International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 20, Issue 9 (September, 2024), PP 84-91

Integration and Innovation: An A disciplinary Approach to Scientific Education for the Environment.

Adna Rodrigues de Alencar[1] https://orcid.org/0009-0001-2347-4036; Fábio Fares Marques da Silva[2] https://orcid.org/0009-0006-5297-2532; Fábio Ferreira Amaral[3]; Jeckson Rubens Macedo de Lima Pereira[4]; Ivan de Oliveira Holanda Filho[5] https://orcid.org/0000-0002-6368-9971; Juvanildo Terra de Alencar Junior[6] https://orcid.org/0009-0005-0523-9875; Lilian do Socorro Viana e Viana Amaral[7]; Marcos Paulo Mesquita da Cruz[8] https://orcid.org/0000-0001-7390-6602; Patrícia Pimentel Pereira[9] https://orcid.org/0000-0002-3059-4095; Régia Maria Carvalho Xavier[10]; Rickardo Léo Ramos Gomes[11] https://orcid.org/0000-0001-6101-9571.

[1] *Doctorate in Educational Sciences from Universidad del Sol - UNADES*
[2] *Specialist in Systems Analysis from the Federal University of Pará (UFPa) and in Education from the Faculty of Sustainable Development (FADIRE).*
[3] *Bachelor's Degree in Business Administration from the Faculty of Advanced Studies of Pará (FEAPA)*
[4] *Master's Degree in Educational Sciences from Universidad del Sol-UNADES*
[5] *Master's Degree in Rural Economics - UFC/PPGER*
[6] *Doctorate in Educational Sciences from Universidad del Sol - UNADES*
[7] *Master's Degree in Educational Sciences from Universidad del Sol - UNADES*
[8] *Pursuing a PhD and holds a Master's Degree in Rural Economics - UFC/PPGER*
[9] *Specialist in Psychopedagogy - Estácio de Sá University Center*
[10] *Master's Degree in History from the Federal University of Pernambuco (UFPE)*
[11] *Doctorate in Biological Sciences - FICL; Master's in Phytotechnics - Federal University of Ceará*
Corresponding Author: Rickardo Léo Ramos Gomes

ABSTRACT
This article, entitled "Integration and Innovation: An Adisciplinary Approach to Scientific Education for the Environment," seeks to understand how an adisciplinary approach can innovatively integrate scientific and environmental education. The methodology employed in this research was qualitative, utilizing a bibliographic research procedure that involved the analysis of relevant scientific articles and dissertations on the subject. This approach enabled a comprehensive understanding of the various dimensions of scientific and environmental education, as well as the pedagogical practices that can be adopted. The general objective of this research was to analyze how an adisciplinary approach can innovatively integrate scientific and environmental education. Through a theoretical framework addressing topics such as adisciplinarity in scientific education, curricular transversalities in environmental education, the extracurricular dimension of scientific education focused on the environment, cooperative approaches, and ecosystemic perspectives, a comprehensive analysis of this theme was constructed. This article contributes to highlighting the importance of considering scientific and environmental education in an integrated and adisciplinary manner, breaking away from fragmented and decontextualized models. It is hoped that the reflections presented herein will inspire educators, researchers, and policymakers in the development of educational practices and policies aligned with the principles of sustainability and planetary citizenship.

Keywords*: Adisciplinary Approach, Scientific Education, Environmental Education, Sustainability.*

Date of Submission: 28-08-2024 Date of Acceptance: 08-09-2024

I. INTRODUCTION

In recent years, the growing concern for environmental issues has driven the need for an education that not only informs but also promotes a significant transformation in social practices and behaviors. Scientific education, when integrated with an adisciplinary approach, emerges as a powerful tool to address contemporary

environmental challenges, enabling learners to develop a critical and holistic understanding of the interactions between humans and the environment. In this context, the adisciplinary approach stands out by breaking the traditional boundaries of disciplines, fostering a learning process that considers the complexity of socio-environmental problems.

The urgency of rethinking scientific education justifies this research, aiming to make it more relevant and effective in training conscious citizens engaged in building a sustainable future. The integration of diverse knowledge and educational practices is essential to prepare students for the challenges they will face in a constantly changing world.

The methodology employed in this research was qualitative, utilizing a bibliographic research procedure that involved analyzing relevant scientific articles and dissertations on the subject. This approach allowed for an in-depth understanding of the various dimensions of scientific and environmental education, as well as the pedagogical practices that can be adopted.

The general objective of this research was to analyze how an adisciplinary approach can innovatively integrate scientific and environmental education. The specific objectives are as follows: to investigate the characteristics and benefits of an adisciplinary approach in scientific education; to examine how curricular transversalities can be applied in environmental education; to assess the importance of extracurricular activities in promoting scientific education focused on the environment; to analyze the impact of collaboration among students on learning about environmental issues; and to explore how adopting an ecosystemic perspective can enrich scientific education for the environment.

This article is structured into four sections: introduction, methodology, theoretical framework, and conclusion, providing a comprehensive view of the integration and innovation in scientific education for the environment.

II. MATERIAL AND METHODS

The research presented in this article, entitled "Integration and Innovation: An Adisciplinary Approach to Scientific Education for the Environment," adopts a qualitative approach, which is characterized by a focus on the deep understanding of social and educational phenomena, seeking to capture the complexity of interactions and meanings.

According to Denzin and Lincoln (2018, p.12), "qualitative research is a way of understanding human experiences and social interactions in specific contexts". The research procedure used was bibliographic research, which consists of analyzing works already published on the topic in question. According to Gil (2019, p. 45), "bibliographic research is a fundamental step that allows the researcher to know the state of the art on the topic, in addition to theoretically grounding the work."

The research was based on scientific articles obtained from renowned journals and dissertations that address the theme of scientific and environmental education. This choice of sources allows for a comprehensive and well-founded analysis, contributing to the construction of a solid and up-to-date theoretical framework on the integration and innovation in scientific education focused on the environment.

III. THEORETICAL FRAMEWORK

In exploring the theoretical foundation of scientific education, it is essential to address the integration of environmental education through various approaches. A transdisciplinary approach to scientific education within and for the environment emphasizes the need to bridge different disciplines, fostering a comprehensive understanding of environmental issues. This perspective encourages educators to go beyond traditional subject boundaries, integrating knowledge from diverse fields to address complex environmental challenges.

Environmental education, when positioned as a transversal curriculum component, highlights its role in intersecting with various subjects and disciplines. This approach ensures that environmental themes are woven throughout the curriculum, promoting a holistic understanding of how human activities intersect with ecological systems. By embedding environmental topics across different subjects, students can develop a nuanced perspective on sustainability and environmental stewardship.

Furthermore, scientific education for the environment, when approached as an extracurricular activity, provides opportunities for students to engage with environmental issues beyond the classroom setting. This extracurricular focus allows for hands-on, experiential learning that complements formal education and fosters collaborative efforts among students. Emphasizing a cooperative approach in scientific education, combined with an ecosystemic focus, encourages students to work together to address environmental challenges, promoting a deeper, systemic understanding of ecological interactions and sustainability.

3.1 An Adisciplinary Approach to Scientific Education in and for the Environment

The relationship with nature and the environment has always been an educational concern, whether explicitly or implicitly, consciously or unconsciously. Currently, this relationship largely depends on the representations we construct regarding the origins of the environmental crisis. For educators who link the contemporary environmental crisis to the disconnection between humans, societies, and nature, the preferred educational approach emphasizes direct contact and interaction between the learner and their surroundings. This "education in and for the environment" focuses on "the relationship between humans and nature, contributing to the formation of individuals who respect their surroundings" (Cidreira-Neto and Rodrigues, 2017).

According to Cidreira-Neto and Rodrigues (2017, p. 01): "Human-nature relationships have undergone changes that accompany the development of society itself, particularly those of an economic nature, where the modes of utilization are shaped by the state of the global and local economy."

The goal is not merely to acquire knowledge or modify behaviors, but to enable a physical and emotional connection with our environment, which serves as a source of personal fulfillment. It is known that the quality of an environment is influenced by various factors, such as the configuration of spaces, their functional organization, the materials used in construction, and the set of sensory perceptions (lighting, colors, climate, sounds, textures, smells, tastes) provided by the available elements and materials (Barros & Menezes, 2018).

Thus, the selection of materials offered to students is extremely relevant, as "by expanding the repertoire of elements and resources for play, interaction, and learning, both sensorially and motorically, the possibilities for imagination, creation, learning, and movement are increased" (Hachler, 2022, p. 40). The role of the school appears to be to establish the necessary conditions for students to take responsibility and engage in actions in defense of the environment in the subsequent stages of their education. One of these conditions is the ability to 'perceive' the environment and, even passively, maintain a deep connection with the natural world. The previously mentioned pedagogical considerations emphasize "the formation of students through interdisciplinary studies on topics that align with their interests and are conducted in their everyday environment" (Costa Júnior et al., 2023).

Costa Júnior et al. (2023, p. 02) assert that:

> In the educational context, a positive learning environment refers to a physical, emotional, and social space that promotes the well-being, motivation, and engagement of students. It is an environment where learners feel safe to express their ideas, take risks, and learn from their mistakes. Furthermore, it is an environment that values diversity, inclusion, and mutual respect among all participants in the educational process.

This approach represents a pedagogical current centered on the individual and their development, situated within an educational perspective (rather than solely environmental) of Environmental Education for Sustainability (EAS) (Ferreira, Pires & Nápolis, 2021).

Reinforcing this understanding, Ushakova et al. (2021, p. 03) affirm that:

> Currently, learning is not restricted to the traditional school environment. Museums are fundamental educational spaces and present significant teaching-learning potential. The collections displayed in museums provide students with meaningful contact with eras, places, events, or people, allowing them to experience the history of humanity and the evolution of cultural heritage.

This aspect is particularly evident in various museum institutions that emphasize visitor immersion, creating the sensation of being in a natural environment, even if artificially recreated. This can be observed in immersive zoos or aquariums, butterfly conservatories, and marine environment interpretation trails, which utilize museological approaches that prioritize visitors' sensory experiences over the acquisition of scientific knowledge. This trend seems to indicate a significant decline in the relevance of environmental education within the school context (Ushakova et al., 2021).

3.2 Environmental Education: A Curriculum Transversality Perspective

Countries such as Brazil and France have chosen to promote environmental education without creating a specific new subject. From the outset, the orientation adopted by the Ministry of Education (MEC) was not to add a new discipline but rather to integrate environmental issues into existing subjects.

It is noteworthy that this directive primarily led biologists, as well as geographers, to adopt this teaching approach, which was initially based on the study of the environment, often focusing on the functioning of ecosystems or landscape interpretation.

> [...] the incorporation of environmental education into the National Common Curricular Base (BNCC) is primarily restricted to the subjects of Natural Sciences, History, and Geography, lacking articulation among them and with other disciplines. An example of how integration among these subjects could occur would be through the analysis of [natural sciences and geography] of space, examining the damages caused by urbanization processes to different ecosystems; History could bring to light the industrial revolutions and their associated environmental issues (Andrade & Piccinini, 2017, p. 09).

It is important to emphasize that this latter activity can involve an interdisciplinary approach, mobilizing knowledge and practices from the disciplines of history, geography, and biology. In this way, students could be

asked to locate the landscape in time, considering the seasons and historical aspects (such as the organization of the village, types of construction, and materials used), to observe the presence or absence of bodies of water or rivers, to study vegetation (such as broadleaf forests, for example), and to identify agricultural or industrial activities, both past and present.

However, authors such as Andrade & Piccinini (2017) and Behrend, Cousin & Galiazzi (2018) point out that a crucial aspect to highlight is that environmental issues are treated superficially, with a predominance of the ecological focus, without considering their natural, historical, social, political, economic, and cultural dimensions. It is worth noting that the analysis of the environment has been particularly developed in schools dedicated to vocational education, especially in the agricultural modality.

According to Mota et al. (2017, p. 07), this is due to the fact that:

> Agricultural practices encompass all cultural care involved in the art of cultivating plants for various purposes, including soil preparation and conservation, seed acquisition (mainly native and heirloom), the implementation of low-water consumption irrigation systems such as drip irrigation, direct planting, and transplanting with agricultural biodiversity, fertilizations (green and organic), pruning (cleaning and training), application of pesticides (organic and alternative), harvesting (ensuring food security for families and communities), processing, storage (food sovereignty), and marketing of production (solidarity economy). Environmental Education and Sustainable Agricultural Practices converge in this new science called Agroecology, which combines ancestral ecological practices with the latest scientific research, aiming to rethink and reshape pathways for the sustainability of humanity and the planet.

It is important to highlight that the opening of agricultural vocational schools to their surroundings, both natural and socio-professional, the existence of pedagogical experimentation centers, the introduction of ecology into programs, and interdisciplinarity have been determining factors for this dynamic and its continuity to the present day (Martins et al., 2021).

According to Martins et al. (2021, p. 05), the emphasis on environmental education in agricultural vocational schools occurred

> Especially through a pedagogical proposal that unites theory and practice in an interdisciplinary manner. The subjects of permaculture and agroecology stimulate the autonomy, creativity, and critical thinking of students through activities that promote reflections on socio-environmental issues present in their daily lives, at both micro and macro social scales.

The associative sector and non-formal education have also become involved to enrich education about the environment, which has come to be known as "Environmental Education - EA." In this context, it is important to mention the participation of National Parks, as these various structures have incorporated a mission of environmental education, generally centered on learning about the functioning of ecosystems or specific environments, through different forms of information transmission (such as guided tours or interpretative trails).

According to Oliveira, Santos & Lima (2023, p. 67), national parks, from a "critical perspective of Environmental Education (EA), focus on the essence of humanity and its relationships with the environment, as well as on social interactions, including political, cultural, economic, and sustainable development aspects, thereby favoring the objectives of this education."

Currently, environmental education is the most prevalent pedagogical approach in schools. Various topics are addressed, such as water, pollution, forests, energy, and biodiversity. This approach is based on scientific observations and practical activities, such as physical-chemical measurements to assess the water quality of a river or conducting experiments. In high school, educational activities often translate into scientific and technical workshops. For example, it is possible to acquire knowledge about a specific issue, such as marine pollution, through experiences and investigations conducted across various subjects, including sciences, geography, and economics (Martins et al., 2019).

3.3 Scientific Education for the Environment: An Extracurricular Perspective

Scientific education focused on the environment has the "environment" as its object, often from an anthropocentric and/or sociocentric perspective of security or improvement of living conditions. The goal is to learn "to solve and prevent environmental problems, as well as to manage collective resources. The environment becomes an end in itself" (Santana & Araújo, 2021).

According to Santana and Araújo (2021, p. 02),

> When we think and seek greater scientific and technological development for the country, we need to reflect intensely on how to prepare our citizens to live, coexist and actively participate in this development process. For this, we can seek means and strategies aimed at a more critical scientific education for the environment for society as a whole, considering that the main way for this search is through a quality science education.

The Ministry of Education (MEC), recognizing the need to overcome disciplinary teachings, has always emphasized that the integration of environmental education into the school system should occur "through the

realization of projects that combine action and reflection, transcending the traditional framework of learning and often requiring outings outside school premises" (Silva & Campos, 2018).

Silva and Campos (2018, p. 02) highlight that "Science teaching can make use of activities that value the environmental and social context, with a view to teaching through the observation of the place, the surroundings where we live, roles that dialogue with field classes."

In Brazil, it is observed that most scientific education projects aimed at the environment are based on an interdisciplinary approach, with this trend being more evident in high school. However, it is important to criticize that a significant part of these works adopts a positivist perspective and does not mobilize or transfer knowledge acquired in various school subjects, which would hinder the understanding of the close links between ecological dimensions and cultural, economic, political and social aspects of contemporary issues (Brasil, 2018).

Authors such as Compiani (2015) and Silva and Campos (2017) agree that the use of non-formal spaces as complementary to formal spaces can help break with traditional teaching and provide, through interdisciplinary practices, the construction of values, knowledge and sociability in the study of the Earth System.

Field classes, for example, can become an effective strategy to bring students closer to scientific practice. Indeed, the focus is often on encouraging students to take "good actions" for the benefit of the environment. However, it is important to note that initiatives aligned with the social criticism movement are progressively emerging (Compiani, 2015).

It is noteworthy that some of these projects emphasize the notions of debate and conflicts of interest, thus initiating the learning of participatory democracy and the understanding that the environmental crisis is, above all, a social crisis of use and representations.

3.4 Scientific Education for the Environment with a Focus on Cooperative Approaches

The cooperative approach (CA) is a collective initiative characterized by "cooperation in learning, for and through cooperation in action. It involves learning from one another, where students and teachers ideally become co-managers of the pedagogical situation" (Bello, Capellini & Ribeiro, 2018).

CA can be formally understood as a teaching method or strategy based on social interaction, which involves the use of small groups, allowing members to work together to maximize their own learning and that of their peers. It entails structured group work, often heterogeneous, so that all students interact, exchange information, and can be individually assessed for their contributions (Bello, Capellini & Ribeiro, 2018).

This approach is based on the idea that resolving the socio-environmental crisis requires more collective engagement than individual effort. Later, we will demonstrate why we consider this cooperative approach a relevant strategy for introducing meaningful Education for Sustainable Development (ESD) in schools (Hencke & Silva, 2022).

According to Hencke and Silva (2022, p. 03):

> The notion of development implies a progressive, linear, and continuous transformation that encompasses both the economy and society, highlighting the need to increase productive potential and ensure fair opportunities for all social individuals. This ideal permeates school contexts and underpins the proposal for an educational process that forms and manages projects aimed at the individual and collective construction of a sustainable life, both environmentally and economically.

However, before delving deeper into the understanding of this cooperative approach, it is important to briefly present its main pedagogical and epistemological assumptions. The cooperative approach is situated within the social critique movement, which aims to promote engagement in action based on collective investigations to improve the physical and social environment.

In the literature, we identify four essential elements for genuine cooperation to occur, corresponding to the basic assumptions of CA: accountability, promoting interaction, group processing, and social skills. The absence of any of these elements compromises the productivity and effectiveness of Learning Groups/Cooperative Approaches. Thus, we can assert that without one of these assumptions, there is no CA (Silva & Campos, 2018; Reis, 2011).

By prioritizing the collective dimension of learning and action, the cooperative approach aligns with the epistemology of social constructivism, which opposes, among others, behaviorism and cognitivism, emphasizing "the predominant importance of social and cultural interactions in learning mechanisms," that is, the role of social interactions among students in the development of intelligence in general (Viana et al., 2023).

Viana et al. (2023, p. 03) state that "the socioconstructivist approach favors the learning process through thinking, critical action, the exchange of experiences, and various forms of knowledge among the subjects involved in this process."

This stance is widely supported in the field of environmental education, especially by those who view the environmental crisis as a social construction issue, recognizing that social interactions are a fundamental causal agent (Rocha and Viveiro, 2016).

Rocha and Viveiro (2016, p. 07) assert that "the interaction of the cooperative approach with environmental education provides favorable conditions for creating environments conducive to the development of critical thinking whenever possible."

As described, the cooperative approach also aligns with the notion of a learning community, defined as a group of individuals, voluntary members, who share values and interests, organizing around a concrete project and constructing a learning process in an interdisciplinary context, complementing contextualized knowledge. In the cooperative approach, the focus is not on individual competencies and behaviors; rather, the environment is viewed as a shared object in a collective process of learning and problem-solving.

Rocha et al. (2019, p. 07) state that

> CA, within a perspective of scientific education aimed at the environment, can positively influence the constitution of individuals, as well as their learning and thought processes (intrapsychological), which occur mediated by relationships with others (interpsychological processes). CA and scientific education generate reference models that underpin our behaviors and reasoning, as well as the meanings we attribute to things and people.

The cooperative approach breaks with the classical model that associates knowledge with behavior change. Another characteristic of this approach is the involvement not only of students but also of adults in the educational community, both in learning and in action. This last point seems especially important, particularly at the primary education level: the cooperative approach raises the question of each individual's role and responsibility, without requiring students to solve adult problems, as has often occurred in many environmental education initiatives and as suggested by some discourses on education for sustainable development (Rocha et al., 2019).

According to Oliveira, Santos & Lima (2023), Education for Sustainable Development (ESD) would benefit from adopting the notion of differentiated development. In this way, we could reflect on a differentiated development concerning its object, space, and time, to establish priorities based on needs and the quality of productions, allowing growth for the poorest while slowing it down for the wealthiest.

Society has reached a point where it is necessary to stop deluding itself: the development needed for the poorest implies renouncing the unlimited development of the rich, considering the planet's limits. The cooperative approach, in turn, favors the development of endogenous projects chosen and constructed by communities and societies (Oliveira, Santos & Lima, 2023).

It suggests that the environmental crisis is a crisis of use and representations, meaning that there is no single solution or correct type of development, but rather the need to seek compromises that take into account values, academic knowledge confronted with uncertainties, risk management, experiential, vernacular, and popular knowledge, as well as the social representations of various stakeholders, etc. (Souza et al., 2024).

According to Souza et al. (2024), the connection between the environmental crisis and the cooperative approach is based on the understanding that the crisis is not merely a resource management problem but also involves issues of use and social representations. The cooperative approach suggests that instead of seeking a single correct solution, it is essential to engage communities in collective processes of learning and action, where different perspectives, values, and knowledge are considered to achieve sustainable compromises.

As discussed, scientific education focused on the environment (with an emphasis on environmental education) must currently integrate into the perspective of sustainable development, seeking to prioritize rational educational practices that do not restrict themselves to limited pedagogical proposals.

3.5 Scientific Education and the Adoption of an Ecosystemic Approach

In the past decade, the ecosystemic approach has gained prominence due to the increasing environmental challenges we face. Although this approach has been advocated by various international organizations for a long time, many governmental decision-makers and corporations still believed that technologies could solve all our problems (Long, Charles & Stephenson, 2015).

Silva (2019, p. 18) provides a definition of the ecosystemic approach with which we concur:

> [...] in general terms, this approach is a tool that integrates terrestrial and aquatic environments and living resources, as well as the processes, functions, and interactions between living beings and the environment, with the ecosystem as the basic unit. It also considers humans as one of the components of the ecosystem, which influences it and receives services, taking into account the cultural, economic, and social elements that influence this relationship.

The ecosystem-based adaptation approach recognizes that a healthy and resilient ecosystem performs essential functions and provides effective ecosystem services, allowing for human survival. Generally, a healthy ecosystem is more diverse and complex in its structure, which gives it the capacity to withstand and even regenerate efficiently after extreme events, such as heavy rainfall or major storms. Through its diversity, the ecosystem can perform various complementary functions, some of which may support others that are affected by climatic events (Araújo, 2018).

Numerous studies have demonstrated the importance of ecosystem services that encompass the use of specific ecosystemic approaches in local communities. This is evident in mangroves, which function as buffer zones against storms. The health of these ecosystems allows adjacent local populations to be less impacted during major storms. For instance, it has been observed that a healthy mangrove area can significantly reduce the number of fatalities during extreme weather events (Long, Charles & Stephenson, 2015).

The ecosystemic approach is directly linked to sustainable development, as it allows for the generation or assurance of socioeconomic benefits, such as shrimp and crab fishing and timber production in mangroves, while also providing protection against storms (Long, Charles & Stephenson, 2015).

The destruction of mangroves for large-scale commercial shrimp farming or residential developments (as is the case with salt marshes and floodplains near rivers) destroys this buffer zone and considerably increases the likelihood of severe consequences for coastal communities (Small; Munday & Durance, 2017).

Therefore, it is clear that the ecosystemic approach has become an essential strategy for many communities, especially those that depend on natural resources for their development and survival. It is understood that this strategy should be strongly favored if Brazil's educational policies value scientific education in and for the environment.

IV. DISCUSSION AND CONCLUSION

The present article sought to understand how an adisciplinary approach can innovatively integrate scientific and environmental education. Drawing from a theoretical foundation that addressed topics such as adisciplinarity in scientific education, curricular transversality in environmental education, the extracurricular dimension of scientific education focused on the environment, cooperative approaches, and the ecosystemic perspective, it was possible to construct a comprehensive analysis of this theme.

The research conducted, of a qualitative nature and employing bibliographic research procedures, allowed for the achievement of predetermined objectives, highlighting that the integration of scientific and environmental education through an adisciplinary approach is not only possible but necessary to promote citizenship and sustainability education.

It became clear that adopting a holistic perspective, which relates humans, nature, and the universe, is fundamental to addressing contemporary socio-environmental challenges. In this sense, the research points to the importance of formulating a critical and innovative scientific and environmental education, both in formal and non-formal contexts, that encourages the development of values, behaviors, and a global and interdisciplinary view of environmental issues. Furthermore, the adoption of a cooperative approach and an ecosystemic focus proves promising for engaging students in collective processes of learning and action aimed at sustainability.

As a suggestion for future research, it is recommended to investigate more deeply the teaching practices that integrate scientific and environmental education, seeking to understand the challenges and potentials of this adisciplinary approach in specific educational contexts. It is also necessary to analyze how this integration has been addressed (or not) in public policies and curricular documents, in order to support the formulation of guidelines that favor the adoption of this innovative perspective.

In summary, this article contributes to highlighting the relevance of considering scientific and environmental education in an integrated and adisciplinary manner, breaking away from fragmented and decontextualized models. It is hoped that its reflections can inspire educators, researchers, and policymakers in the construction of educational practices and policies aligned with the principles of sustainability and planetary citizenship.

REFERENCES

[1] Andrade, M. C. P., & Piccinini, C. L. (2017). Environmental education in the National Common Curricular Base: setbacks and contradictions and the erasure of socio-environmental debate. In Electronic Proceedings of IX EPEA (pp. 1-13). Federal University of Juiz de Fora. http://epea.tmp.br/epea2017_anais/pdfs/plenary/0091.pdf.

[2] Araújo, F. C. B. (2018). Challenges to adopting the ecosystemic approach as a legal instrument for marine resource management in the Brazilian coastal zone. In C. C. de Oliveira et al. (Eds.), Marine environment and law: sustainable management of the investigation, exploitation, and extraction of marine resources in the Coastal Zone, the continental shelf, and the seabed. (p. 87). Juruá.

[3] Barros, M. I. A. de, & Menezes, P. M. de. (2018). De-pareding childhood: the school as a place to encounter nature. (2nd ed.). Alana and Child and Nature Program.

[4] Behrend, D. M., Cousin, C. S., & Galiazzi, M. C. (2018). National Common Curricular Base: what is shown as reference to environmental education? Environment & Education, 23(2), 74-89. https://periodicos.furg.br/ambeduc/article/view/8425/5469.

[5] Bello, M. M. S., Capellini, V. L. M. F., & Ribeiro, J. A. G. (2018). Cooperative learning in the Brazilian academic educational scenario. Nuances: Studies on Education, 29(1), 239-256. https://doi.org/10.32930/nuances.v29i1.5472.

[6] Brazil, Ministry of Education. (2018). National Common Curricular Base. http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518_versaofinal_site.pdf.

[7] Compiani, M. (2015). For a critical pedagogy of place/environment in the teaching of geosciences and environmental education. In D. L. C. Bacci (Ed.), Geosciences and environmental education. (Chap. 4). Ponto Vital. http://www.academia.edu/31379250/Por_uma_pedagogia_cr%C3%ADtica_do_lugar_ambiente_no_ensino_de_Geoci%C3%AAncias_e_na_Educa%C3%A7%C3%A3o_Ambiental.

[8] Costa Júnior, J. F., Moraes, L. S., Souza, M. M. N. de, Lopes, L. C., Meneses, A. R., Pontes Pinto, A. R. de A., Santos, L. S. R., & Zocolotto, A. (2023). The importance of a positive and effective learning environment for students. REBENA Brazilian Journal of Teaching and Learning, 6, 324-341. https://doi.org/10.33448/rsd-v8i8.1262.

[9] Cidreira-Neto, I. R. G., & Rodrigues, G. G. (2017). Man-nature relationship and the limits for sustainable development. Social Movements and Spatial Dynamics Journal, 6(2), 142-156. https://doi.org/10.22633/rpge.v25iesp.7.16152.

[10] Denzin, N. K., & Lincoln, Y. S. (2018). The qualitative research plan: theories and approaches (10th ed.). Artmed.

[11] Ferreira, L., Pires, P. G., & Nápolis, P. (2021). Environmental education and sustainability: conceptual changes of future natural sciences teachers. REMEA - Electronic Journal of the Master's Program in Environmental Education, 38(1), 50-71. https://doi.org/10.14295/remea.v38i1.11885.

[12] Gil, A. C. (2019). How to develop research projects. (6th ed.). Atlas.

[13] Hachler, K. R. (2022). De-pareding childhoods: possible relations with school physical education and early childhood education. Undergraduate Thesis, Federal University of Rio Grande do Sul.

[14] Long, R., Charles, A., & Stephenson, R. L. (2015). Key principles of marine ecosystem-based management. Marine Policy, 57, 53-60. https://doi.org/10.1016/j.marpol.2015.03.017.

[15] Martins, P., Silva, A. C., Maneschy, D. M., Sánchez, C., Ambivero, M. C., & Lopes, A. F. (2019). Critical environmental education, from theory to school practice: analysis of a project experience in the context of a public school in Rio de Janeiro. Brazilian Journal of Environmental Education, 14(2), 86-102. https://doi.org/10.34024/revbea.2019.v14.2683.

[16] Martins, P. de C., et al. (2021). School environmental education from agroecology and permaculture: the experience of the Permacultural School project. Development and Environment, 58, 334-350. https://doi.org/10.5380/dma.v58i0.72551.

[17] Mota, N. F., Chaves, L. O., Sales, N. F., & Sousa, G. P. (2017). Considerations on environmental education, agricultural practices, and agroecology. In: Environmental education, agricultural practices, and agroecology (pp. 167). UERN Editions.

[18] Oliveira, A. S. de, Santos, L. J. O. G. dos, & Lima, T. C. S. (2023). Environmental education in national parks: possibilities for a critical perspective. Multidisciplinary Scientific Journal of Knowledge Core, 8(4), 51-66. https://doi.org/10.32749/nucleodoconhecimento.com.br/educacao/parques-nacionais.

[19] Santana, D. B., & Araújo, M. L. F. (2021). Scientific education and environmental education: approaches in teaching practice. Electronic Journal of Science Teaching, 20(1), 26-48.

[20] Reis, P. R. (2011). Group work management: induction and teacher professional development. University of Aveiro.

[21] Rocha, P. N., & Viveiro, A. A. (2016). Critical environmental education promoted through cooperative learning. SBEnBio Journal, 9.

[22] Rocha, P. C. da S., Souto, R. N., Jucá, S. C. S., & Silva, S. A. da. (2019). Case study on cooperative learning in a state school of professional education in Pentecoste-CE. Research, Society and Development, 8(8), e48881262. https://doi.org/10.33448/rsd-v8i8.1262.

[23] Small, N., Munday, M., & Durance, I. (2017). The challenge of valuing ecosystem services that have no material benefits. Global Environmental Change, 44, 57–67. https://doi.org/10.1016/j.gloenvcha.2017.03.007.

[24] Silva, M. S., & Campos, C. R. P. (2017). Investigative activities in the training of science teachers: a field class at Formação Barreiras de Marataízes, ES. Science and Education, 23(3), 775-793. http://www.scielo.br/pdf/ciedu/v23n3/1516-7313-ciedu-23-03-0775.pdf.

[25] Silva, M. S., & Campos, C. R. P. (2018). Field classes for scientific literacy: a pedagogical intervention at Fonte Grande State Park (Vitória/ES). Images of Education, 8(2), e41740. https://doi.org/10.4025/imagenseduc.v8i2.41740.

[26] Silva, A. C. M. (2019). For an ecosystemic approach to environmental civil liability: an analysis based on cases of marine pollution from land-based sources. (Master's Thesis). Postgraduate Program in Law at the University of Brasília - UnB.

[27] Souza, P. K. C., Oliveira, A. F. de, Chagas, J. da C., Erazo, R. de L., & Ferreira, R. G. da S. (2024). Jigsaw: a cooperative proposal for environmental education in Manaus-AM. Brazilian Journal of Development, 10(3), e67861. https://doi.org/10.34117/bjdv10n3-021.

[28] Ushakova, S. V., Baryshnikova, V. A., Srybnaya, M. A., & Shabalina, E. A. (2021). Museum education and regional identity formation. RPGE– Online Journal of Educational Policy and Management, 25(special issue 7), 3960-3972. https://doi.org/10.22633/rpge.v25iesp.7.16152.

[29] Viana, A. F., Reis, B. C. D., Costa, P. A., & Santos, M. C. (2023). The social constructivist approach and digital technologies. Conexão ComCiência Journal, 3(1), e8650. https://doi.org/10.32930/nuances.v29i1.5472.