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Systematization of pedagogical experiences in early childhood: Critical and scientific thinking in rural and urban contexts in Colombia

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ABSTRACT

This article presents the systematization of experiences developed in the project "Strategy for the Generation of New Knowledge and the Promotion of Educational Innovation in Early Childhood and Preschool Education" of the Ondas Early Childhood program. The project aimed to strengthen critical and scientific thinking in children aged 4 to 6 years old attending public educational institutions in both rural and urban contexts of Colombia. Using a qualitative methodology based on action research and adopting a pedagogical research approach, the project involved students formulating research questions rooted in their environment and interests, which they investigated with teaching support. Seven teachers received support in designing, implementing, and reflecting on classroom projects centered on curiosity, observation, and children's questions. Data collection was conducted through logs, audiovisual recordings, semi-structured interviews, and pedagogical products created by the children. The findings indicate significant transformations in teaching practices, including increased didactic intentionality, question mediation, and formative assessment. Additionally, there was notable development in cognitive, ethical, and social skills, evidenced by the formulation of hypotheses, collaborative work, and situated argumentation. The emerging categories environmental, emotional, aesthetic, bodily, ethical-civic, and cognitive provide insights into children's thinking as a situated and relational process, interconnected with territories, affections, and sensory experiences. The study concludes that the Ondas methodology fosters innovative, critical, and contextualized education, with important implications for teacher training, curriculum-territory integration, and early childhood education policy.

Contribution/Originality: This study contributes to the existing literature by systematizing early childhood pedagogical experiences using the ONDAS methodology in both rural and urban Colombian contexts. It is one of the few studies demonstrating how young children act as epistemic subjects, integrating scientific, emotional, aesthetic, and territorial knowledge into a situated, research-based pedagogy.

1. INTRODUCTION

The development of critical and scientific thinking in early childhood has been prioritized in contemporary curricular frameworks and in the agendas of international organizations (OECD, 2020; UNESCO, 2022). This approach recognizes that children, from the earliest years, possess cognitive, communicative, and social capacities

that enable them to explore, ask questions, and construct explanations about their environment, provided they are in stimulating, democratic, and affective pedagogical contexts.

In Latin America, the challenges to implementing an education that fosters inquiry and participation in early childhood are numerous. This is especially true in rural and urban areas facing vulnerable situations, where unequal access to resources, curricular rigidity, and the devaluation of teachers' pedagogical knowledge limit the development of meaningful educational proposals (Díaz-Barriga, 2022; Ramírez & Parra, 2020). In this context, the proposal of the ONDAS program by the Ministry of Science of Colombia becomes relevant. It advocates for research as a pedagogical strategy, positioning the child as an epistemic subject and teachers as mediators of thought.

This study systematizes a training experience through a virtual diploma in Educational Innovation, derived from the project "Strategy for the Generation of New Knowledge and the Promotion of Educational Innovation in Early Childhood and Preschool Education." This project is financed by the Ministry of Science, Technology, and Innovation, the Ministry of National Education, and United Way. It is executed by the Autonomous University of Bucaramanga in partnership with the Autonomous University of Manizales, the University of Rosario, and the Colombian Observatory of Science and Technology.

Throughout the course, participants designed, implemented, and systematized classroom projects inspired by children's curiosity and environmental issues. These projects were developed under a pedagogical approach focused on critical thinking, dialogue of knowledge, and the transformation of the teaching role. For this study, seven significant experiences were selected for in-depth analysis.

The general objective of this research was to analyze how, based on the Ondas methodology, scientific and critical thinking processes are enhanced in children aged 4 to 6 years in rural and urban educational contexts. To this end, a qualitative approach using action research and systematization as methodological strategies was employed. These strategies are understood not only as narrative reconstruction but also as the production of situated knowledge (Jara, 2018). This article aims to contribute to debates on educational innovation, cognitive justice, and public policies in early education. It demonstrates how children's thinking can be activated, valued, and made visible through contextualized pedagogical practices.

2. THEORETICAL FRAMEWORK

2.1. Critical and Scientific Thinking in Early Childhood

For decades, the traditional view of child development limited critical and scientific thinking to later stages of the school cycle, underestimating the epistemic capacities of children in early childhood. However, recent research in neuropsychology, philosophy of education, and cognitive sciences has shown that, from an early age, children are able to formulate hypotheses, make causal inferences, and construct logical explanations based on observation and interaction with their environment (Ardila, Bernal, & Rosselli, 2021; Gopnik, 2020). These skills not only represent cognitive potential but also an ethical disposition towards questioning the world, which must be pedagogically stimulated to promote autonomy, argumentation, and critical reflection. In this process, critical thinking in childhood cannot be understood solely as a logical or verbal competence but as a form of relationship with knowledge and with others that integrates cognitive, emotional, and cultural dimensions. From a Latin American perspective, critical thinking is linked to processes of cognitive emancipation and epistemic justice, where children are recognized as subjects capable of interpreting and transforming their reality (Díaz-Barriga, 2022; Santos, 2021). Authors such as Lipman (1997) and Tonucci (1995) highlight the role of questioning, play, and dialogue as engines of children's thinking, as opposed to transmissive approaches that limit their cognitive agency.

2.2. Research as a Pedagogical Strategy in Early Childhood

The methodology of research as a pedagogical strategy (IEP) proposes a profound transformation of the pedagogical relationship, in which children are not conceived as passive recipients of content but as active epistemic

subjects capable of inquiring, experimenting, and constructing contextualized knowledge. This perspective has been systematized and promoted in Colombia by the Ondas program of the Ministry of Science, Technology, and Innovation, which promotes education based on children's curiosity, the formulation of relevant problems, and the collective construction of knowledge (Colciencias, 2018; Minciencias, 2023).

The implementation of IEP in early education has demonstrated positive effects on the development of fundamental scientific skills systematic observation, information recording, empirical validation, and socialized argumentation. Research such as that conducted by Siraj-Blatchford and Brock (2020) and Baroody (2021) indicates that when children engage in inquiry experiences guided by authentic questions, their logical thinking, cognitive self-regulation, and willingness to solve complex problems are enhanced. In this framework, the role of teachers is redefined: the current teacher acts as a mediator of thought, a co-researcher, and a reflective practitioner who plans instruction based on the real needs and interests of students (Camilloni, 2021; Ramírez & Parra, 2020).

2.3. Situated Education, Epistemic Diversity and Cognitive Justice

The paradigm of situated education is based on the approach that learning is a socially mediated process, in which the context, culture, and previous experiences of the subject are determinants. Under the thought of Freire (2021), he questions the technocratic conception of the curriculum and postulates a theory of the pedagogy of meaning in which the contents are emergent from the problems of the environment, local knowledge, and significant relationships. In Latin America, both in vulnerable rural and urban contexts, where diverse cultural practices, languages, and worldviews are mixed, situated education is presented as an "ethical alternative" to avoid the reproduction of inequalities (Reimers, 2023; Tarlau, 2020).

The concept of cognitive justice, developed by Santos (2021), is articulated with this perspective, seeking the recognition and questioning of Western epistemological domination. It aims to integrate ancestral, popular, and community knowledge into the construction of the curriculum. Within the framework of the Ondas program, this conception is operationalized through classroom projects that emerge from children's questions about their environment: the observation of iguanas, the use of medicinal plants, the exploration of water, or the customs of their community. By situating knowledge in the child's real experiences, a pedagogical space is created where scientific knowledge and everyday knowledge intersect, thereby strengthening the child's cognitive agency and cultural identity.

2.4. Systematization of Experiences as Situated Research

The systematization of experiences has been established in Latin America as an educational research methodology that enables the recovery, interpretation, and theorization from practice. Unlike traditional evaluative approaches, systematization does not aim to measure achievements or apply standards but rather to understand the processes experienced, the meanings constructed, and the pedagogical transformations that emerge in real contexts (Jara, 2018; Soto, 2022). This strategy is particularly relevant in regions where teaching knowledge has historically been undervalued, and where innovative practices are often rendered invisible by standardized regulatory frameworks.

In this research, systematization was employed as a method to generate situated knowledge through reflexive analysis of the pedagogical experiences of seven teachers participating in the ONDAS diploma program. By reviewing logs, conducting interviews, analyzing classroom products, and engaging in collective conversations, emerging categories were identified that facilitate understanding of how critical and scientific thinking processes are developed during childhood when teaching practices are redefined. This exercise not only contributes to educational innovation but also enriches Latin American pedagogical research from a decolonial and contextualized perspective.

3. METHODOLOGY

3.1. Approach and Type of Study

This study is based on a qualitative approach, with an interpretative and critical orientation. Its purpose is not to generalize findings but to understand in depth the experiences that teachers and children encounter in a specific educational context. It is a systematization of experiences, regarded as a situated pedagogical research strategy that enables the recovery, reconstruction, and critical analysis of processes developed in teaching practice (Jara, 2018; Soto, 2022). The systematization was conceived not as an evaluative closure of the training process but as a means of producing reflective knowledge about the experience of implementing the ONDAS methodology. The methodological design is based on the principles of action research, since the participating teachers were not merely objects of study but co-authors of the research process, actively involved in the collection, analysis, and interpretation of the information generated in their classrooms.

3.2. Participants and Context

The experience was developed within the framework of the Diploma in Educational Innovation of the Ondas program (Minciencias, 2023), aimed at early childhood education teachers in Colombia. For this study, seven significant experiences of teachers belonging to official educational institutions in the departments of Meta, in the Colombian Orinoquía region, and Santander, in the northeastern Andean region of the country, were systematized. In total, nine institutions participated, as some teachers implemented more than one project in different locations. These institutions, located in both rural and urban contexts, demonstrated how the Ondas methodology adapts to diverse realities and engages with local knowledge and environmental issues. In the department of Meta, the María Montessori Educational Institution (Acacías, urban), the Marco Antonio Franco Rodríguez Educational Institution (Villavicencio, urban), the La Julia Educational Institution, La Chamuza campus (La Uribe, rural), the Nuestra Señora de la Paz Educational Institution, Nuevo Amanecer campus (Villavicencio, urban), the Villavicencio Higher Normal School (urban), and the Acacías Normal School (urban) participated. In the department of Santander, the Bosconia Educational Institution headquarters C (rural area), the Provenza Educational Institution (Bucaramanga, urban), and the Gabriel García Márquez Institute (Floridablanca, urban) were part of the experience. Children between 4 and 6 years of age participated in these institutions, where they were recognized as protagonists of research classroom projects formulated based on their own questions and interests. As part of the training process, each teacher designed and implemented a project based on the methodology of Research as a Pedagogical Strategy (IEP), aimed at strengthening critical and scientific thinking in early childhood. These projects were accompanied and refined throughout the diploma course through synchronous spaces for training, methodological advice, and collective reflection. The systematization of these experiences was not approached as a final technical task but as a continuous process of critical analysis, which allowed for the recovery of learning, resignifying practices, and building knowledge situated from the teaching experience. The territories in which the experience took place are characterized by their cultural, linguistic, and ecological diversity, which made it possible to observe how the methodology adapts to heterogeneous realities, dialoguing with local knowledge and environmental problems. This diversity enriched the analysis by evidencing common patterns and significant variations in the forms of implementation.

3.3. Information Collection Techniques and Instruments

For the construction of the units of analysis, multiple sources of qualitative information were used, collected during the process of implementing the diploma course and classroom projects, such as:

- Teacher logs: systematic records written by teachers during the development of their projects, where observations, reflections, achievements, and difficulties are recorded.

- Semi-structured interviews, conducted at the conclusion of the process, enabled us to gain a deeper understanding of teachers' perceptions of the experience. These interviews provided insights into the pedagogical transformations that occurred and the observed impact on the children.
- Pedagogical portfolios: compilations of documentary and visual evidence (drawings, photographs, videos, classroom products) produced by children and teachers during project development. In the process of systematization, teachers collected field diaries and artistic expressions created by children. These records included drawings, collages, and graphic representations that, beyond being simple artistic activities, served as means to capture hypotheses, observations, and reflections on their environment. In addition to answering guiding questions related to knowledge, these productions enabled children to contextualize the realities of their environment and generate new learning. Through these, participants represented natural phenomena such as the water cycle or insect behavior and expressed emotions associated with their investigations. This demonstrated the power of the Ondas methodology to integrate scientific thinking, aesthetic sensitivity, and the construction of meaning in early childhood.
- Collective analysis sessions are synchronous virtual spaces where teachers share findings, learning, and reinterpretations of their practice, which are documented in reports. These sessions serve not only as platforms for exchange but also as processes for the collective construction of knowledge. During these sessions, teachers compare experiences, validate interpretations, and enhance their critical perspective on pedagogical work.
- Appendix A presents examples of classroom projects, activities, and evidence collected during the implementation of the ONDAS methodology in both rural and urban contexts.

3.4. Analysis Strategies

The analysis was conducted through a process of open coding and emergent categorization, following Grounded Theory techniques. Initially, units of meaning were identified from logs and interviews. Subsequently, they were grouped into inductive categories that allowed the findings to be organized around six key dimensions: environmental, emotional, aesthetic, bodily, ethical-civic, and cognitive.

The analysis was iterative and participatory, as each category was validated during collective meetings with the participating teachers to ensure that the constructed meanings were shared and appropriately contextualized.

4. RESULTS

The systematizations conducted by the seven participating teachers enabled us to identify six recurring dimensions in their transformed pedagogical practices: emotional, aesthetic, cognitive, ethical-citizen, corporal, and environmental. These dimensions did not arise as imposed categories; rather, they emerged organically from the reflective process encouraged by the teachers, which was based on the children's questions and the redefinition of their practices. Subsequently, a synthesis is provided that highlights the frequency of appearance and the level of prominence of these dimensions, as evidenced in their narratives, projects, and systematization products.

Table 1. Frequency and prominence of pedagogical dimensions in teaching systematizations.

Pedagogical dimension	Presence (N=7)	Level of prominence declared by the teachers	Representative example
Emotional	7/7	Loud	Emotional regulation in cooperative play situations.
Cognitive	7/7	Loud	Formulation of hypotheses about natural phenomena.
Aesthetics	6/7	Stocking	Artistic production as a language of inquiry.
Ethical-citizen	6/7	Loud	Questions about social norms and school coexistence.
Bodily	5/7	Stocking	Use of the body in spatial and sensory explorations.
Environmental	6/7	Loud	Projects related to animals, plants, and environmental care.

Source: The systematization of the ONDAS program (2024).

As observed in Table 1, the emotional and cognitive dimensions were present across all experiences and were regarded by teachers as fundamental axes of pedagogical change. These dimensions were often linked to processes such as self-regulation, hypothesis formulation, investigative curiosity, and active participation by children. Conversely, the body dimension, although important, held less prominence in some systematizations, which suggests an opportunity to enhance motor exploration practices and sensory integration in future educational strategies.

The analysis of the systematized experiences allowed us to identify six emerging categories that capture the pedagogical, cognitive, emotional, and ethical effects generated in children during the implementation of research projects in the classroom. Each category represents a significant dimension of transformation, both in teaching practice and in children's ways of learning and thinking. These categories are presented below based on the evidence collected in logs, interviews, pedagogical portfolios, and collective reflection sessions among the participating teachers.

4.1. Environmental Dimension: Situated Knowledge and Ecological Awareness

The environmental dimension became prominent in projects initiated by children's concern for their natural surroundings. Teacher Claudia, from a rural school in Sucre, recounted how a group of children wanted to "investigate why the iguanas were increasingly moving away from the playground." This inquiry led to a process involving systematic observation, hypothesis formulation, and visits to the nearby ecosystem. The children documented their observations through drawings, developed hypotheses regarding noise and tree felling, and promoted environmental conservation actions among their families.

For her part, teacher Luz Marina, from a peri-urban area of Meta, guided a project on "water from the pipe that smells bad," which allowed the children to explore causes of pollution, design rudimentary filters, and socialize proposals with the community. In both cases, scientific knowledge emerged from a direct relationship with the territory, validating the idea of situated scientific literacy (Siraj-Blatchford & Brock, 2020) and promoting early ecological awareness as a form of active citizenship.

With these experiences, it is evident that critical thinking in childhood can be linked to environmental education from both a critical and an affective perspective. It is not solely about understanding nature but also about caring for it, guided by the ethics of the territory and of life.

4.2. Emotional Dimension: Bonding Pedagogy and Self-Regulation

In the execution of the projects, a strong emotional involvement of children and teachers was observed. The inquiry process not only activated curiosity but also emotions such as surprise, fear, frustration, or joy. Teacher Diana, in the department of Cauca, developed a project based on a girl's fear of crickets. This fear was shared by other colleagues and became a collective question: "Why do crickets make that noise?" Through dramatizations, stories, and observations, the children redefined their fear and began to see the cricket as an interesting being, necessary for the ecosystem.

From the perspective of developmental psychology, these experiences are fundamental for the construction of emotional self-regulation, a key executive function in early childhood (Ardila et al., 2021). Additionally, teachers recognized that spaces for dialogue enabled them to identify children's emotional states and develop pedagogical strategies to support them. The pedagogy of bonding centered on empathy, respect, and trust was reinforced by valuing emotional expression as an integral part of the learning process.

4.3. Aesthetic Dimension: Sensible Thought and Symbolic Representation

The aesthetic dimension permeated all the projects. Artistic productions such as drawings, collages, models, and dramatizations were not used as "filler activities" but served as essential tools for representing knowledge, communicating findings, and exploring emotions. Teacher Veronica, in the Nariño department, utilized drawing as a

daily resource for recording observations: each child illustrated what they had observed or understood during the day. These drawings became cognitive maps of the children's thinking, enabling the teacher to reconstruct the logical and affective pathways of the research process. In another instance, sound mapping of nature was employed, as mentioned by one of the teachers during the pedagogical accompaniment interview.

"Today, Maria asked why the river sounds louder when it rains. We decided to go for a walk and measure the riverbed. The children proposed recording the sounds with their cell phones. I had never thought of investigating water like this...."

Aesthetic representation makes it possible to visualize dimensions of thought that do not always emerge in verbal language. According to Díaz-Barriga (2022), in early childhood, artistic expression is a legitimate way of thinking and knowing, as it combines image, emotion, and narration. This dimension enhances sensitive thinking and articulates cognitive processes with sensory experiences, which is key in critical pedagogies that recognize the body and emotion as languages of learning.

4.4. Body Dimension: Sensory Experience and Thought in Action

The body was an active protagonist in all the research processes. During activities such as observation outings, exploratory walks in the environment, role plays, dramatizations, and collective constructions, children engaged their motor skills as the primary means of acquiring knowledge. The project led by teacher Yazmin, developed within an indigenous community in Tolima, involved three observed procedures: 1. Direct observation of anthills in the forest; 2. Measuring the distance between two trees using steps: 3. Modeling animal movement patterns in the classroom. These actions interconnected perception, action, and representation, facilitating the development of inferences based on situated evidence.

The pedagogical coherence of the proposal is based on contributions from neuroeducation that associate movement, exploration, and play with the activation of circuits involved in attention, memory, and motivation (Gopnik, 2020). Consequently, the body is recognized as a cognitive device and not just an expressive one, contrasting with school practices focused on abstract and decontextualized processing. This perspective promotes transferable learning by encouraging, in real contexts, processes such as measurement, comparison, categorization, and argumentation.

4.5. Ethical-Civic Dimension: Collective Thinking and Care for Others

In several projects, reflections on rules of coexistence, collective responsibility, and mutual care spontaneously emerged. Teacher Maritza, in an urban neighborhood of Cartagena, guided a project on "noise at recess," from which the children identified how excessive shouting affected classmates with auditory hypersensitivity. Based on surveys, observations, and debates, the children designed a "sound traffic light" that allowed them to self-regulate the volume in the classroom.

These experiences demonstrate how critical thinking can be integrated with ethical reasoning, even at an early age. The school thus becomes a space for citizenship education, where children learn to deliberate, argue, and build agreements based on differences. The ethical-citizen dimension is expressed here as an act of care for others and the environment, grounded in collective reflection and respect.

4.6. Cognitive Dimension: Thought Structures and Logical Processes

Finally, high-level cognitive processes were evidenced in all projects. The children asked relevant questions, classified objects, ordered temporal events, identified patterns, formulated hypotheses, and validated results. These processes were made possible thanks to the methodological guidance of the teachers, who knew how to guide without imposing, posed open questions without limiting meanings, and recorded without censoring. This systematization of questions can be seen in Table 2.

Table 2. Mapping children's questions.

No.	Student Code	Question asked	Context of the question	Type of thought involved
1	Girl 1	Will it be the cockroaches that eat the plants?	Garden Tour	Hypothetical-causal
2	Child 2	Do all insects feed on leaves?	Post-Scan Talk	Generalization/Categorization
3	Girl 3	What happens if insects eat all the leaves of a plant?	Observation of damage to plants in the garden	Projection / Logical Consequence
4	Child 4	Do worms eat leaves too?	Checking Sheets with Holes	Inquiry / Comparative
5	Child 5	Should we kill living beings?	Ethical reflection on spider-stepping behavior	Ethical/Evaluative
6	Girl 6	Are spiders living beings?	Group dialogue before the discovery of a spider	Classificatory / argumentative
7	Girl 7	Can I go explore?	School break time	Autonomous initiative / interest
8	Child 8	Can we visit the farm?	Spontaneous proposal during a conversation	Desire to expand the environment
9	Child 9	Teacher, come on, I'll show you a bug.	Free exploration during recess	Spontaneous observation

Teacher Tatiana, in Valle del Cauca, described how her students "went from asking why the sky is blue to drawing the water cycle and explaining it to their classmates." This transition evidences a process of conceptual construction guided by experience, in which empirical observation, logical inference, and symbolic representation were articulated. The findings support Gopnik (2020) and Siraj-Blatchford and Brock (2020): in early childhood, children explore the world as born scientists and can reach abstract thinking if they have an environment that feeds curiosity and respects their learning rhythms and times.

5. DISCUSSION

The results of this study demonstrate fundamental changes in the way early childhood education is understood, practiced, and experienced in vulnerable contexts in Colombia. It is not merely a matter of isolated learning; the observations indicate a structural shift across three interconnected levels. First, in pedagogical practice, where teachers transition from mechanical teaching routines to designing situated, dialogued, and evaluated experiences guided by formative criteria. Second, in the cognitive development of children, who no longer limit themselves to rote repetition; instead, they explore their environment, ask meaningful questions, compare observations, and defend their ideas through argumentation. Third, in curriculum conceptualization, which evolves from a fixed list of content to a dynamic, living fabric of situated knowledge that holds relevance for everyday life. Collectively, these transformations present a promising horizon for Latin American early childhood education, emphasizing the centrality of the subject, recognizing territorial knowledge, and democratizing the production of pedagogical knowledge.

5.1. Transformation of Teaching Practice: Towards A Reflective, Critical and Situated Pedagogy

One of the clearest findings was the change in the role of teachers from a primarily technical-administrative function to a critical pedagogical stance, where reflection, active listening, and open questioning become central. Rigid sequences were replaced by flexible sequences, taking into account the context, interests, and real concerns of the children. This view was not accidental; it was supported by situated training that helped teachers recognize themselves as subjects of knowledge and strengthen their creativity and professional ethics. A participant in the accompaniment interview summarized this transformation: "This process of systematization made me rediscover my vocation. I used to think that teaching was simply applying a guide. Today, I understand that educating involves accompanying questions. My children taught me to truly listen. Researching together has transformed us."

In line with Camilloni (2021), Jara (2018), and Freire (2021), teaching is understood as a research praxis built on reflective practice. Instead of applying active methodologies, the emphasis is on examining and reconstructing teaching practices collaboratively with colleagues, families, and students. This approach fosters greater professional autonomy, which is evident in pedagogical decisions grounded in systematic observation, collective analysis, and the revaluation of pedagogical knowledge.

5.2. Transformation of Children's Thinking: Childhood as An Epistemic Subject

The second level of transformation appears in the realm of children as active subjects of thought: they explore, formulate questions, contrast evidence, and sustain arguments with others, actively participating in the production of knowledge. In all the analyzed projects, there was evidence of a departure from the traditional approach that views childhood as a passive object of instruction. Conversely, children were recognized as active agents of knowledge, capable of observing, recording, classifying, formulating hypotheses, arguing, and critically reflecting on the world around them. This cognitive agency, often rendered invisible by normative school practices, emerged strongly when children were allowed to formulate their own questions, inquire about their environment, and build collective knowledge based on their genuine interests, as noted by one of the teachers in her teaching log.

"The children surprised me today with their question about 'why does the sun heat some houses more than others?' It was then that I understood that his observations went beyond the classroom. We designed an activity with homemade thermometers and natural shades. What emerged was incredible: the children formulated hypotheses with total freedom and tested them with the help of their families." (Fragment of log)

This view aligns with the approaches of Gopnik (2020), who demonstrates that children, from an early age, possess scientific thinking structures comparable to those of adults, although mediated by play, emotion, and sensory exploration. Additionally, Ardila et al. (2021) emphasize the importance of executive functions in childhood as a foundation for developing metacognitive, regulatory, and communicative skills. In this study, such skills were not artificially forced through exercises but organically enhanced within meaningful contexts of inquiry, dialogue, and collective creation. In this way, the research experience becomes a platform for the development of complex thinking in childhood, understood not only as a logical capacity but also as a way of viewing the world with depth, sensitivity, and an ethical sense.

5.3. Epistemological Transformation

In accordance with these epistemological transformations, a matrix was developed that articulates the dimensions identified in the systematization with the competencies of the national curriculum for initial education and the pedagogical approaches prioritized by the Ministry of Education. Table 3 then aims to provide a tool for reflection on pedagogical design that is situated and coherent with the research and critical practices developed.

Table 3. Transformations observed in teaching practice before and after the ONDAS diploma course.

Observed appearance	Before the systematization process	After systematization
Role of the teacher	Content streamer	Reflective companion and mediator of children's inquiry
Evaluation	Repetitive tests and written assignments	Formative assessment through portfolios and dialogue
Curriculum Design	Based on rigid meshes and guides	Based on projects developed from children's questions.
Child participation	Scarce, focused on following instructions	Protagonistic, creative, deliberative
Integration with the territory	Null or anecdotal	Contextualized with local, environmental, and community knowledge.

Source: Comparative analysis of systematized experiences (2023–2024).

End: Finally, one of the most profound contributions of the study is located on the epistemological level: the projects designed by the teachers did not follow a rigid and monotonous curricular sequence; they were born from authentic questions asked by the children, in dialogue with local knowledge, the problems of the territory, and the cultural dynamics of each community. This gesture meant a shift in the idea of curriculum, ceasing to be a list of decontextualized contents to be assumed as a situated, living, and critical construction. In practice, it implied a process of "curricular decolonization"; pedagogical knowledge ceased to be supported only by official sources and began to be enriched with experiences, stories, and concerns of the educational community.

This approach connects Santos (2021)'s proposal for cognitive justice, which advocates for recognizing multiple forms of knowledge beyond the Western academic canon. In the systematized projects, this recognition was not limited to the theoretical level; it was translated into action. By inquiring about the medicinal plants used by grandmothers, the customs of the neighborhood, or the lives of iguanas, children articulate scientific knowledge alongside ancestral and community knowledge. The result is a hybrid, situated, and legitimate form of knowledge that holds relevance to everyday life and possesses the capacity to transform both teaching and learning processes.

The epistemological transformation observed here is not a minor fact: it implies questioning the technocratic paradigm of education and opening the way to a pedagogical model based on epistemic diversity, the problematization of reality, and intercultural dialogue. In contexts marked by inequality and exclusion, this transformation has a deeply political character, enabling new ways of thinking, teaching, and learning from the margins.

Although the principles of the IEP were common to all the systematized experiences, their implementation acquired differentiated characteristics in rural and urban contexts. Geographical, cultural, technological, and social conditions influenced both the children's questions and the pedagogical strategies used by teachers. Table 4 summarizes these contrasts.

Table 4. A comparison between rural and urban contexts in the implementation of the IEP.

Observed Appearance	Rural context	Urban context
Origin of children's questions	Based on the natural environment, animals, crops, and family relationships.	Associated with digital media, social phenomena, cities, and technologies.
Family and community involvement	High: grandparents, peasants, and neighbors become involved as sources of knowledge.	Low or punctual: participation is limited to school spaces.
Emerging knowledge	Ancestral, environmental, productive (Agriculture, biodiversity)	Technological, social, urban cultural
Teaching resources	Environment materials: stones, leaves, soil, seeds	Digital resources, bibliography, printed billboards
Predominant dimensions	Environmental, bodily, ethical-community	Cognitive, aesthetic, communicative
Challenges and Faced	Access to continuing education and limited connectivity	Lack of time and curricular overload
Teacher transformation	Greater openness to intercultural dialogue and revaluation of the territory.	Focus on active methodologies and technological mediation.

Source: The cross-analysis of systematizations of teachers in diverse contexts (2024).

This comparison demonstrates that the IEP is not a rigid, methodological "recipe" but a dynamic, context-dependent, and adaptable pedagogical practice. In rural areas, community and ecological knowledge serve as the foundation for inquiry; in urban environments, curiosity is reshaped and mediated by technology and cultural diversity. Far from being a problem, this tension creates opportunities for educational innovation and promotes cognitive justice.

To conclude the analysis, Table 5 consolidates the structural contributions to the systematization process across five dimensions: pedagogical, formative, epistemic, social, and political. This comprehensive perspective enables us to understand the scope of the study beyond the classroom and acknowledges its transformative potential at various levels of the educational system.

Table 5. Synthesis of contributions from the process of pedagogical systematization.

Analysis dimension	Identified contribution	Example in the study
Pedagogical	Construction of curricular proposals based on the child's genuine question.	Project "Why are iguanas hiding?" as a curricular starting point.
Teacher training	Strengthening the reflective and critical perspective on educational practice.	Systematization logs written during and after the diploma course.
Epistemic	Recognition of children as subjects of knowledge and rights.	Active listening to children's questions serves as a catalyst for research and exploration.
Social and community	Integration of ancestral, family, and territorial knowledge into the classroom.	Participation of grandmothers, peasants, and families in the projects.
Politics	Impact on the conception of a situated and diversified curriculum.	Adjustments made by teachers to the official curriculum based on their local context.

Source: The cross-analysis of narratives, portfolios and teaching matrices (2024).

6. CONCLUSIONS

The systematization of experiences carried out within the framework of the Diploma in Educational Innovation of the Ondas program has demonstrated that research, as a pedagogical strategy, is not merely an accessory or supplementary methodology. Instead, it functions as an epistemological and political tool capable of profoundly transforming educational processes in early childhood education. Far from being limited to enhancing academic performance or the acquisition of specific competencies, the analyzed projects revealed that it is possible to create critical, sensitive, and culturally situated learning environments. In these spaces, children and teachers participate as active co-constructors of knowledge, fostering a more inclusive and reflective educational experience.

From a pedagogical transformation perspective, the findings of this study confirm that when teachers adopt an investigative, reflective, and situated stance, their relationship with knowledge, childhood, and their professional roles is fundamentally altered. The participating teachers moved beyond a transmissive and standardized approach, embracing pedagogical practices based on listening, questioning, dialogue, and contextual recognition. This transition not only enabled them to recover their capacity for agency but also allowed them to redefine their professional identities as subjects producing pedagogical knowledge, aligning with Latin American approaches to critical teacher training (Díaz-Barriga, 2022; Jara, 2018). In child development, the results reveal that children display a richer capacity for knowledge than is usually assumed. When they encounter an environment that accompanies and challenges them, careful observation, analysis, inference, symbolic creation, and ethical reflection are clearly visualized. The experiences described confirm that scientific thinking is not exclusive to advanced courses; on the contrary, it can be cultivated from early childhood if its own rhythms, languages, and ways of knowing are respected. This view questions approaches that tend to underestimate children and proposes an initial education focused on their cognitive and emotional agency, recognizing them as subjects with rights and knowledge. At the epistemological level, the systematization analyzed constitutes a concrete example of how it is possible to de-school the curriculum, not in the sense of eliminating the school, but of decolonizing its practices, contents, and approaches. By starting from the children's authentic questions linked to their ecological, social, and cultural environment and by articulating scientific knowledge with local knowledge, these teachers built a situated, transdisciplinary, and ethically committed body of knowledge. This practice embodies the principle of cognitive justice (Santos, 2021), according to which all knowledge has the right to exist and dialogue, positioning the school as a legitimate space for the production of knowledge from and for communities. The implications of these findings are manifold, as shown in Table 6. In terms of educational policy, the study reaffirms the urgency of designing teacher training programs that value situated reflection, collaborative work, and pedagogy of the question as guiding principles. In Latin American contexts marked by inequality and curricular homogenization, strengthening research as a pedagogical strategy is a way to democratize knowledge and build culturally relevant, emotionally safe, and cognitively challenging schools. Likewise, the contributions presented here can guide processes of curricular updating, the design of didactic materials, and institutional support in early education.

Table 6. Practical implications of the study for the education system and early childhood pedagogy.

Transformation dimension	Implications for teaching practice	Implications for public policy	Implications for teacher education
Pedagogical (Transformation of the teaching role)	- Promote pedagogical autonomy. Favor practices based on observation, listening, and questioning. Strengthen the role of the teacher as a reflective and creative subject.	- Design flexible curricular frameworks that allow for research projects. Valuing the work involved in institutional evaluation is also essential.	- Include pedagogical research approaches in initial training programs. - Promote the development of critical teacher identity.
Childhood (Transformation of children's thinking)	- Recognize children as epistemic subjects. Encourage research processes based on children's questions. Use play, exploration, and art as tools for thought.	- Incorporate indicators of critical thinking, not only academic performance. - Guarantee material conditions for play, exploration and dialogue.	- Train in neuroeducation, early cognitive development and respectful accompaniment strategies.
Epistemological (Transformation of school knowledge)	- Value local, community, and ancestral knowledge as pedagogical inputs. Generate interdisciplinary and transversal practices.	- Recognize and finance initiatives that integrate situated knowledge. - Develop curricular justice and interculturality policies	

Source: The findings of the study developed within the framework of the Diploma in Educational Innovation of the ONDAS Program, Minciencias (2023).

From a research perspective, this study opens up avenues of work that require further investigation. It would be pertinent to develop longitudinal studies that evaluate the sustained impact of these experiences on children's educational journeys, as well as ethnographic studies that analyze changes in the pedagogical culture of educational institutions adopting these approaches. Additionally, it is necessary to advance the theoretical construction of categories that account for childhood as an epistemic subject from a Latin American perspective, engaging with the epistemologies of the South, critical pedagogy, and childhood studies.

In summary, this systematization demonstrates that a critical, situated, and investigative initial education is possible, desirable, and necessary. In the face of technocratic models that reduce teaching to procedures and childhood to indicators, this study affirms that when the word of children is dignified, the autonomy of teachers is respected, and the knowledge of the territory is recognized, the school is transformed into an act of social, cognitive, and affective justice. In this sense, we are not only facing an effective methodological proposal but also an ethical and political commitment to an education that thinks with, from, and for life.

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Institutional Review Board Statement: This study was approved by the Institutional Review Board of (CIEI) of the Autonomous University of Bucaramanga (UNAB), Colombia under protocol (CIEI-UNAB-026-2021, as recorded in minute No. 163) dated October 15, 2021. According to Resolution No. 008430 of 1993 of the Ministry of Health of Colombia, the research was classified as minimal risk. Informed consent was obtained from the participating teachers and the guardians of the children involved, guaranteeing the confidentiality and anonymity of the information.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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APPENDIX

Appendix A. Examples of projects and evidence of activities carried out.

Project 1: Who's There? Let's discover the fauna that accompanies two groups of transition degree students in the department of Santander.	
Female research teachers	Yeny Rocío Bayona Álvarez Edith Johana Sierra Sierra
Educational institution:	**Gabriel García Márquez Institute**
Department	Santander (San Gil and Floridablanca)
Activity name	**Evidence**
Let's get to know our school environment	The activity "Let's get to know our school environment" was established as a space for exploration, discovery, and research. During this activity, children toured the surroundings of the educational institution, providing them with opportunities to observe their immediate environment critically and with curiosity. Throughout this process, they identified elements of nature, noted the diversity of flora and fauna, and observed specific features of the physical space. These observations enabled them to formulate questions and develop new hypotheses about their environment, fostering a deeper understanding and engagement with their surroundings. This teaching-learning process, based on discovery and research, encourages detailed observation, inquiry, and recording of findings, thereby strengthening participants' fundamental investigative and cognitive skills in early childhood. The role of the teacher is consolidated as a provocateur of experiences, facilitating children's transition from simple curiosity to the transformation of knowledge. This process involves connecting observations with daily realities and generating individual interpretations. Emphasizing the importance of the school environment, it ceases to be merely a physical space for transit and becomes a dynamic pedagogical scenario where knowledge emerges from direct interactions among children, nature, and the educational community.
Birdwatching days	In this pigeon watching process, he offered the children the opportunity to learn about the different birds that come to the educational institution. The activity of feeding them facilitated the approach of some species, which allowed them to be observed in greater detail. From this experience, the children identified characteristics related to the classification of birds, their diet, the colors of their plumage, sizes and ways of flying. The fact that the birds were fed with some caution, but motivated by an interest in food, aroused in the children curiosity and enthusiasm to continue observing and investigating. This direct experience strengthened their disposition towards inquiry, as spontaneous questions arose about the life and behaviors of birds. Thus, the sighting became a scenario of discovery and research, which not only promoted the development of scientific thinking but also enhanced the ability to critically and thoughtfully interpret the reality of their natural environment.
Workshop with parents (Preparation and installation of bird feeders)	The project "Who's There? Let's Discover the Fauna" enabled children to explore the diversity of birds and insects present in their educational environment through observations, field diaries, and drawings. As part of the initiative, workshops were conducted for parents, in which attendees actively participated in the production and installation of bird feeders. This involvement helped strengthen educational co-responsibility between the school and families. The collected evidence demonstrated how children's curiosity, supported by research and family involvement, was transformed into meaningful learning and the development of critical attitudes toward environmental care.

Bird feeding days	The bird feeding days established a pedagogical space in which children and families actively intervened in the protection and care of the fauna present in the school institution. Through the installation of feeders and the supply of food, the children were able to closely observe the different species, identify their behaviors and recognize the importance of preserving biodiversity and caring for the environment. They promoted values of respect and environmental care. The participation of parents made it possible to strengthen educational co-responsibility, completing the care of nature as a practice to be carried out between the institution and the home. In this way, the feeding days were transformed into situated learning scenarios, where research, discovery and community action came together to generate ecological awareness from early childhood.
We are entomologists	This activity allowed the children to assume the role of young researchers by exploring the universe of insects found in their school environment. Provided with magnifying glasses, field diaries and of course curiosity, the children closely observed different species, took notes verifying findings and shared notes on their shapes, colors and behaviors. This exercise of direct observation strengthened competencies related to scientific inquiry, the recording of grades and the posing of questions, enhancing critical thinking from early creative childhood.
Expert visit	
Project Closure	The closure of the project provided a space for socialization where children had the opportunity to showcase their learning through performances and creative exhibitions. In this initial experience, it was observed how children, characterized by costumes related to the topics investigated, shared their productions with classmates, family members, teachers, and visitors. This process integrated symbolic play with the communication of the knowledge acquired. This moment allowed for the visibility of progress in verbal expression, increased confidence in participation, and a better understanding and appropriation of the concepts explored during the research process. In the second routine, the children organized an exhibition of products made in the classroom, showing models, murals and artistic representations of the findings achieved. The presentation of this knowledge not only strengthened the sense of belonging and collaborative work, showing how the knowledge built throughout the project was transformed into visual and symbolic narratives accessible to the entire educational community and of course the appropriation of new knowledge. The closing of the project was presented to the community as a scenario for the celebration of learning and teaching, in which research, creativity and communication were articulated. This space reaffirmed the role of children as protagonists of their own process of discovery and research, making visible both their achievements and the richness of collectively constructed experiences.

Project 2: Little Scientists in Action: All Against Pollution	
Female research teachers	Yorleny Mosquera González
Educational Institution:	**Bosconia headquarters C- Rural**
Department	Santander
Activity name	**Evidence**
Maps with history: stories from the territory	This process, led by the research teacher Yorleny Mosquera in the department of Santander, aimed to promote environmental awareness among children regarding waste management and recycling practices. Based on mobilizing questions about the causes of pollution in their environment, the students identified problems such as ignorance, a lack of a sense of belonging to the environment, inadequate garbage collection, and the absence of recycling practices in the community.

	The "Painting Change" phase enabled children to express environmental issues and potential solutions through drawings and artistic creations. These activities demonstrated not only their comprehension and understanding of the topics addressed but also their ability to articulate opinions, emotions, and proposals for environmental care. The children's expressions were coherent with their developmental stages and realities of childhood, reflecting their engagement and awareness of environmental concerns. Critical thinking, creativity and awareness about environmental protection were definitely strengthened, positioning children as active actors of change within their educational community.
Painting the change: Let's take care of our planet	The artistic process provided to children enabled them to express, through drawings, expressions, and creations, their understanding of environmental challenges and potential solutions. Their work demonstrated a commitment to environmental care, pollution reduction, and the importance of protecting flora and fauna. These experiences not only reflect the acquisition of knowledge covered in the classroom but also showcase the participants' ability to share their feelings, analyze their thoughts, and propose actions related to environmental preservation. This process helps solidify their role as active agents in transforming their educational community, fostering a sense of responsibility and engagement in environmental issues.
Decompose with love	With this experience of sensitizing the children, they understood the responsible management of organic waste and its use as a resource to grow food plants, led the students to collect remains of fruits, vegetables and kitchen waste, which were used as natural fertilizers to nourish the land and strengthen school cultivation processes. With this experience, the children understood decomposition and its relationship with ecological balance, while promoting values of responsibility, care for the environment and environmental awareness. In this way, the children not only learned about recycling and waste use, but also recognized themselves as protagonists of sustainable practices within their educational community.
Let's organize love bottles	The activity sought to promote creativity, environmental care and the reuse of plastic containers and bottles in children. The students learned to give them different uses, transforming them into new products such as containers for toiletries, pots for plants, organizer boxes, decorations and even simple furniture. Recognizing the footprint of plastics in the environment made it possible to make visible that, through creative recycling habits, it is possible to turn waste into a resource. The invitation favored the creation of responsible practices regarding consumption and waste management, while stimulating imagination, collaborative work and ecological responsibility, strengthening children as diligent actors of change in their educational community.
Pedagogical outing: Cleaning with awareness	The pedagogical outings, in which the children assumed a leading role as leaders in the care of the environment, allowed them to carry out waste collection tasks in their community, recognizing in a practical way the impact that waste generates on nature and the importance of reducing the human footprint on the environment. This experience made it possible to articulate action with reflection, because while the students cleaned their environment, they also discussed the need to transform their daily habits and those of their families. Thus, the pedagogical outing not only favored environmental awareness, but was also projected as a life project, aimed at building a more respectful and positive relationship between human beings and nature.
Recicrearte: From Waste to Art	The children transformed recyclable materials into works of art and decorative elements. With plastic bottles, cardboard, caps, tubes and packaging, they built animals, vehicles, figures and useful objects,

	demonstrating that waste can be turned into art or decorative elements for the home or classroom. This activity enhanced imagination and creativity, strengthened awareness of caring for the environment, by clearly demonstrating how materials that would normally be discarded can be given a second life. It favors collaborative work, the development of motor skills, and the adoption of responsible habits regarding consumption and waste management.
Letters with love, to create little bottles of love	The letters made it possible to generate narratives and didactic strategies to raise awareness among children about the responsible use of plastic and the importance of love bottles as an alternative for creative recycling. Through written and decorated letters, the students shared messages addressed to family and classmates, inviting them to participate in the collection of plastic waste and the construction of ecological bottles. This exercise integrated reading and writing with environmental education, promoting written expression, creativity and the communication of ideas and proposals in a meaningful way. At the same time, it allowed children to recognize themselves as promoters of environmental awareness in different social contexts, strengthening the sense of co-responsibility and collective commitment to caring for the planet.
Plant beautification and planting campaign	The campaign helped children actively participate in land organization, planting ornamental flowers of various colors, and creating planters from recycled materials such as tires and plastic bottles. These efforts contributed to revitalizing spaces with abundant natural elements, promoting environmental awareness and community involvement. The activity helped the students understand the importance of vegetation for environmental balance and in the improvement of everyday spaces, it also promoted the values of cooperation, responsibility and collective care.