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Atmospheric Pollution - From smoke to solution: A report of an educational extension activity in Cuité-PB

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ABSTRACT

Air pollution, caused by pollutants such as nitrogen dioxide and particulate matter, threatens human health, the environment, and the global economy. This study, carried out by students of the Chemistry Degree course at the Federal University of Campina Grande, aimed to raise awareness among students of a public school in the State of Paraíba about the causes and effects of air pollution and to promote sustainable practices on this theme. The interactive lecture was followed by a survey to assess the students' understanding. The results indicated a good general perception of the impacts of pollution, but showed uncertainties about the role of transport in reducing pollution. The study highlighted the importance of environmental education and lifestyle change to combat air pollution, highlighting the need for educational actions and community engagement.

Keywords: Air pollution, Environmental education, High School.

INTRODUCTION

Air pollution, or air pollution, refers to the presence of chemicals, particles, and compounds in the atmosphere that compromise air quality and have profound adverse impacts on human health, the environment, and the global economy. This phenomenon is characterized by the introduction of air pollutants in concentrations that exceed natural levels, impairing the balance of the atmosphere and exacerbating environmental and health problems. The main causes of air pollution are associated with human activities, including the burning of fossil fuels in vehicles and power plants, industrial processes, and intensive agricultural practices (Arbex et al., 2012). These sources of pollution introduce various pollutants into the atmosphere, such as nitrogen dioxide (NO2), carbon monoxide (CO), and particulate matter. In addition, industrial and agricultural processes release compounds that, when reacting in the atmosphere, form secondary pollutants such as tropospheric ozone (O3) and sulfuric acid (H2SO4).

Air pollutants can be classified as primary and secondary. Primary pollutants are those emitted directly into the atmosphere, whereas secondary pollutants are formed by chemical reactions between primary pollutants and other atmospheric components. Air pollution has

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extensive and varied consequences. In terms of human health, exposure to air pollutants is associated with respiratory and cardiovascular diseases, in addition to contributing to the increase in premature mortality (Drumm et al., 2014). Environmentally, pollution causes acidification of water bodies and soil, degradation of ecosystems and loss of biodiversity, and intensifies the greenhouse effect and global warming (Azuaga, 2000). The economic impacts of air pollution are significant, encompassing high costs related to the treatment of diseases, loss of productivity, and damage to cultural and natural assets (Gulia et al., 2020; Yang et al., 2020). The need to implement control and mitigation technologies also poses a substantial economic burden.

The dispersion of air pollutants is influenced by multiple factors, including wind speed and turbulence, which affect the transport and dispersion of these pollutants. At the regional or local level, air circulation is modulated by variables such as land use, proximity to water bodies, and topographic features. Precipitation also plays an important role, helping to remove suspended particles and dissolve gases (Santiago, 2013). The presence of urban and industrial areas can create low pressure zones and other meteorological phenomena that alter the dynamics of pollutant dispersion. The interaction processes between air pollutants and the environment are complex and can result in adverse effects in distant areas due to atmospheric transport. Understanding these interactions is essential for developing effective control and mitigation strategies. Measures such as the implementation of advanced air quality monitoring systems, the improvement of technologies for reducing emissions, and the adoption of sustainable urban planning practices are essential to face the challenges posed by air pollution. In addition, the integration of these standards with local and national initiatives, along with collaboration between various sectors and the active participation of the community, are crucial for the effectiveness of policies. Legislation and public policies must be applied in a coordinated manner to maximize their impact on reducing air pollution. These approaches are essential to improve air quality, protect public health, and reduce environmental impacts (Garvão; Baia, 2018).

Extension plays an essential role in addressing air pollution, connecting scientific knowledge with the community and promoting awareness and the adoption of practices to reduce its impacts. Similar to extension focused on raising awareness about the safe use of chemical products, this extension approach can involve the population through lectures, workshops, and educational campaigns that address the causes, effects, and mitigation strategies of air pollution (Pinheiro; Narciso, 2022). These educational activities are essential to raise awareness in the community about the importance of sustainable practices, such as reducing the use of fossil fuels, adopting alternative transportation, and supporting public

policies aimed at improving air quality. In addition to disseminating knowledge, extension actions enable the community to adopt practices that reduce the emission of pollutants and actively participate in air quality monitoring initiatives. By strengthening the collective commitment to the protection of public health and the environment, these activities promote collaboration between society, government, and the private sector, which is essential for the implementation of effective air pollution control strategies. In this way, the extension contributes significantly to improving the quality of life and general well-being of the population, by fostering a healthier and more sustainable environment.

In this context, the extension was aimed at 1st year students of the André Vidal de Negreiros State Elementary School, located in the city of Cuité, Paraíba, with the objective of raising awareness among students about the impacts of air pollution and training them to adopt sustainable practices in their daily lives. Through educational activities, such as lectures and workshops, the initiative sought to engage students and motivate them to become agents of change in the preservation of air quality and the protection of the environment, promoting a positive transformation in the school community and beyond. This study aims to evaluate the effectiveness of these educational activities in raising students' awareness and promoting sustainable practices. Through the application of questionnaires and the analysis of the data collected, we sought to measure the impact of lectures and workshops on students' understanding of air pollution and its consequences. The expected results may provide important information to improve educational practices and guide strategies and measures aimed at environmental protection.

OBJECTIVE

The purpose of the lecture on air pollutants in a school is to make students aware of the causes and effects of air pollution, as well as the possible solutions to this problem. The lecture aims to highlight the importance of preserving air quality and the negative impacts that air pollution can have on both human health and the environment. In addition, it seeks to encourage students to adopt more sustainable practices and to actively participate in initiatives that help reduce pollution, promoting a reflection on the responsibility of each one in protecting the planet.

METHODOLOGY

The lecture entitled "From Smoke to Solution: Exploring the Causes and Consequences of Air Pollutants" was conducted by students of the Chemistry Degree course at the Federal University of Campina Grande (UFCG), belonging to the PET-Chemistry group. The lecture was

held at the André Vidal de Negreiros State Elementary School, located in the center of the city of Cuité, Paraíba (Figure 1).

The event was attended by three students (Figure 2) and was presented in an expository format, with the main objective of stimulating students' interest in knowledge related to atmospheric pollutants, their origins and impacts. The didactic approach was carefully planned to make the content accessible and relevant to the student audience, providing a clear understanding of the topics covered.

At the end of the lecture, a quantitative research was carried out through questionnaires distributed to the participants. These questionnaires were designed to collect information about the degree of satisfaction of students with the lecture and to assess their understanding of the content presented. In addition, the questionnaires will serve as a basis for measuring the effectiveness of educational actions like this, carried out in schools and communities. The data obtained will allow the organizers to identify areas for improvement and adjust future pedagogical interventions, in order to maximize the educational impact and increasingly engage students in scientific topics of social and environmental relevance. It is important to highlight that the lectures are part of the activities aimed at extension, one of the main aspects of the Tutorial Education Program (PET).

Figure 1: Location of the school.

Source: Google photos, 2024.

Figure 2: Lecture on Air Pollution in the Classroom.

Source: The authors, 2024.

RESULTS AND DISCUSSION

Lectures in schools, integrated into educational programs, enrich the student experience by providing hands-on learning and preparing them to become informed and engaged citizens. They are essential for the integral formation of students and for the development of crucial life skills. Similarly, academic events in higher education offer more than a simple approach to themes; They are vital for the dissemination of information, promote meaningful interactions between speakers and participants, and between the participants themselves. These events play an important role in enhancing science communication skills. They are vital for the dissemination of information, encourage enriching interactions between speakers and participants, and promote exchange between the participants themselves. In addition, these events are essential for the development of science communication skills. The active participation of students in these events is crucial for their personal development, providing training and opening paths for future choices and opportunities.

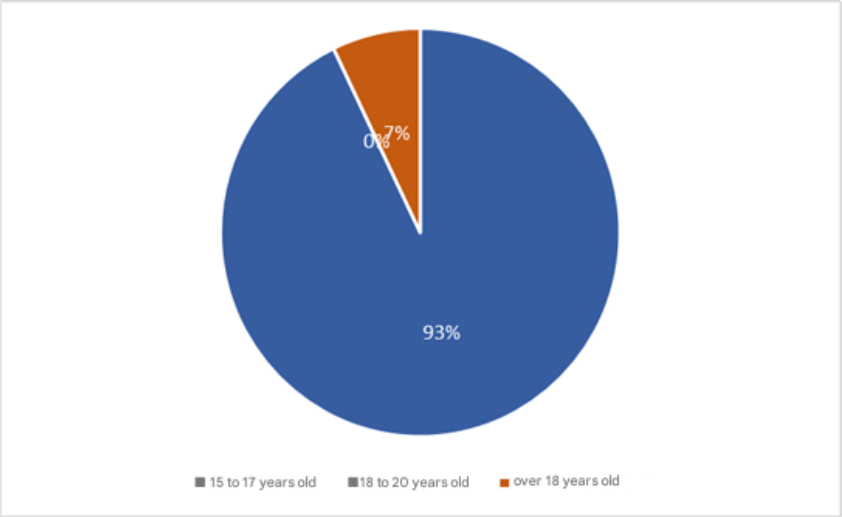
At the end of the lecture, a questionnaire was made available containing some questions about the topic addressed, the collected data were submitted to analysis and some graphs were prepared about them. The collection of these data was essential to have a basis on the students' understanding of the content, and on their interdisciplinary knowledge around everyday themes, taking into account that the topic addressed is often present in their lives, because environmental education is of paramount importance in our daily lives, as we need to educate everyone about the environment, teach how to preserve the environment and punish in an educational way those who do not take environmental education seriously.

The graphs elaborated from the answers to the questionnaires were analyzed and it

became possible for the students to interpret the topic addressed.

Graph 1 shows the distribution of the research participants in relation to their ages. The results reveal that the vast majority of respondents, 93%, are in the age group of 15 to 17 years. This indicates that the survey was predominantly answered by adolescents. On the other hand, no person aged between 18 and 20 years participated in the survey, as indicated by the lack of answers in this age group. In addition, 7% of respondents are over 20 years old, suggesting that a small portion of participants are young adults. These data show that the survey was largely dominated by teenagers, with a small representation of older participants. The absence of respondents in the 18-20 age group may be relevant depending on the context of the survey, indicating a possible need to reassess the scope or sampling of the study to include this age group, if of interest.

Graph 1: Age group of the research participants.

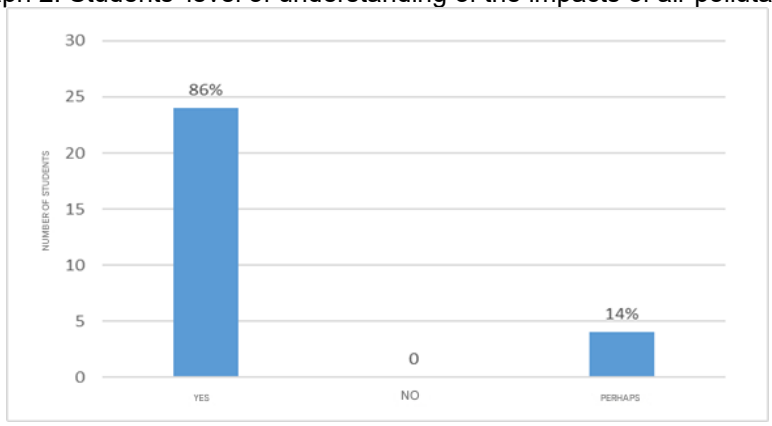


Source: The authors, 2024.

Graph 2 shows the participants' level of understanding of the effects of pollutants. The data shows that 86% of respondents stated that "yes", they understand the impacts caused by air pollutants, which indicates a broad awareness of the negative effects of air pollution. This is a positive sign in terms of environmental awareness among the group surveyed. There were no participants who answered "no", which means that all respondents have some level of knowledge on the topic, and no one considers themselves totally uninformed about the impacts of air pollutants. On the other hand, 14% of participants answered "maybe", suggesting that a smaller part of the group has a partial understanding or is not entirely sure about the impacts of air pollutants. This group may need additional information to achieve a more complete understanding. In studies carried out by Regis and Bello (2011) in the analysis of the answers

about the characterization of pollutants, it was found that 60% of the students had a satisfactory perception, 28% a partially satisfactory perception and 12% an unsatisfactory perception. However, when it comes to air pollutants, the percentage of satisfactory responses dropped to 24%, while that of unsatisfactory responses increased to 64%. In summary, the graph indicates that most participants are well informed about the impacts of air pollutants, although a small portion may still benefit from further clarification or education to solidify their understanding of the topic.

Graph 2: Students' level of understanding of the impacts of air pollutants.

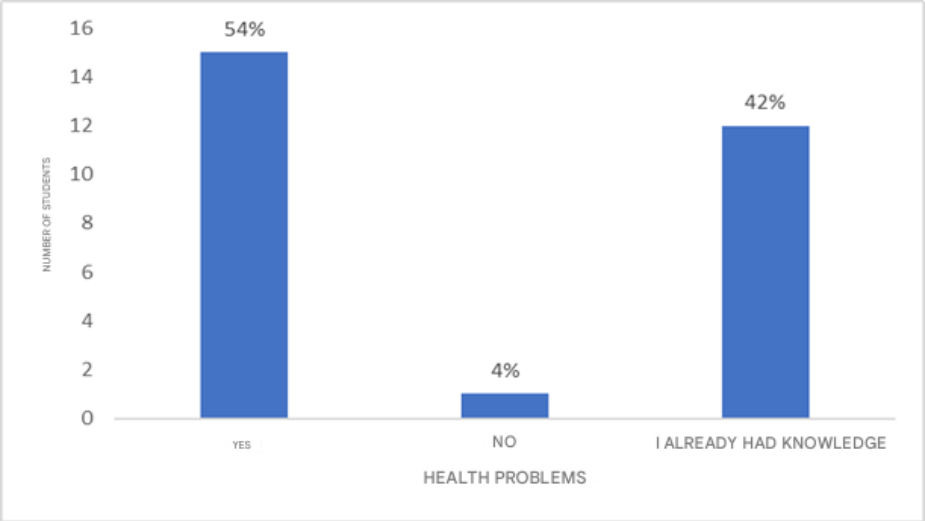


Source: The authors, 2024.

Graph 3 illustrates the participants' level of understanding of the factors that can influence health. According to the data, 54% of respondents said "yes", indicating that they have an understanding of the causes and health problems addressed. This reveals that more than half of the participants are aware of the elements that can impact health. Recent research investigated a correlation between pollutant levels and the development of several health conditions, such as ischemic heart disease, cerebrovascular diseases (including ischemic strokes), lung cancer, chronic obstructive pulmonary disease, and lower respiratory infections. The results indicated that there is consistent evidence of a causal relationship between exposure to these particles and the incidence of the aforementioned diseases (Cohen et al., 2017). On the other hand, 4% of respondents answered "no", indicating that a small portion of the group has no knowledge or understanding about these issues, which suggests the need for greater education or awareness for these individuals. In addition, 42% of the participants mentioned that they already had previous knowledge about the causes and health problems discussed, which demonstrates that a considerable part of the group was already informed about the topic before any educational action. In summary, the graph indicates that most participants have a solid understanding of the possible causes and health problems, with a significant portion already having this knowledge

previously, while only a small fraction remain uninformed on the topic.

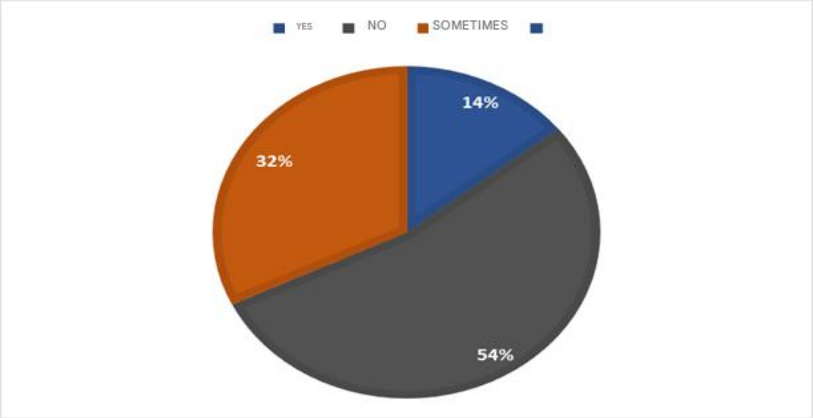
Graph 3: Knowledge about the possible causes and health problems related to environmental pollution.



Source: The authors, 2024.

Graph 4 illustrates the participants' perceptions of the influence of means of transport in reducing air pollution. The data shows that only 14% of respondents indicated "yes", which suggests that they have a clear knowledge about how different transport options can help reduce air pollutants. This points to a limited but existing understanding of the positive impact of more sustainable transport choices. In contrast, the majority, with 54% of participants, answered "no", indicating that they do not have an understanding of how modes of transport can affect the reduction of air pollution. This result reveals a significant lack of awareness about the importance of sustainable transport, highlighting the need for more educational campaigns on the environmental impact of means of transport. In addition, 32% of participants answered "maybe", suggesting that they have some notion or are undecided about the relationship between modes of transport and air pollution, but are not completely sure about the subject. In a study it was shown that a notable advance in the policy of reducing emissions is the adoption of the diesel/biodiesel mixture. Such studies demonstrate that this combination significantly reduces carbon monoxide emissions and, above all, particulate matter, although there is a slight increase in nitrogen oxide emissions (Braga; Braga, 2012). In sum, the graph reveals that the majority of participants are not yet fully aware of the role of modes of transport in reducing air pollution, with a small fraction demonstrating a clear understanding and a considerable part having partial knowledge or uncertainties about the topic.

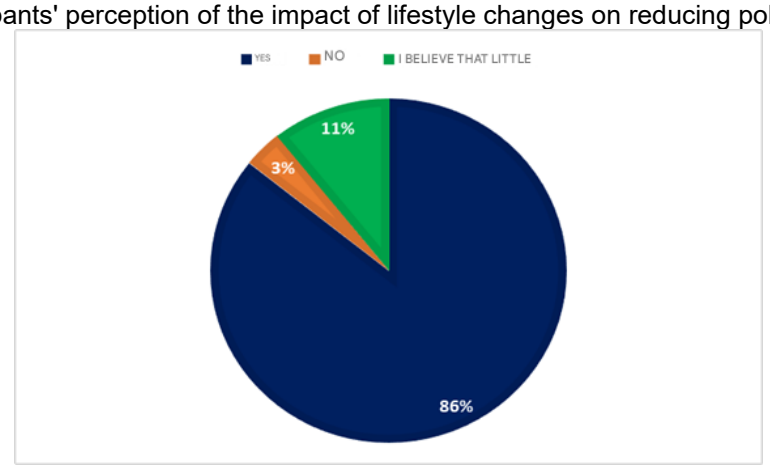
Graph 4: Participants' perceptions of the influence of the use of means of transport to reduce air pollutants.



Source: The authors, 2024.

Graph 5 reflects the participants' perception of the impact that adjustments in daily life can have on reducing pollution. The vast majority, 86%, firmly believe that lifestyle changes are effective in reducing pollutants, indicating a broad awareness of the importance of individual and collective attitudes for environmental preservation. On the other hand, 11% of respondents have doubts, expressing that they believe "little" in the effectiveness of these changes. This group may be skeptical about the ability of such adjustments to generate significant impacts, or they may have a limited view of what changes would be necessary. Only 3% of participants believe that changing their lifestyle does not contribute to the reduction of pollutants, reflecting a minority that sees no connection between individual actions and the mitigation of environmental pollution.

Graph 5: Participants' perception of the impact of lifestyle changes on reducing pollutant emissions.

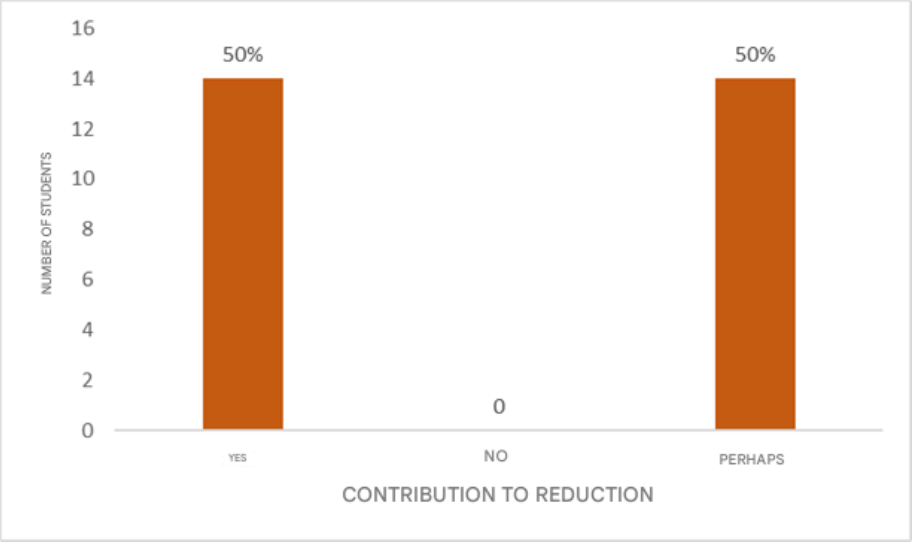


Source: The authors, 2024.

In Graph 6, it can be seen that half of the interviewees believe that contributing to the reduction of air pollutants is a positive and necessary practice, while 50% are not sure, indicating significant uncertainty about the impact or effectiveness of the proposed actions. Interestingly, no one in the sample opposed the idea, suggesting that, despite the doubts, there is a general

consensus on the importance of the topic. This highlights the need for more information and clarification on how these contributions can be effective and how they impact the environment. According to Oliveira Junior (2021), given the increase in pollutant emissions and the crucial importance of vehicles for social well-being, it is necessary to find alternatives to reduce the negative impacts of these emissions. In this context, the replacement of fossil fuel (diesel) with a more sustainable option, such as biodiesel, emerges as an environmentally attractive alternative.

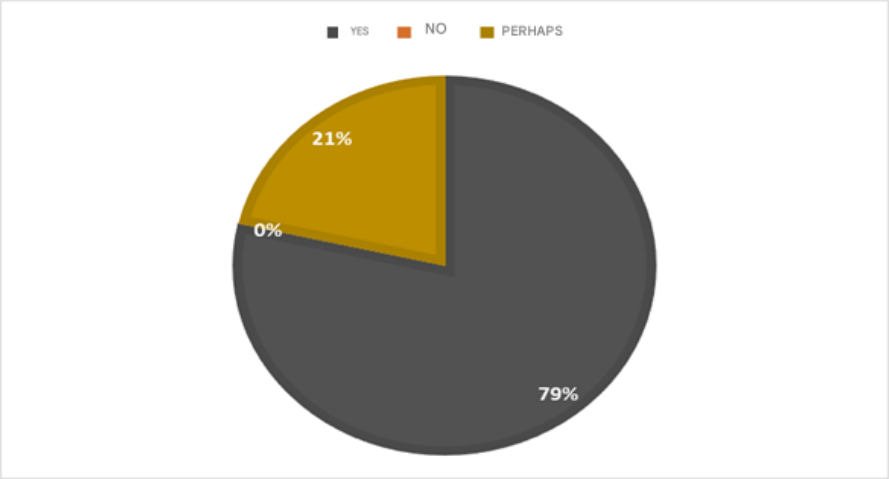
Graph 6: Contribution of environmental education to the reduction of atmospheric pollutants.



Source: The authors, 2024.

Graph 7 shows solid support for the idea of contributing to the preservation of the environment, with 79% of respondents saying yes and none indicating no. This high level of agreement reflects a strong awareness and commitment to environmental issues among the participants. However, 21% expressed uncertainty, suggesting the need for more information or clarification on how these contributions can be implemented effectively. This discrepancy underlines the importance of educating and engaging everyone involved to ensure consistent positive impact. As highlighted by Alves et al. (2009), the population's perception is a crucial parameter in the analysis of environmental and public health problems, indicating that, despite the expressive support for environmental preservation, there is still a significant need for educational and engagement strategies to ensure the effectiveness of contributions and the expected positive impact.

Graph 7: Contribution of environmental education to the environment.



Source: The authors, 2024.

FINAL CONSIDERATIONS

The concepts that encompass Chemistry are increasingly present in everyday life, and with that, there is a need to understand them consciously, considering that contents that approach this science are of paramount importance. With this in mind, the importance of these studies arises that are said about atmospheric pollutants and the search for solutions to avoid them. The air that makes up the atmosphere appears as an essential factor for terrestrial life, considering that it makes up most of the matter that consists of planet earth, this factor becomes more important for studies, considering that every living being that makes up it needs this air for survival. Therefore, the need arose to inform about topics that are consistent with this factor, especially in educational institutions, that is, in schools, universities, among others.

Themes that address the conservation of life on the planet are of collective responsibility, considering that it is a duty as a living being to become aware of structuring issues. The lecture on air pollution held in a school highlighted the importance of environmental education to make students aware of the impacts of air pollution and promote sustainable practices. The initiative has proven effective in increasing students' understanding of pollutants and motivating them to reflect on their own actions. University extension was crucial in this process, connecting academic knowledge with the community and strengthening environmental responsibility among young people. The continuity and expansion of projects of this type are essential to form conscious citizens committed to sustainability.

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