision making and reducing its effects [5]. Therefore, an integrative, multi- and transdisciplinary approach allows students to comprehend scientific evidence based on local knowledge and nature observation [6]. In the context of planetary health, a new field aiming to understand the interrelations between ecosystems and humanity [7], CC becomes a central theme. Schools play a pivotal role in

shaping individuals in society, promoting knowledge that highlights how environmental catastrophes can severely compromise health.

Researchers emphasize the need for an educational transformation to promote planetary health. This transformation should be effectively integrated into the education of children and adolescents, preparing them to face changes in ecosystems and encouraging them to develop actions that protect human and environmental health [8–11]. In this way, they can become future leaders engaged in initiatives focused on planetary health [9,12,13].

This article is part of a doctoral project entitled ‘Planetary Health: necessary dialogues for Scientific Education in a riverside school in the Southern Amazonas, Brazil’. The objective of this study was to investigate how elementary school students in a rural school in the South of the Amazonas region perceive climate change and understand its implications for the health of the planet.

Examining the views and perspectives of young riverside dwellers in the Amazon about climate change makes it possible to understand how the next generations perceive and/or confront the environmental challenges that may define their future and that of the community where they live. This understanding can promote a more comprehensive view of the attitudes and motivations that influence climate action among young people. Additionally, this article considered the role of schools and public policies in shaping environmental awareness and empowering young people to become agents of positive change in a changing world. It is essential to stimulate continuous and collaborative dialogue among various stakeholders, aiming to address this global challenge with the urgency and determination it demands.

1.1. Climatic Changes: A Brief Contextualization

Climate change (CC) refers to long-term alterations in climate patterns, primarily in terms of temperature, originally influenced by natural factors such as variations in the solar cycle. However, since the 19th century, human activities, particularly the burning of fossil fuels, have become the primary driver of CC, releasing significant amounts of greenhouse gases (GHGs) into the atmosphere [14,15].

The increase in GHG concentrations in the atmosphere has visible consequences, such as the melting of polar ice caps, rising sea levels, more frequent and intense extreme weather events, changes in precipitation patterns, and impacts on ecosystems [16,17]. In this context, researchers warn about what they consider one of the greatest threats to 21st-century health, affecting natural systems and humanity, compromising the survival of species and future generations [18–22].

Awareness of the importance of addressing CC has been on the rise, driving global efforts such as the Paris Agreement, which seeks to unite countries around common goals to limit global warming and its adverse consequences [23]. The United Nations Environment Programme (UNEP) emphasizes that although climate change is interconnected with political, social, and economic issues, a greater commitment to collective actions is necessary to minimize impacts and achieve the goals set by global agendas [24].

Climate change has a series of social components that affect communities worldwide, with the main ones being public health, population displacement, social and economic inequality, impact on indigenous and traditional communities, food and nutritional security, and access to clean water, as well as the need for discussions about climate justice.

From a public health perspective, the climate crisis unfolding on planet Earth is considered an urgent issue, even identified as a determinant of health [19,25,26], given its various adverse impacts on ecosystems and the disruptions it causes to humanity.

Studies indicate that climate change affects the quality of the air we breathe, the water we drink, and the food we consume, resulting in various health damages. This includes an increase in cardiovascular, respiratory, and neurological diseases, vector-borne diseases, waterborne diseases, foodborne diseases, malnutrition/food security, traumatic injuries, and deaths, as well as mental health issues [27,28]. Additionally, there are other health conditions resulting from extreme weather events [25,29,30].

Extreme weather events, such as floods, droughts, storms, and rising sea levels, force people to leave their homes and communities [31,32]. In the Brazilian Amazon, the most frequent events are droughts and floods [33], which were particularly significant in the year 2023. These events result in internal migrations and even cross-border migration, which can overwhelm receiving areas and cause social and political tensions [34,35].

It is important to emphasize that the consequences of climate change will affect everyone, but it is in groups considered more vulnerable and less privileged, such as women and girls, children, the elderly, indigenous peoples, Black communities, individuals with disabilities, poor communities, and those with pre-existing health issues, where the direct impacts are expected to be more significant [36,37]; these groups have little to no resources to adapt and recover from extreme weather events [33]. Additionally, they affect local livelihoods [38], as many indigenous and traditional communities directly depend on natural resources for their subsistence and cultural identity.

Climate change directly affects access to clean water, especially in regions prone to drought, such as the Amazonas state. Another heavily impacted aspect is food and nutritional security, as agricultural production, fishing impacts, and the availability of food resources are affected, leading to food insecurity and malnutrition in vulnerable communities [38].

The issue of CC is complex and urgent for humanity, given the significant rise in the planet's temperature and its drastic consequences for ecosystems, health, biodiversity, and socioeconomic, cultural, and political aspects. It is essential to take action to limit the factors that accelerate this phenomenon [29], climate justice being considered a highly significant aspect, as it emphasizes the need for global actions and cooperation to address the problem equitably [39,40].

Overall, it is believed that the current climate crisis necessitates reevaluating the concept of normalcy, demanding the preparation of professionals in various fields to confront its negative effects [41]. Addressing CC across various domains is crucial for reducing the carbon footprint and mitigating the climate crisis. This discussion requires essential connections between different fields of knowledge, including education at all levels, with an interdisciplinary approach being fundamental to effectively tackle this global challenge.

1.2. Amazon in Focus: Biodiversity, Carbon Cycle, and Climate Challenges

The Amazon is the largest tropical rainforest on the planet, spanning an area of 7.76 million square kilometers, of which 5 million are located in Brazil [42]. The contemporary Amazon Basin encompasses a variety of interconnected aquatic and terrestrial ecosystems, including extensive floodplains, large marginal lakes, and upland forests. Furthermore, it harbors over 50 distinct Andean–Amazonian ecosystems [43]. This colossal tropical forest boasts a rich biodiversity and plays a significant role in global climate and environmental balance [44].

The vital contributions of tropical ecosystems to the global ecosystem balance are widely acknowledged [45]. In this context, the Amazon ecosystem plays a crucial role in the carbon cycle [46,47], representing one of the most significant reservoirs of this element and serving as a major carbon sink. Studies indicate that carbon storage in this region reaches approximately 150–200 billion tons, distributed between the soil and vegetation [43,48,49].

As the largest watershed globally, the Amazon Basin is recognized for contributing approximately 15% of the freshwater flow to the oceans [50]. The water resources of the Amazon play a fundamental role in the landscape and transportation, and represent an immense wealth of fish, serving as the primary sustenance for traditional populations [51,52].

The biodiversity of the Amazon is considered a global icon [53], representing a global richness resulting from millions of years of diverse evolutionary processes. The forest is home to approximately 22% of plant species, 18% of tropical fish, 14% of birds, 9% of mammals, and 8% of amphibians worldwide. It is estimated that one gram of soil in the region can contain over 1000 species of fungi [53]. Despite the existing biodiversity

wealth, knowledge about many species is limited, as is the understanding of their ecology and geographic distribution, considering the high rate of endemism in the Amazonian plains [53].

Another crucial feature of the Amazon is its ability to provide climatic stability at both regional and global levels [54]. The forest plays a critical role, acting as a true giant ‘air conditioner’ capable of reducing surface temperatures and playing a fundamental role in rainfall formation. Trees absorb water from the soil and transpire to capture carbon from the atmosphere through the evapotranspiration process, playing a pivotal function in the climate system. In this way, the forest has the potential to sustain the hydrological cycle, releasing volatile compounds that condense and contribute to the formation of rain droplets [53,55].

Among all the characteristics of the Amazon Rainforest, it is crucial to highlight its rich sociocultural diversity. Data presented in the Science Panel for the Amazon (SPSA) indicate that the Pan-Amazon region is home to approximately 47 million people, including about 2.2 million indigenous individuals, distributed across more than 410 groups, 80 of which consist of isolated peoples [43]. In addition to indigenous communities, there are Afro-descendant and mixed-heritage extractivist communities, such as mestizos, caboclos, and riverine populations [43]. The preservation of the Amazon is indispensable for protecting the guardians of the forest, ensuring that all indigenous and local communities have significant representation in preserving this biome.

Despite all its abundance and importance, the Amazon is subject to intense anthropogenic attacks that result in an increase in greenhouse gas concentrations in the atmosphere. From the perspective of climate change influences, the Amazon is considered a high-risk region [56], as the significant rise in gases compromises the dynamic balance of this biome, essential for the planet [57].

The Amazon is compromised due to intense anthropogenic pressures, reaching a critical stage where the forest struggles to regenerate. There is an imminent risk of this vast forest reaching a point of no return and transforming into a savanna by the end of the century [58,59].

Climate changes in the Amazon are driven by factors such as the burning of fossil fuels, biomass, and land use changes [60,61], including deforestation. Deforestation in the Amazon is considered a vector for changes in regional and global climate [62].

The devastation of the Amazon reached a record-high destruction in 2022, totaling 10,573 km² of the devastated area, standing as the highest rate in 15 years [63]. In addition to deforestation, forest fires are the primary cause of removing plant biomass and transferring carbon into the atmosphere [64,65]. Deforestation and wildfires impact the loss of productivity, alterations in hydrological regimes, soil degradation, and biodiversity loss [66,67].

The loss of biodiversity is a widely studied issue in the context of the Amazon, often associated with climate change. However, it is crucial to recognize that this loss is not solely linked to climate change but also to changes in land use and overexploitation [68]. Additionally, consumerism and materialism play a significant role, especially concerning agricultural commodities. These patterns of excessive consumption and mass production can lead to environmental degradation and biodiversity loss, primarily through the destruction of natural habitats and pollution resulting from human activities [69,70].

One of the highlighted issues is the alterations in the hydrological cycle which were intensely experienced in the year 2023. The Amazonas state underwent the worst drought in recent years, affecting approximately 600,000 people [71]. The riverine populations of the Amazon directly suffer these impacts, as they depend on river transportation, facing shortages of food and water, and an increase in diseases [72].

With the intensity of climate change in the Amazon and its direct impacts on various forms of life, this issue needs to be a priority on global agendas, with the implementation of effective actions to minimize the damage caused. Furthermore, preserving the Amazon Rainforest and the health of its populations is crucial, actively involving communities [73].

Given this perspective, bringing this issue into the educational sphere, and engaging children and adolescents, is a way to awaken minds that can intervene in these matters in the future.

Given the vital importance of the Amazon and the severe impacts on the biome resulting from climate change, this work identifies the urgent need to understand the perceptions of riverside students in the Amazon regarding climate change. The conceptions of these students about climate change not only allow the identification of educational opportunities but also contribute to supporting and understanding the challenges, recognizing the relevance of young voices [74].

2. Materials and Methods

This paper introduces an exploratory study conducted in the Southern Amazonas that seeks to shed some light on the awareness levels of young persons living on the Amazon River about climate change and its effect on health.

2.1. Study Area

The study was conducted at Cristo Rei Elementary School, located on Lake Uruapiara, in the Southern Amazonas state ($6^{\circ}20'25''$ S and $62^{\circ}1'19''$ W), approximately 172 km from the urban area of the municipality of Humaitá/AM (Figure 1).



Figure 1. Study Area: Cristo Rei Elementary School, Lake Uruapiara/AM.

2.2. Data Collection

The research was conducted in the first semester of 2023 with a group of 37 9th-grade elementary school students, aiming to assess students' knowledge about the subject. In this stage, investigative questionnaires containing three central open-ended questions were administered:

1. How much do you know about climate change?
2. Have you studied climate change before?
3. In your opinion, do climate changes affect your health?

2.3. Data Treatment and Statistical Analysis

The questionnaire data were organized into groups with equivalent responses from the students. To investigate possible associations between responses and groups, a Fisher's exact test was used. This choice is justified due to the relatively small sample size ($n = 37$) and the presence of expected frequencies less than 5, which makes the use of the Chi-square approximation unfeasible. Additionally, absolute, relative, and percentage frequency tables were created to facilitate the understanding of the data.

During the statistical analysis, the groups were combined to generate 2×2 contingency tables to compare responses. In these tables, columns represent coherent responses to the first question of the questionnaire, as well as those who did not know how to answer. The rows, in turn, represent the following groups in each table: (i) students who studied or did not study climate change, and (ii) students who claimed to be affected or not affected healthwise by climate change. In the latter case, those who did not express an opinion were excluded from the analysis.

A Fisher's exact test was conducted using the R programming language, in the open-source version of RStudio 3.6.1. The analysis considered a two-sided alternative hypothesis and a significance level of 5%.

2.4. Ethical Aspects

The research was approved by the Ethics Committee for Research with Human Beings (CEP) of the Federal University of Rio Grande do Sul (UFRGS), under CAAE 42320821.6.0000.5347, through the Plataforma Brasil. Data collection took place after the parents or legal guardians of the students signed the Free and Informed Consent Form (FICF).

3. Results

3.1. Students' Perception of Climate Change

The first question of the questionnaire identified that only 11% of those surveyed (4 students) provided coherent answers to the concept of climate change, while 43% (16 students) gave imprecise responses, and 46% (17 students) could not answer (Table 1). Thus, it is observed that most students are unfamiliar with the concept of climate change, emphasizing the need for an effective approach to the topic in basic education.

Table 1. Descriptive synthesis of the responses to the first question of the questionnaire, where f_i represents the absolute frequency and f_p the percentage relative frequency.

Responses	f_i	f_p (%)
Coherent	4	11
Imprecise	16	43
Don't Know	17	46
	37	100

In analyzing the students' responses, it is noteworthy that coherent answers were not necessarily the precise scientific definition of climate change, but responses that come closest to this concept. We chose to highlight some of the coherent responses provided by the students:

They are alterations recorded over time in temperature patterns. (S 23)

They are changes in the climate. (S 26)

They are changes that occur in our climate, such as temperature and air. (S 30)

3.2. Climate Change in Basic Education

In the second question, it is observed that out of 37 students, 57% claimed to have studied CCs, while 43% never had this opportunity (Table 2). Although the curricular content of natural sciences and geography disciplines in Brazil mention CCs, many basic

education schools still present a fragmented education, particularly lacking context regarding the global and local scenario concerning these issues. For instance, there is a lack of effective discussions about the negative impacts of losses in the Amazon Rainforest and the consequences of these losses for the local and global climate. In light of this, it reinforces the importance of considering climate issues as urgent topics to be integrated into schools, considering their impacts, which significantly affect planetary health.

Table 2. Descriptive synthesis of the responses given to the second question of the questionnaire, where f_i represents the absolute frequency and f_p the percentage relative frequency.

Groups	f_i	f_p (%)	Coherent Answers		Imprecise Answers		I Don't Know	
			f_i	f_p (%)	f_i	f_p (%)	f_i	f_p (%)
Studied	21	57	3	14.3	11	52.4	7	33.3
Never Studied	16	43	1	6.25	5	31.25	10	62.5
Total	37	100	4	-	16	-	17	-

In Table 2, it is observed that among students who studied climate changes (CCs) in basic education (57%), only 14.3% of them provided coherent answers to the first question of the questionnaire, while 52.4% gave imprecise answers, and 33.3% claimed not to know. Among those who never studied CCs (43%), approximately 6.25% provided coherent answers to the first question of the questionnaire, while 31.25% gave imprecise answers, and 62.5% did not respond, indicating they did not know. From a statistical perspective, there is no significant difference between the responses given by students to the first question of the questionnaire, whether they studied CCs or not. In fact, Fisher's exact test, at a significance level of 5%, supports this finding through the obtained p -value, namely, equal to 0.41.

3.3. Climate Change and Its Relationship with Health

The third question of the questionnaire allowed us to verify that 83.8% of students stated that climate change has health implications, while 10.8% said there is no relationship, and only 5.4% stated they did not know whether there is a relationship. More specifically, among those who stated that CCs affect health, 12.9% answered the first questionnaire question coherently, 51.6% wrote imprecise answers, and 35.5% abstained. On the other hand, among those who said that CCs do not affect health and those who did not know whether there is a relationship between these things, 100%, in each case, abstained from answering the first questionnaire question (Table 3). Statistical analysis shows that there is no relationship between the students' ability to define CCs and whether there is a relationship between CCs and health. In fact, Fisher's exact test provides a p -value equal to 0.60, corroborating this statement.

Table 3. Descriptive synthesis of the responses given to the third question of the questionnaire, where f_i represents the absolute frequency, and f_p represents the percentage relative frequency.

Groups	f_i	f_p (%)	Coherent Answers		Imprecise Answers		I Don't Know	
			f_i	f_p (%)	f_i	f_p (%)	f_i	f_p (%)
Affect	31	83.8	4	12.9	16	51.6	11	35.5
Do Not Affect	4	10.8	0	0	0	0	4	100
I Don't Know	2	5.4	0	0	0	0	2	100
Total	37	100	4	-	16	-	17	-

4. Discussion

4.1. Students' Perception of Climate Change

From the analysis of the answers to the first question (as shown in Section 3.1), it is clear that students are unable to give a satisfactory definition of the concept of climate

change. It is essential to address this topic in depth with this audience, given their ability to engage in and contribute to the discussion of complex environmental issues. The difficulty in conceptualizing climate change demonstrates a low level of knowledge, especially in interdisciplinary topics [75].

In the Curriculum Analysis Document of the Regional Comparative and Explanatory Study (ERCE) by UNESCO for Latin America and the Caribbean, it is presented that children and young people demonstrate performances below expectations in science, which may suggest a lack of understanding of topics such as the environment, biodiversity, and climate change. According to the analysis, comprehensive measures encompassing knowledge, values, and climate action capacity among this demographic group have not yet been implemented. Additionally, science tests are identified as a possible means of assessing the understanding of these topics, as they have traditionally been integrated into the science curriculum [76,77].

In this perspective, studies conducted by various authors indicate that correct scientific knowledge about climate issues, including their causes, impacts, and solutions, tends to increase with age and the availability of transmitted scientific information. This means that the next generations have the possibility of better understanding the necessary actions in the face of climate change, as well as the importance of governmental, corporate, and individual measures [74]. This higher level of awareness can lead to a deeper understanding of the urgency of mitigating climate change [78].

As climate change negatively influences the dynamics of human life, climate change education (CCE) is a reality in other countries where climate issues are considered urgent and need to be integrated into formal education, informal education, and educational research [79]. Educating about climate change is one of the most effective ways to develop initiatives to address the existing climate crisis [80]. Knowledge about the subject and its implications for humanity will enable students to be more engaged in actions to confront climate change, mobilizing and disseminating information that can contribute to addressing the climate crisis.

In the Brazilian scenario, scientific research focused on discussions about the impacts of climate change is growing. Some published works address the context of climate change in education, but the data presented are still incipient, especially considering the serious impacts that some biomes located in Brazil face.

The most frequent works are concentrated on practical studies and some focus on the development of materials. Theoretical studies, on the other hand, are focused on literature reviews in an attempt to understand how the theme is advancing in the educational context [81].

The main focus has been on the challenges of adapting and developing educational programs that include themes of regional diversity, recognizing complex and diversified ecosystems, and the predominance of an urban way of life with all its contradictions, linked to consumption and, mainly, to the increase in a logic of unsustainability [82]. The authors believe that the inclusion of the topic of climate change in formal education can be approached in various ways, with efforts extending beyond the school, where crucial resources, infrastructure, public policies, and teacher training are essential [82–87].

It is important to highlight that Brazil has Law No. 12.187/2009 [88], establishing the National Policy on Climate Change (PNMC), in which the country commits to reducing greenhouse gas emissions. Article 5 of this legislation envisages the promotion of information, education, training, and public awareness about climate change. Additionally, the State of São Paulo has implemented a specific law related to climate issues, education, and sustainability, State Law No. 13.798/2009 [89], which establishes the State Policy on Climate Change (PEMC), aiming to establish the state's commitment to the challenge of global climate change. Another important example is the Bill of the State of Bahia currently under consideration, which includes climate education in public education in Bahia [90].

The most recent document for Brazilian education is the Common National Curriculum Base (BNCC) [91], proposed in 2017, which mentions climate change in the thematic

axis of natural sciences and their technologies. This document emphasizes the importance of addressing environmental issues to solve problems and understand the world, including assessing climate change in the medium and long term. However, some authors emphasize that climate issues are treated superficially and are little explored in this document [92].

Brazil also has initiatives to promote environmental sustainability, such as the School Agenda 21 [93], developed based on the global, Brazilian, state, and local Agenda 21. It highlights the influence of schools, families, and society in environmental issues, aiming at social sustainability, economic sustainability, environmental protection, and human needs.

In this sense, it becomes crucial to include and/or reinforce climate change themes effectively in educational documents, establishing connections with other areas such as health, economy, politics, social, and cultural aspects. This approach allows visualizing the impacts of climate change on all spheres of life, ensuring that the educational formation of children and young people is grounded in responsibility towards nature and all forms of life. It is essential to emphasize the urgency of mitigation and adaptations to the impacts of climate change, aiming to build a society that is more conscious and engaged in environmental protection.

4.2. Climate Change in Basic Education

In the United Nations' 2030 Agenda, Goal 13 titled 'Climate Action' emphasizes the fundamental importance of combating climate change. Target 13.3 underscores the need to enhance education, raise awareness, and empower individuals and institutions to address the mitigation, adaptation, and reduction of climate-related impacts and risks [23].

Researchers affirm that generations between the ages of 10 and 24 are being shaped by global forces such as population mobility, global communications, economic development, and ecosystem sustainability [94]. These factors are not only influencing the future of this generation but also the fate of humanity as a whole [94].

To achieve this transformative action, it is essential to rely on the open-mindedness, willingness to take risks, and innovative capacity of young people. With their limited interest in established power structures, they have the potential to question the status quo and speak openly with authorities if they are given a significant voice at the decision-making table [13].

Education has the potential to promote actions to address CCs and their consequences, involving all citizens in the process of mitigation and adaptation [23,95]. On the other hand, a lack of knowledge about the subject becomes a barrier to contributing to climate issues [96].

This result should be interpreted with caution, without the intention of questioning the educational methods adopted by schools or judging the practice of teachers and/or the lack of interest from students in the subject. However, our findings emphasize the fundamental need to reinforce the essentiality of transformative teaching approaches and strategies, incorporating multidisciplinary and holistic characteristics [97,98], that can inspire students to become active citizens in these emerging issues [99,100].

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has developed a course entitled 'Climate Change in the Classroom: Course for Secondary School Teachers (Middle School and High School) on Climate Change Education and Sustainable Development (CCESD) [101], intending to emphasize the importance of integrating climate change into school curricula globally. Reinforce that climate change education is intrinsically linked to the life context of countries and relates to society and nature, where each locality (country or region) needs to develop its ways of teaching about the subject, employing specific educational methods [102].

Climate education and ecological skills are essential for children and young people to adapt and prepare effectively for the negative effects of climate change, considering the most impactful consequences on their lives. Therefore, the leaders of the future are already facing the worst impacts of climate change, such as extreme events and contamination of

natural resources, especially because they live in countries more susceptible to frequently experiencing these impacts [103].

It is essential to prepare children and young people to face the challenges of the future, and therefore, it is crucial to include climate change education in school curricula with greater dedication. This requires the implementation of pedagogical methodologies, curriculum, and evaluative strategies that enable an understanding of the urgency of climate change and the need for mitigation [80]. An effective approach to addressing the topic of climate change and its impacts is to promote planetary health education, as this approach incorporates the complex interaction between climate change, equity, governance, human health, vulnerabilities, biodiversity, and other relevant issues.

Teaching about climate change requires adequate preparation from the professionals involved, as well as innovative methodologies and in-depth discussions on the subject. As a strategy to narrow the gaps in teaching about the theme, the creation of detailed teaching materials is also proposed, involving the didactic transposition of concepts and a scientific approach [104].

4.3. Climate Change and its Relationship with Health

Understanding the connection between climate change and health is one of the most effective ways to raise awareness among citizens about the climate crisis. Diseases and the negative impacts of climate change are already being felt globally [105,106]. There are several studies pointing to the multifaceted impacts of climate change on mental health and both communicable and non-communicable diseases, increasing the risks of stress, anxiety, psychological trauma, and physical health problems, especially for the most vulnerable communities.

Several studies have highlighted the profound effects of climate change on mental health [107–112]. There are four pathways that demonstrate the impact of climate change on mental health: isolated extreme events (such as natural disasters and extreme weather phenomena), the direct effects of gradual changes (such as sea-level rise, increasing temperatures, and changes in precipitation patterns), indirect effects associated with climate change on physical and social systems, and effects linked to the perception of climate change [113].

It is important to emphasize that the effects on mental health, climate anxiety, and eco-anxiety are more pronounced in certain demographic groups. Among the groups considered vulnerable are young people, who, compared to other groups, report higher climate-related anxiety [114–117]. Furthermore, the level of climate anxiety has been increasing over time as more and more people are directly affected [107,114].

Young activist Greta Thunberg has strongly emphasized climate anxiety as an urgent concern and has been a prominent voice on these issues, emphasizing the importance of recognizing and addressing the challenges of the climate crisis [118].

On the other hand, research highlights that forms of social communication and social media are identified as drivers of climate anxiety [119,120]. It is understood that climate change is evidence-based; however, authors [120,121] argue that it is common to use a discourse of fear to communicate the urgency and severity of the problem, which can affect people's perception of the issue.

In addition to the above issues, climate change has the potential to affect human health in various ways, both directly and indirectly, contributing to the emergence and spread of communicable and non-communicable diseases [122,123]. These changes can be considered pandemics due to their drastic effects on human health and natural systems [124,125].

Non-communicable diseases (NCDs) are associated with air pollution, water pollution, and soil pollution [126–128]. Among them, cardiovascular diseases, diabetes, chronic lung diseases, cancer, mental health disorders, and injuries are considered the leading causes of mortality and morbidity, disproportionately affecting vulnerable groups [129–132], being associated with poverty and ultimately creating inequalities within and between coun-

tries [133,134]. An example pointed out by researchers is the existence of three pandemics, obesity, malnutrition, and climate change, which represent a global syndemic [124,135].

Communicable diseases are mainly associated with rising temperatures and changes in precipitation patterns, which can expand the geographical areas where disease vectors, such as mosquitoes, can proliferate, resulting in an increase in vector-borne diseases such as malaria, dengue, and leishmaniasis [136–139]. There is also the spread of pathogens such as bacteria, viruses, and fungi through water and air due to extreme events, resulting in outbreaks of gastrointestinal diseases such as cholera, rotavirus infections, and parasitic diseases [140,141].

As shown above, there is a variety of research linking health to climate change, reinforcing how important it is to incorporate this theme into various areas, including basic education. By understanding that human health is conditioned by environmental issues [6], it will be essential to leverage strategies that address the Sustainable Development Goals (SDGs).

Furthermore, according to the UNICEF report (2021), children and adolescents face significant risks due to the negative effects of climate change, threatening their health, education, and protection, and exposing them to fatal diseases. The report emphasizes that approximately 1 billion children live in countries with a higher climate vulnerability, making them more susceptible to the impacts of climate extremes [103].

Research conducted with this audience in various countries such as Australia, Brazil, Finland, France, India, Nigeria, the Philippines, Portugal, the United Kingdom, and the USA has provided relevant data demonstrating concerns about climate change. These issues impact the emotions, cognitive development, and overall functioning of children and adolescents [114].

Education in Brazilian schools should increasingly recognize the importance of climate issues, assigning children and young people the responsibility to advocate for climate causes, both in terms of mitigation and adaptation. Curricula must be strategically planned, moving beyond cross-cutting themes, to address these issues considering all types of knowledge and available scientific evidence.

5. Limitations

This study was limited to a small group of riverside students from the Brazilian Amazon, and further research should be conducted with this group, as they play a significant role as guardians of the forest. Additionally, this study presents limitations regarding the data collection instrument, and it is crucial to recognize that a questionnaire needs adjustments to be applied in new research, considering that open-ended questions have disadvantages in the responses given about concepts and their relationships with other interconnected issues.

It is essential to understand the need for new initiatives that can amplify their voices in the face of political leadership, particularly in the educational context, by introducing emerging themes in schools, as the impacts of climate change compromise planetary health. There is a need for qualitative research that explores the associations between climate change and health in educational contexts, especially how these changes impact populations and geographic areas differently.

In addition to investigative nature, studies on interventions are crucial to empower young people to promote constructive actions for human and environmental health.

6. Conclusions

The study in question revealed a limited awareness among students in a rural school in the Amazonas region, Brazil, regarding climate change and its relationship with health. It also became evident the reluctance to construct a concept, in this case, about climate change (CC), with some students having studied it while others had not. Additionally, the research allowed for reflections on the inclusion of climate change themes in Brazilian

schools, particularly when considering the significant impacts already experienced globally, compromising human survival, as the effects are felt in health.

Climate change education is advocated in this work, focusing on planetary health, enabling children and young people to develop resilient perspectives and a commitment to this emerging cause. This contributes to the process of mitigating and adapting to climate change and planetary issues. Furthermore, the aim is to encourage them to become future global leaders in this cause, considering that the negative impacts are expected to fall more severely on their lives.

The approach to addressing these issues more actively in Brazilian schools should be articulated as a set of strategies that allows for reflections on everyday scientific concepts and knowledge, especially in the riverine communities of the Amazon, which are heavily impacted by climate change. Understanding the issue also requires the creation and/or improvement of legislation related to the climate crisis, as well as implementing initial and ongoing training to empower teachers, the community, and the school, making them more engaged in the cause.

The integration of knowledge about climate change in schools should be included from an early age through transdisciplinary and participatory approaches that involve science, socioenvironmental impacts, health, and economics. Furthermore, it is relevant to include projects on sustainable practices, such as recycling, energy conservation, and responsible use of resources.

Awareness in schools and communities should emphasize the impacts of climate change at both the local and global levels, considering major events experienced in the present, such as recent occurrences in the Amazon like deforestation, wildfires, severe drought, water crisis, and air pollution. In this sense, it is crucial to recognize the importance of collective action to promote sustainable initiatives within the community.

Author Contributions: Conceptualization, P.R.H.d.M.; methodology, P.R.H.d.M. and P.V.A.; software, P.V.A.; validation, P.R.H.d.M. and P.V.A.; formal analysis, P.R.H.d.M. and P.V.A.; investigation, P.R.H.d.M. and P.V.A.; resources, P.R.H.d.M. and P.V.A.; data curation, P.V.A.; writing—original draft preparation, P.R.H.d.M. and P.V.A.; writing—review and editing, T.S.d.C. and V.B.; visualization, P.R.H.d.M. and P.V.A.; supervision, T.S.d.C. and V.B.; project administration, P.R.H.d.M.; funding acquisition, P.R.H.d.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research was sponsored by the Amazonas State Foundation for Research Support (FAPEAM).

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Federal University of Rio Grande do Sul (protocol code CAAE 42320821.6.0000.5347, approved 30 March 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study. Written informed consent has been obtained from the participants to publish this paper.

Data Availability Statement: The original contributions presented in the study are included in the article material, further inquiries can be directed to the corresponding author.

Acknowledgments: We would like to thank the Amazonas State Foundation for Research Support—FAPEAM for their support through the promotion of qualification via Notice No. 012/2021—POSGFE, which granted doctoral scholarships to the first two authors of this study. Furthermore, we extend our gratitude to the Coordination for the Improvement of Higher Education Personnel—Brazil (CAPES)—Funding Code 001.

Conflicts of Interest: The authors declare no conflicts of interest.

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