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Environmental education and the impact of climate change on a local colombian ecosystem

Educación ambiental e impacto del cambio climático en un ecosistema local colombiano

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ABSTRACT

The objective of the research is to analyse environmental education and the impact of climate change in a local Colombian ecosystem focused on the San Antonio Educational Institution, located in the municipality of Villa del Rosario, Norte de Santander in Colombia. Methodologically, it was approached from the qualitative approach and interpretative paradigm through a phenomenological research in 03 research subjects. The importance of connecting the curricular contents with the local environmental reality is highlighted, promoting citizen, scientific and critical competences that allow students to understand and act in the face of the challenges of climate change. In this sense, categories were identified such as: i) the relationship between the curriculum and environmental culture, ii) competences related to environmental training, iii) didactic strategies for the inclusion of environmental culture, iv) educational contents oriented towards environmental sustainability and v) proposals for a critical-constructive didactics.
Descriptors: environmental sciences; ecosystems; environmental education. (Source: UNESCO Thesaurus).

RESUMEN

Se presenta como objetivo de investigación analizar la educación ambiental e impacto del cambio climático en un ecosistema local colombiano focalizado en la Institución Educativa San Antonio, ubicada en el municipio de Villa del Rosario, Norte de Santander en Colombia. Metodológicamente se planteó desde el enfoque cualitativo y paradigma interpretativo mediante una investigación fenomenológica en 03 sujetos de investigación. Se destaca la importancia de conectar los contenidos curriculares con la realidad ambiental local, promoviendo competencias ciudadanas, científicas y críticas que permitan a los estudiantes comprender y actuar frente a los desafíos del cambio climático. En este sentido, se identificaron categorías como: i) la relación entre el plan de estudios y la cultura ambiental, ii) las competencias relacionadas con la formación ambiental, iii) las estrategias didácticas para la inclusión de la cultura ambiental, iv) los contenidos educativos orientados a la sostenibilidad ambiental y las v) propuestas para una didáctica crítico-constructiva.
Descriptores: ciencias ambientales; ecosistema; educación ambiental. (Fuente: Tesauro UNESCO).

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Research articles section

INTRODUCTION

Climate change represents one of the greatest contemporary challenges, not only because of its devastating effects on ecosystems, but also because of the social, economic and cultural implications it generates. In Colombia, a country with exceptional natural wealth, the impacts of climate change are especially visible in local ecosystems, where communities face phenomena such as the loss of biodiversity, the degradation of natural resources and the alteration of climate cycles. In this context, environmental education is based on a pedagogical proposal to form critical citizens, aware of and committed to sustainability, capable of understanding the complexity of environmental problems and acting accordingly.

From a pedagogical perspective, environmental education not only seeks to transmit knowledge about the environment, but also to develop competencies, values and attitudes that allow students to actively participate in the construction of solutions to environmental challenges. In this sense, the school becomes a privileged space for the formation of environmentally responsible citizenship, by integrating processes of reflection, critical analysis and transformative action into its educational practices. In this particular case study, the San Antonio Educational Institution, located in the municipality of Villa del Rosario, Norte de Santander in Colombia, is a scenario for exploring how environmental education can contribute to mitigating the effects of climate change in a local ecosystem. This municipality, located in a border region and characterised by its ecological diversity, faces complex environmental problems that require a comprehensive and contextualised educational approach.

Thus, activating environmental education from a transformative pedagogical perspective demands an educational response that transcends the mere transmission of information and promotes meaningful and transformative learning. Amaya-Corredor et al. (2020) and Hurtado-Loaiza (2024) have highlighted the importance of incorporating environmental education into school curricula, not only as a thematic content, but as a cross-cutting theme that articulates the different areas of knowledge. In the Colombian case, authors such as Flórez-Yepes (2015) and Ortiz-Torres (2021) have pointed out that, although there is progress in the implementation of environmental education policies, there are still challenges related to teacher training, the availability of pedagogical resources and the connection between educational institutions and local communities.

However, despite the progress made, environmental education in Colombia faces important challenges. Carvajal-Suárez & Moreno-Flores (2023) highlight the need to integrate the environmental dimension into higher education curricula, promoting interdisciplinary training that allows environmental problems to be addressed comprehensively. Subía-Cabrera & Subía-Cabrera (2022) emphasise that environmental policies must be strengthened to guarantee the right to a healthy environment, while Escobar (2023) highlights the importance of environmental education in the formation of aware and responsible citizens in the face of the challenges of climate change.

In accordance with the above, the objective of this research is to analyse environmental education and the impact of climate change in a local Colombian ecosystem focused on the San Antonio Educational Institution, located in the municipality of Villa del Rosario, Norte de Santander in Colombia.

Theoretical reference

In Colombia, a country with a great natural wealth and diversity of ecosystems, environmental education not only seeks to raise awareness about the importance of caring for the environment, but also to train people who are committed to and responsible for their surroundings. This theoretical framework explores how environmental education can help mitigate and adapt to the effects of climate change, analysing its impact on local ecosystems and its integration into educational processes.

Environmental education

Environmental education is a comprehensive pedagogical process that seeks to form critical, responsible citizens committed to the sustainability of the environment. In the Colombian context, Flórez-Yepes (2015) points out that this education has evolved towards the incorporation of sustainable development in educational curricula, promoting a balance between theoretical learning and practical action, which allows students to understand the relationship between human beings and the environment, and to develop competences to face environmental challenges.

On the other hand, Peñata-Luna & Cuellar-López (2022) emphasise that, although significant progress has been made in the implementation of environmental education in Colombia, there are still challenges to be overcome in order to consolidate an ecological culture that will enable the effects of climate change to be tackled. In this sense, Ortiz-Torres (2021) indicates that the environmental education policy in the country is aligned with the Sustainable Development Goals (SDGs) of the 2030 Agenda, which reinforces its relevance in the training of global citizens with environmental awareness. From a transformative perspective, Hurtado-Loaiza (2024) proposes that environmental education in rural contexts should empower communities to become agents of change, which is complemented by the approach of Quintero-Ferrer & Solano-Peña (2023), who emphasise the importance of starting environmental education from early childhood, as this stage is crucial for the formation of values and attitudes towards care for the environment.

Local ecosystems and their relationship to education

Climate change is one of the greatest global challenges and has a direct impact on Colombia's strategic ecosystems, such as mangroves, moorlands and tropical forests. In this regard, Silva-Beleño, Bolívar & Jiménez-Pitre (2022) analyse the risks that climate change poses to the flora and fauna of mangroves in the Colombian Caribbean, highlighting the need to implement educational strategies that raise awareness among communities about the importance of conserving these ecosystems. In the educational field, Rodríguez-Pacheco, Mejía-Rodríguez & Sánchez-Buitrago (2021) explore the perceptions of university students on climate change, identifying that this phenomenon is seen as a critical threat to biodiversity and ecosystem services, this research highlights the importance of including climate change as a transversal axis in educational programmes, promoting a comprehensive understanding of environmental problems.

On the other hand, Molina-Orjuela, Chavarro-Ospina & Guzmán-Alvarado (2022) address the impacts of the Colombian armed conflict on the environment, highlighting how the degradation of local ecosystems can be mitigated through remediation actions that include environmental education as an essential component. Likewise, Menza-Ortega, Chapi-Chenas & Santander-Moreno (2024) analyse crimes against the environment and their relationship with the protection of environmental rights, highlighting the need to strengthen public policies and environmental education to prevent these crimes. While Amaya-Corredor et al. (2020) present a case study in Bucaramanga, where educational strategies were implemented to raise community awareness of the importance of climate change adaptation in urban environments, this type of pedagogical experience demonstrates how education can be a driver of change in building resilient communities.

Environmental education as a strategy

Environmental education is presented as a pedagogical tool to mitigate and adapt to the effects of climate change, in this order, Plata-Range & Ibáñez-Velandia (2020) highlight the relevance of environmental education in rural communities, where local knowledge and sustainable practices can contribute significantly to resilience in the face of climate change. Escobar (2023) emphasises the importance of strengthening environmental education in basic education, especially in vulnerable contexts, to ensure an adequate understanding of environmental problems and foster sustainable solutions.

From a broader perspective, Cardona-Castaño, Lamprea-Zona & Cubides-Suárez (2021) point out that it is necessary to build a deeper understanding of climate change from the classroom,

integrating scientific knowledge and local knowledge. This perspective is in line with the analysis of Prosser-Bravo, Arboleda-Ariza & Bonilla-Hevia (2020), who examine how education for climate change was addressed in the statements of the high segment of COP25, highlighting the importance of including environmental knowledge in international and local policies.

Environmental leadership and policy in education

Sustainable ecological leadership is an essential component for the preservation of local ecosystems and the promotion of effective environmental education. In this sense, Guanipa-Ramírez (2021) proposes a leadership that encourages the active participation of communities in environmental conservation, highlighting the importance of training leaders who can articulate educational and political actions to face environmental challenges.

In the field of public policy, Subía-Cabrera & Subía-Cabrera (2022) mention that environmental policies should guarantee the right to a healthy environment, while Rojas-Vélez & Londoño-Pineda (2016) suggest that environmental education should transcend traditional teaching, promoting the creation of sustainability networks that involve diverse social actors. These networks can be a bridge between communities, educational institutions and governments to implement effective environmental education strategies.

METHOD

From a methodological context, a qualitative approach and an interpretative paradigm were used through a phenomenological research with the intention of understanding and analysing the experiential perceptions on environmental education and the impact of climate change in a local Colombian ecosystem.

In terms of the geographical spatial context, the reference point was the San Antonio Educational Institution, located in the municipality of Villa del Rosario, Norte de Santander in Colombia.

The study population consisted of 3 key informants, constituted as research subjects, who contributed directly from their life and professional experience, important aspects to the subject of study, through the generation of an open interview, which were coded as follows:

DEP1 = Research subject 1

DEP2 = Research subject 2

DEP3 = Research subject 3

The interviews were recorded, transcribed and analysed through a process of thematic coding, which allowed for the identification of patterns and categories relevant to the study. The interviews were analysed through phenomenological reduction, supported by the technique of content analysis to scrutinise the fundamental aspects to be presented in the results section.

RESULTS

From the analysis of the interview, the results of the research were processed, firstly, the open coding is presented (table 1), to then present the axial coding (table 2), in this the categories and subcategories of research are highlighted as an essential product for the thematic analysis as a research product, in this sense, it is presented:

Table 1. Categorisation of observations on environmental culture.

Categories	Observation DP1	Observation DP2	Observation DP3
Teaching Environmental Culture	The main connection is articulated through the transversal PRAE project, which functions as a centralizing element.	It is crucial to raise students' awareness of the environmental challenges facing the planet. This approach aims to foster ecological sensitivity from early educational levels, forming committed citizens who value the conservation of the natural environment to ensure the well-being of current and future generations.	The connection between the Natural Sciences curriculum and environmental awareness is based on the analysis of ecosystems, populations, and natural balance. It examines how nature has maintained this balance and how human activities have destabilized it due to the lack of an adequate environmental culture.
Formative Competencies Evidenced (DBA, Curricular Guidelines, or Governing Documents)	Citizenship competencies and those related to science, technology, and society are promoted, aligned with the curricular standards defined for each educational level.	The Basic Learning Rights (DBA) define the knowledge and skills that students must master by the end of each academic year. They derive from curricular guidelines but are more detailed and adapted to each school grade.	The Natural Sciences curriculum is based on the Basic Standards of the area and seeks to develop skills such as explaining phenomena, understanding scientific knowledge, and the ability to inquire. These competencies encompass the biological environment, the physical environment, and the interaction between science, technology, and society.
Didactic Processes Related to the Inclusion of Environmental Culture	Didactic approaches vary depending on each teacher's perspective in their discipline, who apply pedagogical and methodological strategies in the exercise of their academic freedom.	Actions are implemented such as: - Promoting recycling and reusing materials. - Cleaning days in the institution and its surroundings with the collaboration of the educational community. - Workshops on environmental care, aimed at both the school and family environment.	Didactic strategies are developed through transversal projects, with an emphasis on the implementation of PRAE. Contents are oriented toward teaching the sustainability and conservation of natural resources.
Sustainability topics are directly addressed in the science, technology, and society component of the curriculum.	Participatory methods and practical activities can be used to connect the content with students' personal experiences.	Key topics are developed in the components of biological processes and science, technology, and society, integrating the analysis of ecosystems, populations, and the principles of PRAE. In grades 10 and 11, although the component of living processes is not directly addressed, it is incorporated transversally through PRAE.	
Contributions to an Environmental Culture Configured Toward Critical-	Addressing environmental problems from early education, such as preschool and	General didactics provide key pedagogical resources to structure teaching and learning, while specific didactics	The lack of environmental awareness is a constant challenge in the institutional context, particularly in communities with deficiencies

Constructive Didactics	primary school, is essential to strengthen learning in secondary and high school levels.	facilitate the design of strategies focused on optimizing this process.	such as lack of potable water and basic sanitation. To promote critical and constructive didactics, it is essential to include not only upper-grade students but also families, encouraging practices such as waste separation at home. This will help create sustainable habits and strengthen a culture of environmental respect.

Source: Own elaboration.

The analysis of the questions presented in Table 1 shows the importance of connecting the curriculum with the teaching of environmental culture, highlighting the key role of projects such as the PRAE and the educational guidelines in the development of environmental competences. It is fundamental that from the early stages of education an awareness of sustainability and care for the environment is fostered, integrating activities that involve both students and their families. There is also a clear need to strengthen pedagogical strategies that promote responsible and sustainable practices, adapted to the realities of each institution, in order to train people committed to caring for the planet and building a more balanced and sustainable future, and so the study categories are presented in table 2:

Table 2. Categories of study.

Contributions of Research Subjects	Category	Subcategories
DEP1: Relationship with the PRAE to raise awareness about environmental issues. DEP2: Focus on ecosystems and environmental balance. DEP3: Planet conservation through cross-curricular projects.	Relationship between the curriculum and environmental culture	- Cross-curricular projects (PRAE). - Early environmental awareness. - Human impact on environmental balance.
DEP1: Citizenship competencies and STS from curricular standards. DEP2: DBA as a guide to acquire specific knowledge and skills. DEP3: Enhancement of scientific competencies in the Natural Sciences area.	Competencies related to environmental education	- Citizenship competencies. - Science, technology, and society (STS). - Inquiry and explanation of phenomena.
DEP1: Freedom of teaching in the inclusion of environmental culture. DEP2: Practical activities such as recycling and cleaning. DEP3: Use of cross-curricular projects like PRAE.	Teaching strategies for the inclusion of environmental culture	- Freedom of teaching. - Practical activities (recycling, cleaning, talks). - Cross-curricular projects (PRAE).
DEP1: Explicit content in the STS component. DEP2: Participatory techniques and practical activities. DEP3: Focus on ecosystems and the cross-curricular nature of PRAE.	Educational content oriented toward environmental sustainability	- Science, technology, and society (STS). - Biological processes and ecosystems. - Cross-curricular nature of PRAE.
DEP1: Addressing environmental issues from early	Proposals for a critical-constructive didactic approach to	- Environmental awareness from childhood.

stages. DEP2: Use of general and specific pedagogical strategies. DEP3: Application of critical-constructive didactics from home.	environmental culture	- General and specific didactics. - Institutional and family context.

Source: Own elaboration.

From the categories presented in table 2, the contributions of the research subjects stand out, highlighting the importance of including environmental culture in the curriculum through projects such as the PRAE, which help to raise awareness from an early age and to reflect on the human impact on the balance of the planet. It also highlights the need to develop citizenship and scientific competences related to sustainability, based on the curriculum standards and focused on the enquiry and understanding of phenomena.

DISCUSSION

The integration of environmental culture into the curriculum requires a cross-cutting approach that allows environmental issues to be addressed from different areas of knowledge. Projects such as the PRAE (School Environmental Projects) are pedagogical tools that facilitate this cross-cutting approach by connecting curricular content with the environmental and social reality of the students. This type of project encourages reflection on the human impact on the balance of the planet and promotes the construction of environmental awareness from an early age. From a pedagogical perspective, transversality not only enriches learning, but also allows students to understand the complexity of environmental problems and their interrelation with other aspects of life. According to Flórez-Yepes (2015), environmental education should be an articulating axis of the curriculum, capable of integrating scientific, ethical and social knowledge to form citizens committed to sustainability.

The development of competences in the field of environmental education is essential for training citizens capable of understanding and acting in the face of environmental challenges. Among the most relevant competences are those related to citizenship, which promote active participation in the solution of environmental problems; those related to Science, Technology and Society (STS), which enable analysis of the impact of scientific and technological advances on the environment; and those of enquiry and explanation of phenomena, which develop scientific skills for researching and proposing solutions.

In the pedagogical context, these competences should be worked on through active methodologies that involve students in meaningful learning processes. Strategies such as project-based learning or scientific enquiry allow students to construct their knowledge in an autonomous and reflective manner, connecting curricular content with their environment and experiences. Cardona-Castaño et al. (2021) stress that these methodologies are fundamental for students to understand the implications of climate change and develop skills to face it from a critical and proactive perspective.

The inclusion of environmental culture in the educational process requires didactic strategies that allow teachers to adapt the contents to the needs and characteristics of the context. These strategies include teaching freedom, which gives teachers the flexibility to design activities and projects that respond to the realities of their students; practical activities, such as recycling, cleaning up public spaces and educational talks, which encourage experiential learning; and cross-cutting projects, such as the PRAE, which integrate different areas of knowledge to address environmental issues in a comprehensive manner. These strategies not only facilitate the teaching of environmental content, but also promote the active participation of students in solving real problems. Hurtado-Loaiza (2024) highlights that, in rural contexts, these strategies can be especially effective, as they connect learning with the specific needs and challenges of the community.

Educational content related to environmental sustainability should address topics such as Science, Technology and Society (STS), biological processes and ecosystems, and the transversality of the RESP. These contents not only seek to transmit scientific knowledge, but also to foster a critical and reflective vision of the relationship between human beings and the

environment. In this sense, interdisciplinarity becomes a key pedagogical principle, enabling students to understand the complexity of environmental problems and develop innovative solutions. In this sense, Ortiz-Torres (2021) points out that the inclusion of these contents in the curriculum is fundamental to form citizens committed to sustainability and capable of facing environmental challenges from an ethical and responsible perspective; these contents must be worked on in a contextualised manner, taking into account the characteristics and needs of the environment in which the educational process takes place.

Critical-constructive didactics is presented as a pedagogical approach that seeks to transform environmental education into a reflective and participatory process, which is based on the construction of environmental awareness from childhood, the adaptation of pedagogical strategies to the needs and characteristics of students, and the articulation between the institutional and family context. From this perspective, environmental education is not limited to the transmission of knowledge, but also seeks to empower students to become agents of change in their communities. In this way, Quintero-Ferrer & Solano-Peña (2023) emphasise that it is especially relevant in early childhood, as it lays the foundations for a citizenry committed to sustainability. Consequently, critical-constructive didactics promote the active participation of students in solving environmental problems, fostering the development of critical and creative skills that will enable them to face the challenges of the future.

CONCLUSION

The integration of environmental education into the curriculum, through strategies such as cross-curricular projects (PRAE), is essential for fostering an environmental culture from an early age. The importance of connecting curricular content with the local environmental reality is emphasised, promoting civic, scientific and critical competences that enable students to understand and act on the challenges of climate change. In this sense, the following categories were identified: i) the relationship between the curriculum and environmental culture, ii) competences related to environmental training, iii) teaching strategies for the inclusion of environmental culture, iv) educational content oriented towards environmental sustainability, and v) proposals for critical-constructive teaching. In the case of the San Antonio Educational Institution, the results highlight the need to address environmental issues from a contextualised approach, involving both the educational community and families, in order to consolidate meaningful learning and train citizens committed to preserving the environment and building a sustainable future.

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CONFLICT OF INTEREST

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