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Biodiversity crisis: scientific trends and the conceptions of natural science teachers

Lucas Felipe Leite de Oliveira Pereira
lucas_leite@ufms.br
orcid.org/0009-0008-0101-1074
Universidade Federal de Mato Grosso do Sul (UFMS), Campo Grande, Mato Grosso do Sul, Brasil.

Tatiane do Nascimento Lima
tatiane.lima@ufms.br
orcid.org/0000-0002-0656-1170
Universidade Federal de Mato Grosso do Sul (UFMS). Aquidauana, Mato Grosso do Sul, Brasil.

ABSTRACT

The Biodiversity Crisis represents the mass extinction of several groups of living beings. This crisis is the result of the capitalist model of our society, which uses natural resources irrationally. In the midst of this environmental crisis, education is an ally in expanding the knowledge and the understanding of nature, highlighting the importance of the relationship between the existence of biodiversity and the maintenance of our quality of life. In this study, through bibliometrics, content analysis and interviews, we evaluated scientific trends and the conceptions of Natural Sciences teachers on the subject “Biodiversity Crisis”. The results demonstrated that the bibliographic production that covers the Biodiversity Crisis in education is not centered in a country, an author or even a research group. Brazil stands out among the productions, since on the Scielo platform the vast majority of articles were produced by Brazilian institutions and Brazilian authors. Scientific production shows tendencies to stimulate discussion in classrooms about the Biodiversity Crisis in education, with a focus on socio-environmental issues. Topics such as education for sustainable development, environmental awareness and environmental education were taken into consideration. Furthermore, the data collected about the teachers' conceptions on the subject showed that they are familiar with the subject and teach classes on it. However, most of the classes are expository and they focus on concepts, without highlighting the relationship between the Biodiversity Crisis and social issues.

KEY-WORDS: Education; School; Environment; Quality of life; Sustainability.

Crise da biodiversidade: tendências científicas e as concepções dos professores de ciências da natureza

RESUMO

A Crise da Biodiversidade representa a extinção em massa de diversos grupos de seres vivos. Essa crise é o resultado do modelo capitalista da nossa sociedade, que utiliza os recursos naturais de forma irracional. Em meio a essa crise ambiental, o ensino é um aliado para expandir o conhecimento e a compreensão da natureza, com destaque para a importância da relação da existência da biodiversidade e a manutenção da nossa qualidade de vida. Neste trabalho, por meio de bibliometria, análise de conteúdo e entrevista, avaliamos as tendências científicas e as concepções dos professores de Ciências da Natureza sobre o assunto "Crise da Biodiversidade". Os resultados encontrados demonstraram que a produção bibliográfica que abarca a Crise da Biodiversidade no ensino não está centralizada em um país, em um autor ou mesmo em um grupo de pesquisa. O Brasil se destaca entre as produções, visto que na plataforma Scielo a grande maioria dos artigos era de instituições e autores brasileiros. A produção científica apresenta tendências de estímulo à discussão em salas de aula sobre a Crise da Biodiversidade no ensino, com foco em questões socioambientais. Sendo levado em consideração tópicos como educação para o desenvolvimento sustentável, sensibilização ambiental e educação ambiental. Ademais, o levantamento dos dados sobre as concepções dos professores sobre a temática demonstrou que eles conhecem e ministram aulas dentro da temática. Mas as aulas, em sua maioria, são expositivas e com foco nos conceitos, não dando destaque à relação entre a Crise da Biodiversidade e as questões sociais.

PALAVRAS-CHAVE: Educação; Escola; Meio ambiente; Qualidade de vida; Sustentabilidade.

INTRODUCTION

Biodiversity encompasses all the variety of life on planet Earth. Environments with a high diversity level have a wide variety of species that together perform several ecosystem functions, such as regulating rainfall and climate, pollination, nutrient cycling, among others (Joly et al., 2019). Despite the importance of Biodiversity, the current sequence of environmental destruction caused by deforestation, fires, the introduction of exotic species and the excessive release of carbon dioxide into the atmosphere has led to a systematic loss of Biodiversity, an event known as the Biodiversity Crisis (Kolbert, 2015).

A study conducted by the University of London, the Natural History Museum in London and the Global Conservation Monitoring Centre indicated that biodiversity on the planet has fallen by 58%, standing below the limits suggested as safe. The study also points out that, in the affected areas, the capacity of biodiversity to maintain key ecosystem functions, such as climate regulation, pollination and pest control, appears increasingly reduced (Agency EFE, 2016). Biodiversity conservation is, without a doubt, one of the greatest socio-environmental challenges of our time. This concern is based not only on the ethical responsibility to guarantee the existence of the diverse forms of life that live on Earth, but also on the intention to maintain the quality of life for all citizens.

In a scenario towards sustainable development, which democratically guarantees access to quality of life for all, Biodiversity will be decisive for mitigating and adapting to climate change. On the other hand, considering the current model of economic “development” based on the burning of fuels, if measures are not taken to reduce the decline of natural systems, the acceleration of climate change will result in negative impacts for our society. This will result in more heat waves, droughts, heavy rains and floods with greater intensity and frequency. This situation affects the food and water resources of societies, it increases the incidence of respiratory diseases, and promotes the mass migration of populations in search of access to essential goods and to guarantee quality of life, the so-called climate refugees.

In this context of environmental chaos that affects the social and economic spheres, it is urgent to discuss the importance of curbing the loss of biodiversity. This discussion must reach the entire society. One way to bring this issue to society is through education. In this sense, educational practices are adopted in schools as an important element for the possibilities and challenges which are focused on sustainable development and socio-environmental justice. These measures promote a break with anthropocentrism and they focus on the fact that we are the environment and we are also within this scenario of environmental chaos, as actors and participants , not just spectators. The objective of this research is to evaluate which scientific trends are being developed in teaching within the theme of the Biodiversity Crisis and to carry out a diagnosis of the conception of Natural Sciences teachers on the theme of the Biodiversity Crisis.

BIODIVERSITY CRISIS AND THE TEACHING OF NATURAL SCIENCES

The word Biodiversity (etymologically, from the Greek root *biós*, meaning life, and *diversity*, meaning variety, multiplicity) is used to represent all species of living beings existing on Earth. Thus, an environment that presents high biodiversity is represented by a great variety of life individuals (microscopic beings, plants, animals, including us, human beings) (Wilson, 1997).

Although the word Biodiversity is part of our daily lives, its concept is quite recent. The concept was conceived by Walter G. Rosen, of the National Research Council/National Academy of Sciences (NRC/NAS) (NRC/NAS) in 1985, when arranging a forum on biological diversity. The event took place in the United States, from September 21 to 24, 1986, under the name “National Forum on BioDiversity”. The forum took place at a time when interest in understanding the diversity of life and concerns about its conservation, both among scientists and a considerable portion of society, were gaining momentum (Wilson, 1997; Sarkar, 2002).

Biodiversity conservation is of great importance for ensuring the environmental balance of all ecosystems and maintaining our quality of life. Biodiversity is the basis for maintaining a wide range of ecosystem services, such as: air quality; availability of fresh drinking water; primary productivity; natural resources; maintenance of biogeochemical cycles; climate regulation; and protection against the emergence and/or reappearance of numerous diseases (Joly et al., 2019).

In recent years, planet Earth has been experiencing an episode of degradation of its ecosystems and extinction of species at a faster rate than natural extinction. Around 200 species are disappearing every day, which represents 1,000 times the natural extinction rate (Zardoya, 2012). Mass extinctions have occurred at least five times previously in world history, due to the actions of volcanism and asteroids. But this is the first time that one of the species, humans, is the cause of this phenomenon, the sixth mass extinction on Earth. This causes a true Biodiversity Crisis (Kolbert, 2015).

The environmental chaos in which we live reverberates in the social, economic, environmental, cultural, territorial, and political dimensions. In this scenario, education can be an ally in expanding knowledge about nature and the effects of human actions on ecosystems. It also contributes to understanding the relationship between the sustainable usage of natural resources to maintain biodiversity and, consequently, to guarantee our quality of life. All of these topics (biodiversity, natural resources, ecosystems, sustainable development) are part of the area of the Natural Sciences subject at school and they have an intrinsic relationship with students' daily lives. Thus, “teaching how to conserve biodiversity means teaching how to understand scientific knowledge and its relationships with society” (Nascimento & Motokane, 2023, p. 2). In the case of Brazil, one of the countries with the greatest biodiversity in the world, understanding the relationship between the environmental and social fields is extremely important.

Biodiversity conservation is a topic that, when studied in the classroom, has the potential to spark discussions about environmental values and ethics, including utilitarian and essentially ethical aspects (Capetola et al., 2022; Dallyn et al., 2024). The study of Biodiversity, however, cannot be dissociated from all other environmental and social problems. It is necessary to develop mechanisms for

integrating actions and the general and comprehensive objectives of education (Moyer-Horner et al., 2010; Mykrä et al., 2023). The appreciation of Biodiversity is directly related to the knowledge acquired about it, especially its importance, usefulness, and variety of life forms. Thus, the cognitive and affective components in relation to living organisms are decisive in the conservation and preservation attitudes that society will have towards them.

Teaching is one of the tools that can help in the search for answers regarding changes in habits, attitudes and social practices that point to a solution to the socio-environmental degradation that afflicts the contemporary world (Lima & Faria, 2025). To create a possibility of raising awareness of this proposal, environmental educators must understand the depth of the crisis in which we are inserted, considering its structural causes to work with the subjects of the educational process, so that the understanding of what is happening is contextualized in their real world (Loureiro, 2012).

When addressing the topic of Biodiversity in schools, teachers need to go beyond teaching concepts. They need to discuss with their students the importance of this topic and its relationship with maintaining everyone's quality of life. It is necessary to understand the importance of Biodiversity for society and the serious consequences of the massive loss of living beings. In this regard, studying environmental issues is important for understanding the mechanisms of nature and the anthropic actions related to its use (Fonseca, 2007; Satokangas & Mikander, 2024). It is necessary to invest in pedagogical practices aligned with a systemic conception of the environment, which unites social reality with the ecological dimension. This can contribute "to the construction of citizens committed to themselves and to the community, as it allows them to recognize weaknesses and then act to remedy them" (Coutinho et al., 2020, p. 14).

More than just idealizing environmental issues as part of the curriculum, this subject should be systematized in classrooms, becoming part of the school system. Systematizing environmental issues in the classroom can contribute to the formation of citizens who are aware of the effects of the loss of biodiversity on their lives, as well as to the development of skills for analyzing and investigating natural phenomena for intervention, action, and application of scientific and technological knowledge, based on ethical and responsible decisions. This provides an opportunity to form individuals with a worldview who understand social and environmental issues.

Maria de Jesus da Conceição Ferreira Fonseca is one of the researchers who explored the use of the theme of biodiversity in the classroom. Her work aims to evaluate whether knowledge about biodiversity and sustainable development is socialized in schools in Belém (PA) (Fonseca, 2007). Authors Maria Luiza Schwarz, Pierre André and Lucia Sevegnani explore the representations made by Brazilian children about the biodiversity of the Atlantic Forest (Schwarz et al., 2012). Author Yonier Alexander Orozco Marín seeks to characterize and reflect on the trends and challenges of teaching Biodiversity in the Brazilian context (Orozco, 2017).

The works cited above, as well as others that adress Biodiversity in teaching (see: Garcia et al., 2023; Kopeginski et al., 2024; Miranda et al., 2022), discuss the importance of Biodiversity, the knowledge about the Biodiversity of a given

location, Environmental Education and the protection and conservation. The articles do not directly and systematically explore the current crisis of biodiversity loss (a true mass extinction) and its consequences on the social scenario. New times require new ways of teaching and dialoguing. It is necessary to overcome the naturalist bias and specific practices disconnected from socio-environmental relations. The Biodiversity crisis is a topic, within the teaching of Natural Sciences, that has this potential to dialogue, to develop critical thinking and to unveil concepts organized in a society that does not see itself as part of the Earth's natural systems.

MATERIAL AND METHODS

The research is qualitative and quantitative, descriptive and exploratory, dedicated to the description and contextualization of the object of study. The quantitative analysis was performed using bibliometrics. The qualitative analysis was performed using content analysis and semi-structured interviews.

The scientific production on the theme “Biodiversity Crisis in Natural Sciences Education” was evaluated using bibliometrics, which is a tool used to study and systematize scientific production and communication. Surveys of scientific production available in the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) databases were carried out in November 2024, using the keywords “Education”, “Teaching”, “Biodiversity”, “Biodiversity Crisis”, and “Loss of biodiversity”. The words were searched by the article title, abstract, and keywords. Access to the Scopus database (Elsevier) is made possible by the Fundação Universidade Federal de Mato Grosso do Sul, through the CAPES/MEC Periodicals Portal. The Scielo platform is open access, allowing the search for full articles from several journals hosted on the platform.

After searching in the platforms, the metadata of the productions (year of publication, place of publication and main authors) was collected. For data analysis, the information was organized in spreadsheets and graphs. All articles were selected from the beginning of the series on each platform up to the day of data collection.

Content analysis (Bardin, 2011) was performed by skimming the productions. After reading the articles and interpreting the information, the data was arranged in an Excel spreadsheet to create categories and subsequently to create the metatext. After the categorization, three categories emerged. They were cited and related several times in the articles, namely: I) use of non-formal teaching spaces (gardens, squares, museums, conservation areas) as a tool to raise environmental awareness; II) teaching approaches to discuss Biodiversity in the classroom; III) diagnoses of teachers' and students' knowledge on aspects involving the Biodiversity Crisis.

After interpreting the content presented in the publications on “Biodiversity Crisis in Natural Sciences Education”, through interviews with Natural Sciences teachers, we aimed to identify the teachers’ conceptions on the topic. Through the interviews, we expected to obtain a qualitative approach to the human reality experienced socially and the pedagogical activities developed. The interviews were conducted throughout 2024 and were applied in the municipalities of

Aquidauana, Anastácio and Campo Grande, in the state of Mato Grosso do Sul. The semi-structured questionnaires were sent via Google Forms and WhatsApp. Questionnaires were also personally delivered to Natural Sciences teachers who were participating in FETEC-2024 (Technology, Engineering and Science Fair of Mato Grosso do Sul), held in the city of Campo Grande. The data were organized in spreadsheets for accounting and interpretation of the data.

The research was approved by the Human Research Ethics Committee of UFMS under the process number 75869923.0.0000.0021. All participants signed the Free and Informed Consent Form (FICF) for those over 18 years of age. The semi-structured questionnaires do not contain the names of the participants or any type of identification to avoid their exposure; and all information provided will be kept strictly confidential. The questionnaire questions are shown in Table 1.

Table 1

Questions from the questionnaire presented to Natural Sciences teachers.

Number	Questions
01	Have you heard about the Biodiversity Crisis? ( ) Yes ( ) No
02	What do you understand by Biodiversity Crisis?
03	Have you ever taught classes on the Biodiversity Crisis? ( ) Yes ( ) No
04	If the answer to the previous question was yes, what methodology was applied in this class? What topic was covered?
05	How does the Biodiversity Crisis relate to your quality of life?

Source: Authors (2024).

RESULTS AND DISCUSSION

BIODIVERSITY CRISIS: SCIENTIFIC TRENDS

The search on the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) platforms generated a total of 41 articles. After reading the articles, 12 were put aside because they were not aligned with the scope of the research. Thus, the bibliometric and content analysis was carried out based on a total of 29 articles.

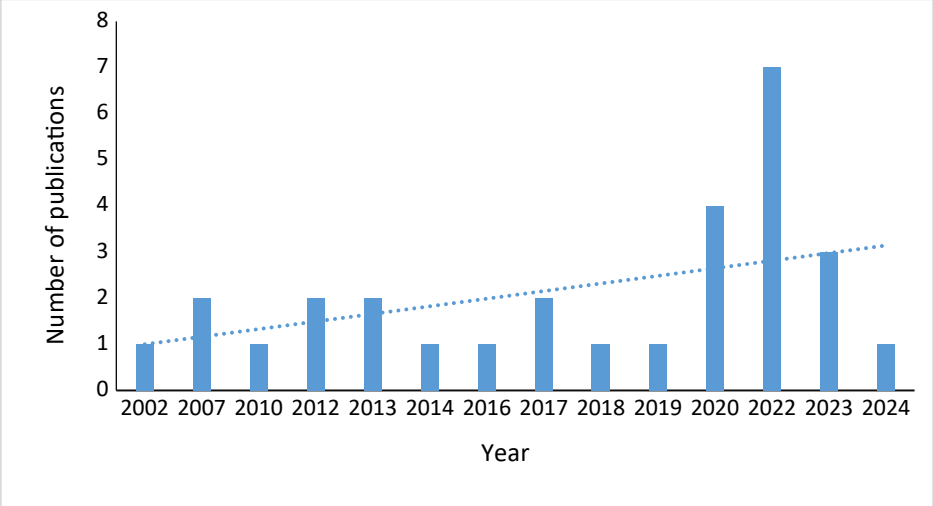
The research began on the platforms in 2002, when only one article was published. From then on, the research varied between one and four per year. At that time, as an environmental milestone, in the early 2000s, the Millennium Declaration of the United Nations (UN), which described the Millennium Development Goals, including environmental sustainability. At the time, Millennium Development Goal 7 established specific environmental targets, including combating the loss of biodiversity, forest cover and access to drinking water.

In 2022, there was the peak of publications, with seven articles. Interestingly, 2022 is marked by the release of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). This left the world alarmed

about the direction of global warming and the impacts of climate change. Subsequently, in 2023, the number dropped again to three publications and, in 2024, only one publication was observed (Figure 1).

Figure 1

Sampling of publications from 2002 to 2024 on the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) platforms.



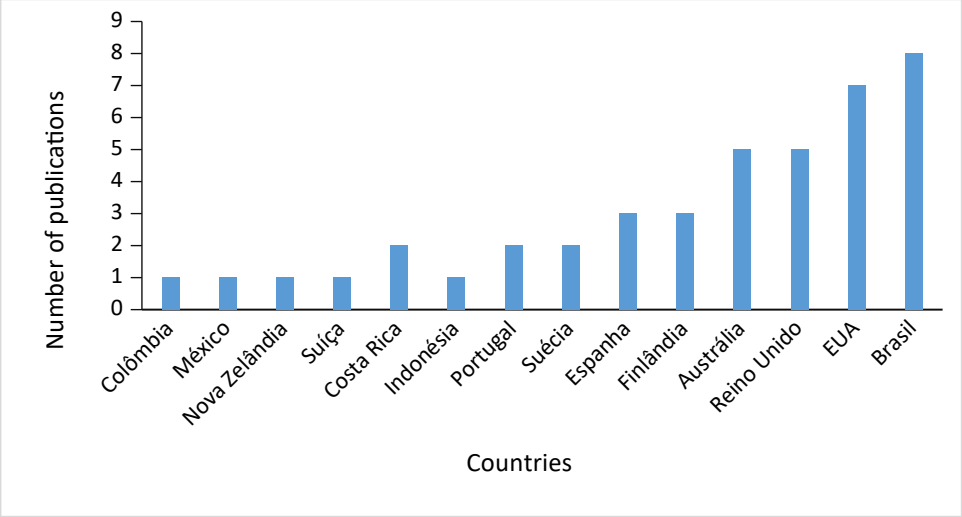
Source: Prepared by the authors (2024).

As for the authorship of the productions, a total of 85 authors were counted, all of them with only one publication. This shows that there is no trend of authorship or research groups developing studies within the theme “Biodiversity Crisis in Natural Sciences Education”. Many articles are written by authors from several countries, which suggests that research tends are inherently collaborative. Thus, the researched topic is a fertile area for international studies and collaborations, with the potential to drive educational and social changes.

When analyzing the number of countries where there are publications on the platforms, 43 countries were counted. Brazil appears in first place with eight publications, followed by the United States, with seven publications. Next come the United Kingdom and Australia, with five publications each (Figure 2). The significant number of articles in Brazil was observed due to the search on the Scielo platform, considered the main digital library in Latin America.

Figure 2

Distribution of publications by country according to Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) searches.



Source: Prepared by the authors (2024).

Regarding the researchers' affiliation data on the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) platforms, 44 institutions were indicated. Of these, the Auckland University of Technology (located in New Zealand) came in first place with nine affiliations. The University of São Paulo came in second place, along with the Institute of Technology Stockholm (Sweden), with six affiliation indications. Among the institutions, another Brazilian institution was also indicated, the Universidade Federal Rural do Semi-árido, with three contributions. It is worth noting that the performance of the University of São Paulo may be related to the FAPESP Biota Program, which has been mapping the diversity of plants and animals in the state of São Paulo since 1999, which may contribute to the creation of a scientific community aligned with the topic. Table 2 shows the top 10 research institutions with the highest affiliation contributions.

Table 2

List of research institutions affiliated with authors of articles from the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) databases, with the first 10 on the list selected for viewing.

Author affiliation	Record count
Auckland University of Technology (New Zealand)	9
Institute of Technology Stockholm (Sweden)	6
Universidade de São Paulo (Brazil)	6
Universidade Federal Rural do Semi-árido (Brazil)	3
Deakin University (Australia)	3
University of Wisconsin-Madison (USA)	3
University of Murcia (Spain)	3
Leeds Beckett University Business School (England)	2
Botanic Gardens Conservation International (England)	2
Science & Conservation, The Morton Arboretum (United Kingdom)	2

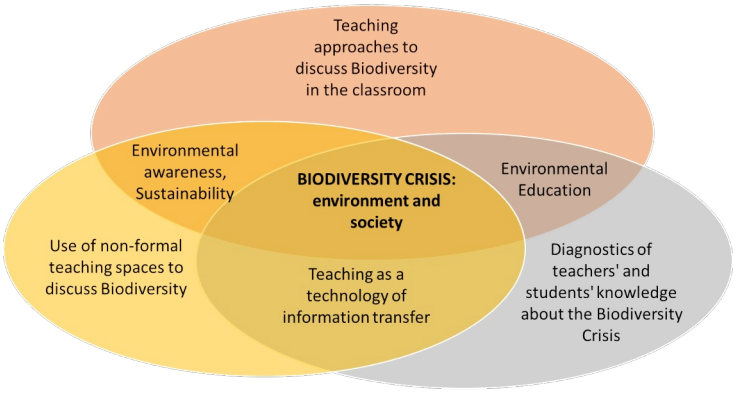
Source: Prepared by the authors (2024).

Regarding the content analysis of the articles, after reading them, it was possible to categorize them into three groups: I) the first deals with the diagnosis of teachers' and students' knowledge about aspects involving Biodiversity (representing 14% of the articles); II) the second group of articles deals with the use of non-formal teaching spaces (gardens, squares, museums, conservation areas) as a tool for awakening environmental awareness (representing 31% of the articles); III) the third group of articles presents teaching approaches to discuss Biodiversity in the classroom (representing 55% of the articles).

The authors of the scientific productions in the three categories agree that the theme of Biodiversity must be associated with sustainable development and the awakening of environmental awareness, in order to encourage humans to belong to the environment. They also argue that the economic development model needs to place environmental issues at the center of discussions, and not on the side. The articles discuss many aspects of environmental education, education for sustainability, the importance of environmental awareness and teaching, acting as a technology for information transfer. At the center of all these aspects is the Biodiversity Crisis as an element of environmental and social debate (Figure 3). Here below, there is a more detailed description of the approaches of the three categories of publications.

Figure 3

Diagram of the relationship between articles categorized from searches on the Scopus (Elsevier) and Scielo (Scientific Electronic Library Online) platforms.



Source: Authors (2024).

Group I: Diagnosis of Teachers' and Students' Knowledge on Various Aspects of Biodiversity

In this group of scientific production, it is pointed out that, in general, teachers demonstrate that they know the importance of teaching about Biodiversity, but their understanding of how to bring the topic to the classroom is still limited. For example, in the article "What Do Pre-Service Preschool Teachers Know about Biodiversity at the Level of Organisms? Preliminary Analysis of Their Ability to Identify Vertebrate Animals", the authors Robles-Moral and collaborators (2022) highlighted that teachers had little knowledge about the native fauna of the Iberian Peninsula (the study site). Thus, the scarce knowledge of native fauna can be an obstacle to teaching it and, therefore, to its conservation. In this sense, the authors point out that training actions are necessary to provide teachers with knowledge about native Biodiversity so that the school can in fact act as a complement to Biodiversity conservation and sustainable development.

The article "Biodiversity and sustainable development in high schools in Belém (PA), Brazil", by the author Fonseca (2007), reports that the knowledge of students and teachers about Biodiversity lacks scientific basis and does not achieve significance in the production of a stance that seeks environmental conservation. Furthermore, the author highlights that the contents in textbooks present universal characteristics, dissociated from regional issues.

The article "Recontextualizing the discourse on Biodiversity in a Training Course for Science Teachers" (Nascimento & Motokane, 2023) presents the idea that in the training course for Science teachers, it is needed more than the presentation of concepts around Biodiversity. It is necessary to address the phylogenetic, genetic, and functional dimensions of Biodiversity. From these considerations there is a possibility of achieving a cultural transformation and overcoming unequal socio-environmental situations.

This group also included the article “How do biology textbooks address the different ways of estimating biodiversity?” (Cardoso-Silva; de Oliveira, 2013). The article highlighted that, in general, the topic of Biodiversity is presented in textbooks in a superficial and, at times, erroneous manner. This makes it difficult for students to understand the topic.

Group II: Use of Non-Formal Teaching Spaces

This group includes productions that feature informal teaching spaces, such as a museum, a garden, or an environmental protection area, which can contribute to teaching about Biodiversity. The use of a non-formal space, such as an island, to teach about Biodiversity conservation, using transdisciplinary approaches that combine scientific and aesthetic knowledge, can promote deeper awareness and more effective environmental care (Klier & Vargas, 2022). By integrating these different perspectives, it is possible to create educational experiences that raise public awareness of the importance of preservation. In addition, the collection of biological specimens, combined with the knowledge of local communities, contributes significantly to environmental awareness, as it values local knowledge and connects it with Science, strengthening the understanding of Biodiversity and its conservation (Medina, 2020).

In the article “Bioliteracy through experiences in a natural library”, the authors Medina-Sandova and Gutiérrez-Ruiz (2014) use the term “bioliteracy” to conceptualize the practice that seeks to raise awareness among children, teachers and communities about the importance of biodiversity through experiential experiences in protected areas. According to the authors, by directly involving participants with nature, this approach promotes meaningful and immersive learning, encouraging environmental awareness and the development of greater respect for the preservation of ecosystems. The authors draw attention to the fact that these teaching activities must be aligned with environmental education. These activities involved students, teachers and parents from communities surrounding conservation areas.

Museums are presented as having an essential role in public education, adopting a more active stance in solving the Environmental Crisis. By integrating concerns about species extinction into their exhibitions and educational programs, these institutions can raise public awareness and promote a deeper understanding of the urgency of conservation. In this way, museums can not only present the Environmental Crisis, but also actively contribute to its solution, encouraging attitudes and actions aimed at preserving biodiversity (Campagna & Campagna, 2014).

The articles also highlight that the use of native plants in landscaping can be an effective strategy to raise awareness about biodiversity and reduce environmental impacts. Furthermore, botanical gardens play a crucial role in offering practical solutions to combat plant extinction. These institutions combine conservation, environmental education and research, creating opportunities for the preservation of threatened species and promoting the restoration of ecosystems, which is essential for maintaining global biodiversity (Westwood;

2020).

Group III: Teaching Approaches to Discuss Biodiversity in the Classroom

The central ideas of this group's productions address varied but interconnected themes, mainly in the idea of discussing Biodiversity in the classroom, within biases focused on sustainability, environmental conservation and environmental education.

The authors Dallyn et al. (2024) use Paulo Freire's critical pedagogy to emphasize the importance of an education that goes beyond the traditional sustainability model. Using classes focused on composting, the authors seek to present models to potentially involve students in practice, promoting a connection with environmental issues, and providing structural and concrete changes. This vision is also addressed in the article “Education as a tool for addressing the extinction crisis: Moving students from understanding to action”, which shows how theoretical-practical teaching can go further, leading students to react directly to environmental challenges, such as reducing consumption and engaging in sustainable practices and slowing down species extinction (Moyer-Horner et al., 2010).

Brazilian author Suzana Ursi and collaborators (2018), in their article on the teaching of Botany, present the importance of contextualization combined with the use of several dynamic teaching strategies that focus on the student's protagonism. The authors also highlight the relevance of the connection between the university and the school. For example, through the extension project “Virtual Herbarium”, botanical biodiversity is brought to schools in a virtual way. The extension project “Education in Biodiversity in Jalapão, TO” focuses on the development of actions that have local populations as partners and co-responsible for conservation actions and the sustainable use of biodiversity.

The authors Eriksson et al. (2022) bring the term “Eco-anxiety”, literally translated as “eco-anxiety”, to the agenda of the discussion on the environmental crisis. Eco-anxiety refers to negative emotions, such as sadness, despair and anxiety, which can be caused by the Biodiversity Crisis and climate change. According to the authors, there are several strategies that can help students cope with these emotions, such as providing safe spaces to discuss these feelings, validating the existence of eco-anxiety and teaching ways to deal with it, including practical and collaborative activities.

This framework of negative feelings can lead people to the path of clinical anxiety, within which the subject may lose the possibility of reaction-action, becoming hostage to their thoughts of fear of an uncertain future. In some cases, this anxiety can trigger fear, and, at the same time, pro-environmental attitudes, such as donating resources to environmental agencies and engaging in debates and environmental thinking. Assessing, monitoring and supporting young people who will be involved in future efforts to mitigate and adapt to environmental changes (and consequently social, cultural and economic changes) requires investing in critical education. It will be beneficial in the long term to have citizens who understand the environmental crisis in which they are inserted, but who, at the same time, have the capacity to deal emotionally and actively to promote

pro-environmental attitudes and, thus, minimize future damage. A young, well-educated and critical population, with the capacity to effect change, would be a formidable resource in the fight against the Biodiversity Crisis.

In this sense, there are also articles that highlight the importance of including teaching about environmental changes in health courses, aiming to prepare professionals who will face (and are already facing) the environmental challenges of the 21st century. Problems such as climate change, biodiversity loss and pollution are affecting human well-being, and they require a new approach to health promotion. To this purpose, health professionals need to have interdisciplinary skills and systemic thinking to deal with these new diseases. The authors present "Planetary Health" as a framework that connects the health of ecosystems with the health of human populations (Capetola et al., 2022).

In general, the articles presented data that teaching about Biodiversity and the Environmental Crisis should begin from childhood, but teachers often do not have the necessary preparation to address these topics effectively (both conceptually and in terms of linking the topic to social issues). Teachers sometimes face difficulties in implementing concrete environmental practices, which leads to a lack of effective integration of the presentation of the implications of sustainable development in primary education. Thus, it was found that although teachers recognize the importance of teaching topics such as Biodiversity and climate change, there are still gaps in the curriculum and in the preparation to address these issues in an interactive and holistic manner.

TEACHERS' CONCEPTIONS ABOUT THE BIODIVERSITY CRISIS (INTERVIEW)

After surveying and diagnosing the bibliographic production on the theme of the Biodiversity Crisis in education, the analysis of the questionnaires answered by the teachers made it possible to observe that the majority of teachers are familiar with the topic and still develop pedagogical practices on the Biodiversity Crisis. However, as observed in the bibliographic survey, teachers face difficulties in bringing the topic to the classroom. For example, there is a lack of hands-on classes in natural environments and there is no connection between the topic and the social issues experienced by the students, so that the classes focus, for the most part, on the concepts addressed.

A total of 21 teachers answered the questionnaire. 86% of them indicated that they had heard of the Biodiversity Crisis. Regarding the understanding of the Biodiversity Crisis, the answers were organized into three most frequent classes. The first, representing 60% of the samples, was related to the extinction of species. The other two, each representing 20%, were related to the reduction of habitats and loss of ecosystems.

For example, Teacher 9 answered that: "*The biodiversity crisis is correlated to the reduction of species of living beings present in the environment. A process that occurs due to the environmental conditions of the planet. Anthropogenic actions are directly correlated to the biodiversity crisis*". In the same direction, Teacher 21 answered: "*It is the constant loss of existing biodiversity, thus leading to changes in ecosystems and in the regulation of Earth's temperatures*".

Among the teachers who said they did not know what the Biodiversity Crisis was, only two responses were collected:

Teacher 3: "*I think it must be something related to the imbalance of the environment, fauna and flora*."

Teacher 10: "*I didn't know the topic by that name, but by the name it's understandable that it's something that causes disturbances in biodiversity*."

As for teaching classes on the Biodiversity Crisis, 81% of teachers said they had already taught classes on the topic. Among the topics of the classes, the extinction of species and fires were mentioned most frequently. Other topics mentioned were: extinction of megafauna, disappearance of pollinators and loss of habitat. The topics mentioned by the teachers interviewed differ from those observed in the survey of scientific productions. In the productions, the most prominent topics were sustainability, environmental conservation and environmental education.

These differences are possibly related to the regionalism of the teachers interviewed. The state of Mato Grosso do Sul suffered from the impacts of the wild fires in the Pantanal in 2023 and 2024. This caused the loss of thousands of specimens of fauna and flora. This fact was part of the daily life of the population of Mato Grosso do Sul, being widely reported by the media and directly affecting the population due to the sky being covered in smoke for a long period of time (MapBiomas Project, 2024).

Among the teaching approaches, the following were mentioned: the use of texts and videos, scientific initiation mini-projects and gamified study platforms, debates and conversation circles. Below there is the teachers' report:

T1: "*Slideshow and videos on species extinction*."

T4: "*I applied the project-based methodology. The activities were developed by scientific initiation students. Topics related to the decline of pollinating insect populations were addressed*."

T17: "*It was addressed through news articles relating the fires in the Pantanal and the losses in Biodiversity*."

Only one teacher mentioned that he uses everyday examples to illustrate the effects of the Biodiversity Crisis on the students' lives. Teacher 9: "*A brief introduction to the biodiversity crisis. Addressing the consequences in everyday life. Discussion and debate on the topic, highlighting possible solutions*." Thus, there was no other mention of the relationship between environmental and social factors.

When asked "What is the relationship between biodiversity and our quality of life?", everyone made it clear that maintaining biodiversity is positively related to maintaining our quality of life. Below there are examples of responses:

Teacher 2: "*Our well-being depends on preserving biodiversity. If there is a biodiversity crisis, our health and livelihoods are also at risk*."

Teacher 7: "*It compromises the availability of food, drinking water, the climate, and human health*."

Teacher 15: "*It is relatively linked to well-being, since one example is heat, which directly affects our personal, professional, and social performance*."

Teacher 21: "*It directly affects my quality of life because the loss of biodiversity ends up influencing the production of some of the foods I consume and also the maintenance of temperature*."

Although the teachers made it clear in their responses the relationship between the Biodiversity Crisis and ensuring our quality of life, this aspect was not included in their classes. The use of external environments as a form of environmental awareness was also not observed, which was observed quite frequently in the articles presented in the survey of scientific trends on the subject. Themes such as sustainable development and environmental education were also not mentioned.

The challenge of the Biodiversity Crisis requires greater environmental/ecological/climate literacy, which involves understanding how the world works. The consequences of environmental changes bring the need for critical and innovative education focused on social transformation, which demands reflection on the relationships between individuals and nature, global and local environmental risks, and the relationships between the environment and development. Investment in transformative learning for sustainable development is necessary, taking into account the understanding of the social, cultural, and institutional factors that contribute to the lack of sustainability in the direction of "progress" in the capitalist system.

Aiming at the comprehensive education of individuals, classes must be contextualized with the real world (Loureiro, 2012). Bringing students' daily lives into the classroom is extremely important, especially in the sense of articulating the various skills proposed in the curriculum with real knowledge (Pereira & Lima, 2024). Thus, in an attempt to bring the Biodiversity Crisis into the classroom, it will be necessary to develop teaching that presents the functioning of the Earth, with its biological, chemical and physical laws, as well as the understanding of the actions of the subjects of the world, which involves the understanding that we are part of the environment and that all changes in nature have the potential to affect our lives.

CONCLUSIONS

In general, the bibliographic production covering the Biodiversity Crisis in Natural Sciences teaching is not centralized in one country, one author or even one research group. Brazil stands out among the productions, since, on the Scielo platform, the vast majority of articles were by Brazilian authors and institutions. Most of the articles present ideas related to teaching methodologies to bring Biodiversity into the classroom.

The scientific production shows tendencies to stimulate discussion around the Biodiversity Crisis in the formal and informal education system. However, in the studies, the authors make it clear that the discussions are incipient, because although there is an intention to promote this discussion, these acts are specific. Furthermore, although there are government structures that bring the discourse of the environmental issue, these structures are not schematized in a way that

can be implemented in educational institutions as a state policy. It is clear that the scientific community agrees that the path to maintaining our quality of life is sustainable development, environmental conservation and the dissemination of this knowledge in formal and informal education systems. However, making this a reality and not just ideas, according to the analysis of scientific production carried out in this work, is still an obstacle observed in several countries.

Through the teachers' responses to the questionnaire, it was clear that, in general, they know about the subject and teach classes focusing mainly on topics such as species extinction. However, contrary to the bibliographic production on the subject, there was no mention of the use of informal teaching spaces as a means of raising environmental awareness. There was no emphasis on topics related to sustainable development, environmental education and social aspects related to the Biodiversity Crisis. In other words, the classes mentioned focused only on conceptual aspects.

The Biodiversity Crisis is not just an environmental problem, but a crisis that echoes in society. Therefore, it needs to be discussed by the entire society. Obviously, education is not an isolated issue within these issues; it is one of the elements of environmental, social, political and cultural issues. Education alone will not solve the catastrophic problem we are facing (a planet that is losing its natural resources and undergoing irreversible ecological changes). However, without education, we will also not be able to imagine a future in which our crises can be discussed, resolved and perhaps minimized. Therefore, understanding how these issues are addressed in education can allow us to at least analyze the situation and, from there, chart a course towards what we want for our future.

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Address:
Tatiane do Nascimento Lima
Rua Oscar Trindade de Barros, n. 740, Bairro Serraria, Aquidauana, Mato Grosso do Sul, Brasil.

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Correspondência:
Tatiane do Nascimento Lima
Rua Oscar Trindade de Barros, n. 740, Bairro Serraria, Aquidauana, Mato Grosso do Sul, Brasil.