ISSN 1981-416X
https://doi.org/10.7213/1981-416X.26.090.AO02EN

Article

Revista Diálogo Educacional

PUCPRESS

periodicos.pucpr.br/dialogoeducacional

Learning through research in early childhood education: a hermeneutical perspective in teaching action[1]

Aprendizagem por pesquisa na educação infantil: um olhar hermenêutico na ação docente

Investigación del aprendizaje en educación infantil: una visión hermenéutica en la acción docente

Marilda Aparecida Behrens [a]
Curitiba, PR, Brasil
Pontifícia Universidade Católica do Paraná (PUCPR)

João Pedro Crevonis Galego [b]
Curitiba, PR, Brasil
Pontifícia Universidade Católica do Paraná (PUCPR)

How to cite: BEHRENS, Marilda Aparecida; GALEGO, João Pedro Crevonis. Learning through research in early childhood education: a hermeneutical perspective in teaching action. *Revista Diálogo Educacional*, v. 26, n. 90, p. 1846-1864, 2026. https://doi.org/10.7213/1981-416X.26.090.AO02EN

Abstract

The research presented focuses on Scientific Literacy in Early Childhood Education. Its objective is to investigate how Scientific Literacy can be fostered at this stage of education through play-based activities. The study adopts an action research design, with a qualitative approach and a hermeneutic method. The research was conducted at a private educational

[1] The research was conducted in accordance with the ethical principles applicable to scientific research. The study was purely observational in nature and did not involve any interventions with teachers or children, which ensured that teaching practices were maintained in their natural context.

[a] Ph.D. in Education from the Pontifical Catholic University of São Paulo; email: PUCSP.marildaab@gmail.com and marilda.aparecida@pucpr.br
[b] Ph.D. candidate in Education at the Pontifical Catholic University of Paraná (PUCPR); email: joaopedrocrevonisgalego@gmail.com

institution in Curitiba that implements practices aimed at promoting Scientific Literacy. The study involved the participation of several educational professionals, including teachers, coordinators, and members of university research groups. The investigation focused on observing teaching practices that promote Scientific Literacy, while also reflecting on teachers' understanding of their own role and that of children as researchers through a triangulation with the Brazilian National Common Curricular Base (BNCC) and Complexity Theory.

Keywords: Complexity. To play. Playful. Research. Scientific Method.

Resumo

A pesquisa apresentada tem como foco a Alfabetização Científica na Educação Infantil. O objetivo é investigar como a Alfabetização Científica pode ser desenvolvida neste ciclo de ensino, por meio de atividades que acolhem o brincar. A metodologia ocorre pela pesquisa-ação, de abordagem qualitativa e método hermenêutico. A pesquisa foi realizada em uma instituição de ensino privada em Curitiba, que adota práticas voltadas para a Alfabetização Científica. O estudo envolveu a participação de diversos profissionais, incluindo professoras, coordenadores e membros de grupos de pesquisa além de refletir sobre a compreensão dos professores sobre seu papel e o das crianças como pesquisadores, por meio de uma triangulação com a Base Nacional Comum Curricular e a Teoria da Complexidade.

Palavras-chave: Complexidade. Brincar. Lúdico. Pesquisa. Método Científico.

Resumen

La investigación presentada se centra en la Alfabetización Científica en Educación Infantil. El objetivo es investigar cómo se puede desarrollar la Alfabetización Científica en este ciclo docente, a través de actividades que abrazan el juego. La metodología se basa en la investigación acción, con enfoque cualitativo y método hermenéutico. La investigación se realizó en una institución educativa privada de Curitiba, que adopta prácticas orientadas a la Alfabetización Científica. El estudio contó con la participación de varios profesionales, entre ellos profesores, coordinadores y miembros de grupos de investigación de una universidad. El foco de la investigación fue observar prácticas docentes que promueven la Alfabetización Científica, además de reflexionar sobre la comprensión de los docentes sobre su papel y el de los niños como investigadores, a través de la triangulación con la Base Curricular Común Nacional y la Teoría de la Complejidad.

Palabras clave: Complejidad. Para jugar. Juguetón. Buscar. Método científico.

Introduction

The first steps of a human being are always significant milestones in development. Analogously, it can be argued that a major milestone in Brazilian Early Childhood Education was established with the promulgation of the 1988 Federal Constitution, which defined childcare and preschool education as a duty of the State and formally recognized Early Childhood Education as the first stage of Basic Education. This constitutional recognition enabled Early Childhood Education to benefit from educational policies and public investments, including teacher education, improvements to school infrastructure, and expanded access to the educational system (Raymundo & Ribeiro, 2025).

Against this background, this study adopted a qualitative action research design, supported by methodological procedures grounded in a hermeneutic perspective, to investigate how Scientific Literacy can be fostered in Early Childhood Education through play-based learning activities while respecting the ethical principles governing educational research. Accordingly, the study addressed the following research question: How can children in Early Childhood Education engage in research-based learning with a focus on Scientific Literacy?

The specific objectives were to identify moments in teaching practice that promote Scientific Literacy, to examine the development of a pedagogical project implemented in an educational institution in Curitiba, and to reflect on whether teachers perceive both children and themselves as researchers.

The study was conducted within the context of Early Childhood Education, which constituted the starting point of this investigative journey. Before presenting the research process itself, however, it is necessary to contextualize the historical development of Early Childhood Education and describe the setting in which the investigation took place. We also clarify our decision to report the study primarily in the first-person plural ("we"), as the project was developed through a methodological approach that embraced the collaborative participation of professionals from a private university in Curitiba and a private school in the same city. Nevertheless, some sections employ the first-person singular to describe individual observations and interventions carried out during the educational and research processes.

The study was developed through the contributions of multiple participants, including Early Childhood Education classroom teachers, pedagogical coordinators, school administrators, and members of two university research groups. The research was conducted in a private school with more than six decades of educational tradition in the Greater Curitiba region. This institution was selected because its educational approach incorporates initiatives aimed at promoting Scientific Literacy, providing a valuable context for reflecting on advances in educational practice. In particular, the school established a Scientific Initiation Club in 2021 and has since organized an annual educational exhibition involving students from all levels of Basic Education.

Methodologically, the study was guided by Dialogical Critical Hermeneutics (Ribas, 2017; Ribas, Donato, & Ens, 2024). Its qualitative methodological framework combined action research (Thiollent, 1986; Dionne, 2007; Alves & Nogueira, 2023) with dialogical observation as the principal data collection strategy. Conducted in this private school in Curitiba, the investigation sought to understand and interpret whether teachers' interactions with children in Early Childhood Education create educational environments that foster the development of Scientific Literacy.

The role of Teachers in Fostering Scientific Literacy

The present study is justified not only by its contribution to strengthening the foundations of an educational approach committed to scientific development and progress, but also by its adoption of a meaningful pedagogical approach—research-based learning—which was informed by the Seven Complex Lessons in Education for the Future proposed by Morin (2000).

Understanding children as researchers who are capable of engaging in research practices requires recognizing them as active subjects with their own voices and ways of acting, which often differ from those of adults. Consequently, it is necessary to broaden our understanding not only about children but also with them. This requires acknowledging children's voices throughout the teaching process and recognizing them as individuals who have much to contribute regarding their experiences, perceptions, and understandings of the world (Araujo & Anjos, 2023).

Within a reconstructive educational perspective, meaningful learning outcomes emerge when children are encouraged to become individuals capable of proposing ideas, raising questions, and critically examining different

perspectives. In this regard, Demo (2006) argues that research activities promoting children's authorship require continuous **teacher guidance and support**. Consequently, teachers assume an essential mediating role in the construction of knowledge, experiences, and discoveries. To fulfill this role effectively, however, educators must understand themselves as teacher-researchers, capable of recognizing children as potential producers of knowledge and of creating opportunities for critical reflection and autonomous inquiry, even within the context of Early Childhood Education (Martins & Vilanova-Campelo, 2023).

This perspective is consistent with the proposal advanced by Nóbrega et al. (2022), who argue that teachers must assume responsibility for fostering Scientific Literacy. Educational practices developed with this purpose can open new pathways for learning that extend beyond traditional instructional approaches. Rather than reinforcing conservative paradigms centered on the reproduction of knowledge, these practices promote, as an educational priority, the active construction of knowledge. Accordingly, the present study examined the pedagogical organization adopted by the school in order to determine whether it incorporated both play-based learning and the principles of Scientific Literacy.

The promotion of Scientific Literacy throughout Basic Education is consistent with the recommendations established by Brazil's National Common Curricular Base (BNCC), which states that:

> [...] Basic Education should aim at global human education and development, which implies understanding the complexity and non-linearity of this development, breaking with reductionist views that privilege either the intellectual (cognitive) dimension or the affective dimension. It also means assuming a plural, singular and intellectual view of the **child,** the adolescent, the young person and the adult. (Brazil, 2018, p. 14, emphasis added).

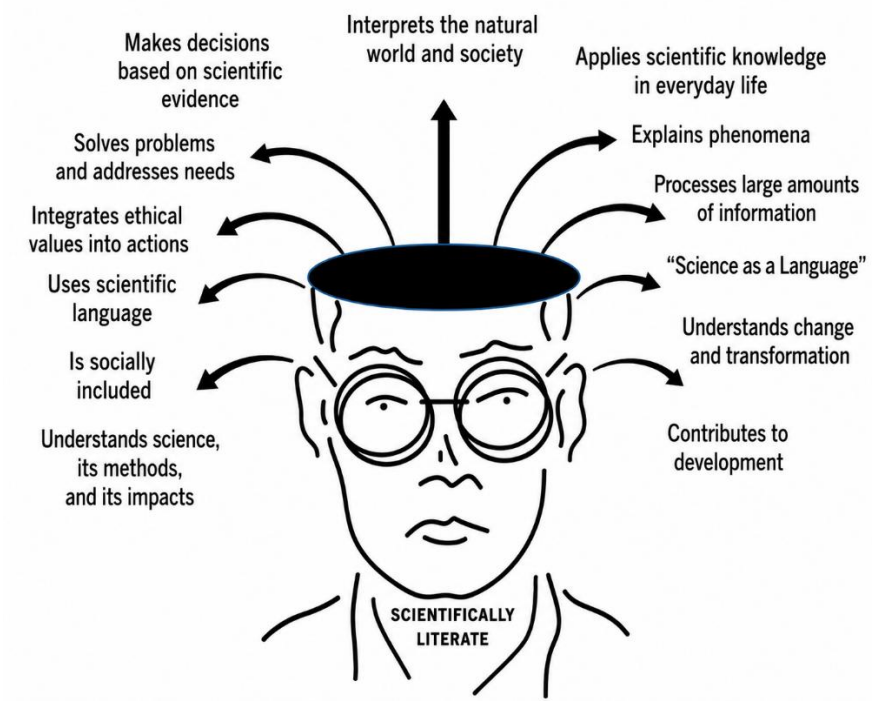
Because we assume that Scientific Literacy, when thoughtfully structured and effectively integrated, encourages children to construct meaning from their knowledge, we concur with Morin (2000, p. 31), who argues that:

> Putting into practice [...] questions constitutes the oxygen of any proposal for knowledge. Just as oxygen killed primitive living beings until life used this corrupter as a detoxifier, in the same way uncertainty, which kills simplistic knowledge, is the detoxifier of complex knowledge.

Building upon Morin's (2000) perspective, we infer from Chassot's (2000) work on Scientific Literacy that science education and its broader educational implications are fundamentally shaped by the teaching methodology adopted by the teacher, as well as by the teacher's observations of how children learn and how teaching practices can be adapted to transform the learning process.

From this perspective, a scientifically literate individual (Figure 1) is not necessarily someone who will become a scientist; rather, it is someone capable of making informed decisions, engaging in critical thinking, and—particularly in an era of fake news—distinguishing misinformation from reliable information (Galego, 2023; Chassot, 2000; Nóbrega et al., 2022).

Figure 1 – The scientifically literate subject



Source: Galego (2023, p. 76).

Regarding Scientific Literacy, the theoretical framework adopted in this study is grounded in the works of Chassot (2000, 2003) and Coppi (2016). We argue that, in Brazil, it is

> [...] one of the goals of Science Education, **can be called in different ways, such as Scientific Literacy, Scientific Literacy and Scientific Enculturation**. Regardless of the reasons that justify one term or another, there is a consensus among the authors on a common thread that defends the importance of scientific knowledge being incorporated by students and school graduates, so that they can make use of this knowledge to enhance the critical reading of the world and responsible decision-making (Vizzotto; Del Pino, 2020, p. 3, emphasis added).

Although there is an ongoing conceptual debate surrounding the terms Scientific Literacy, Scientific Education, and Scientific Enculturation, reflecting different perspectives on science education, these approaches converge in advocating the appropriation of scientific knowledge as a means of enabling individuals to critically interpret reality and participate meaningfully in society. From this perspective, recognizing that such knowledge should be cultivated from the earliest years of schooling requires both critical reflection and sustained educational efforts. Accordingly, Science Education should be understood as a dialogical process of meaning-making, in which scientific knowledge is interwoven with the knowledge, experiences, learning processes, and other educational dimensions that characterize Early Childhood Education.

Scientific Literacy should not be understood merely as the integration of different curriculum subjects. Rather, it is founded on an organizing way of thinking that transcends disciplinary boundaries, enabling children to connect their knowledge and make sense of their reality regardless of the field of study involved. Such an approach also requires, at a minimum, an interdisciplinary perspective. Furthermore,

> Scientific literacy can be considered as one of the dimensions to enhance alternatives that favor a more committed education. It is recommended to emphasize that this should be a very significant concern in elementary school, even if the need for almost identical attention is advocated for high school as well. Dreamily, I would expand the proposal to also include, even if this may cause goosebumps in some, higher education. (Chassot, 2003, p. 91).

We consider it appropriate to adopt the term Sciences rather than Science, as the plural form acknowledges the plurality of scientific disciplines, whereas the singular is often associated exclusively with the natural and exact

sciences. We assume that the sciences constitute a language; therefore, to be scientifically literate is to be able to read the language in which nature is written. As Chassot (2003, p. 91) argues, "A scientifically illiterate person is one who is incapable of reading the universe." When discussing language in the context of Early Childhood Education, it is essential to understand that:

> Children reveal their thoughts, feelings and experiences about childhood, through different languages, through their speeches, looks and actions about what they think/feel and that can favor the organization of Early Childhood Education schools, contemplating their participation in this organization. In the meantime, their knowledge and practices can contribute to new organizations of pedagogical practices aimed at their own learning (Araujo; Anjos, 2023, p. 68-69).

From a methodological standpoint, adopting an innovative perspective requires the selection of an appropriate research methodology capable of providing a coherent framework for the investigation. The chosen methodology offers the procedures needed to address the proposed research problem, respond to the questions that guide the study, and ultimately accomplish its objectives.

To achieve this purpose, it is also necessary to clarify the methodological approach adopted in this study, namely, Dialogical Critical Hermeneutics.

Before discussing Dialogical Critical Hermeneutics, which originated from the work of Ribas (2017), it is important to first examine hermeneutics in its broader and foundational sense. This also explains our deliberate choice of the verb understand throughout this study, as it is intrinsically linked to the hermeneutic method.

Methodological Paths

According to Ribas (2017) and Ribas, Donato, and Ens (2024), Dialogical Critical Hermeneutics is grounded in the pursuit of interpretation. It is critical because it seeks to interpret phenomena in a profound, contextualized, and reflective manner; and dialogical because it pursues understanding through a continuous movement between the whole and its parts, and vice versa. This dynamic unfolds through language, communication, and dialogue, constituting what Gadamer (2007, p. 175) refers to as the "dialogical movement."

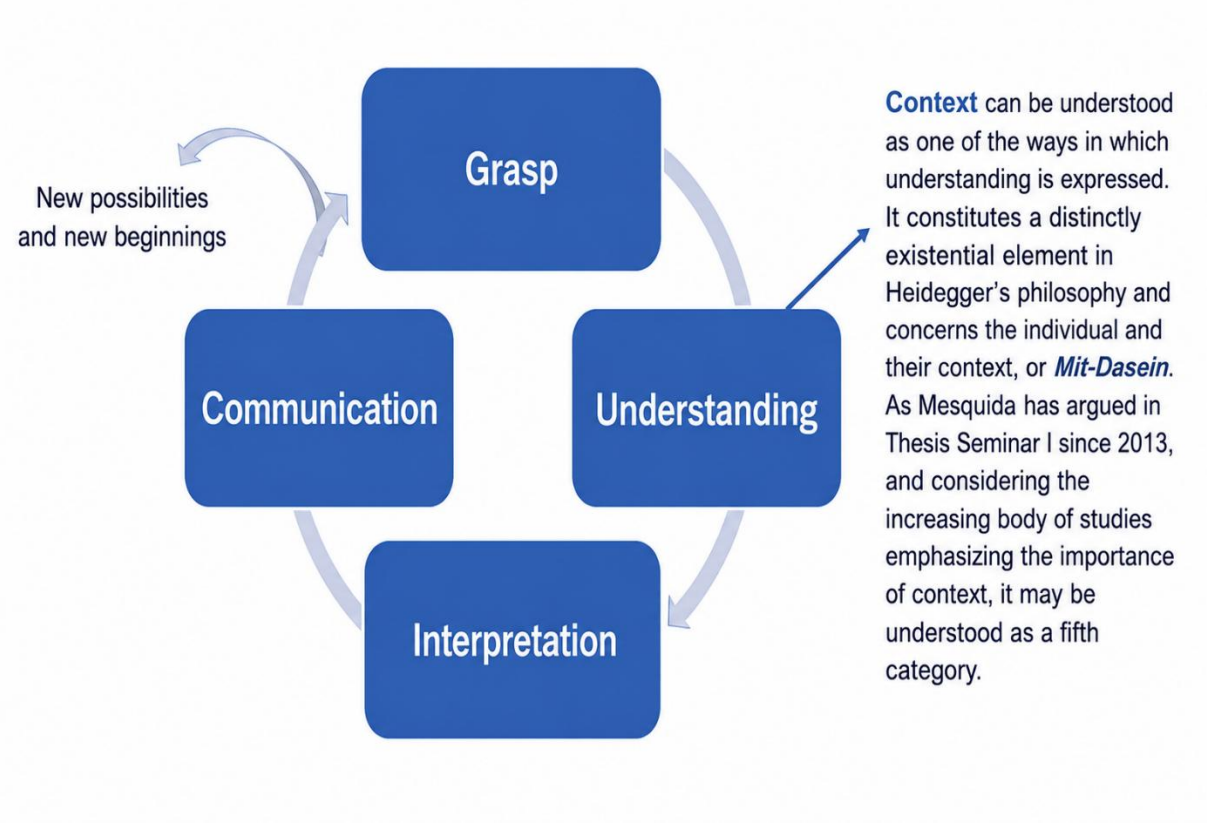
From Gadamer's perspective (1997, 2007, 2010), hermeneutics originally emerged in close association with the interpretation of written texts and did not initially encompass the interpretation of human existence. This broader ontological understanding was introduced by Heidegger. Ribas, Donato, and Ens (2024, p. 23) describe this development as the hermeneutic turn, grounded in Gadamer's Truth and Method (1997), representing a shift from epistemology to ontology. In this framework, epistemology is concerned with interpreting phenomena, whereas ontology is concerned with understanding them.

According to Schmidt (2014), when asked what hermeneutics is, his response is simply that it is "interpretation." This is because hermeneutics, whose origins derive from the Greek language, has been applied across diverse fields of knowledge with the fundamental purpose of enabling correct understanding. In the same vein, Gilhus (2016, p. 144) states that:

> When interpretation is transformed into a scientific method, it is given a Greek name: "hermeneutics" – a concept derived from *hermeneuein*, meaning "to express," "to translate," "to interpret." The materials that constitute the sources for hermeneutics are texts and other expressions, and the objective of the hermeneutic is to achieve the understanding of their meanings.

Therefore, drawing upon the works of Gadamer (1997, 1998, 2007, 2010), Grondin (2012), Ribas (2017), Galego (2023), Ribas, Donato, and Ens (2024), Renner, Galego, and Ens (2024), and Godoi, Galego, and Ens (2024), we argue that hermeneutics can be understood as a process grounded in the complementary acts of understanding and interpretation. This process may be represented through the Hermeneutic Circle, a conceptual framework that has been developed and refined by Mesquida since 2013 (Mesquida, 2024). Rather than constituting a closed or circular form of reasoning, the Hermeneutic Circle is understood, following Renner (2021), as an open and dynamic process organized around interconnected categories, as illustrated in Figure 2.

Figure 2 – Hermeneutic circle with hermeneutic categories



Source: The authors (2024), based on Galego (2023, p. 29), Renner (2021, p. 37), Gihus (2016) and Mesquida (2024).

In order to understand the hermeneutic categories, it is necessary to understand them in their parts, but without forgetting that they occur as a whole, inseparable and in a non-linear way, and there is no one that will precede the other, after all, none occurs in isolation. Therefore, to clarify and guide the categories, Chart 1 follows.

Chart 1 – The hermeneutic categories

CATEGORY	DESCRIPTION
CONTEXTUALIZATION	This filter will outline aspects such as time, place, cultural issue, the sender of the message and the receiver.
APPREHENSION	It can be understood as the "[...] assimilation or understanding of what is knowable" (Houaiss; Villar; Franco, 2001, p. 261 *apud* Renner, 2021, p. 36).
INTERPRETATION	It aims to identify the central idea and, from there, locate the secondary ones through deductions and conclusions.
COMPREHENSION	*A priori*, comprehension is considered a cognitive process, in which interpretation is necessary.
COMMUNUCATION	It is the written or spoken presentation of the steps necessary for the development of the research and the results. Communication does not occur in a single moment, but in the entire research process, as it is in full movement

Source: Godoi, Galego and Ens (2024, p. 44).

Another aspect clarified by Schmidt (2014, p. 22) is that understanding emerges through a respectful and patient process characterized by moments of speaking and listening. Therefore,

> Understanding is like a conversation where the interpreter needs to listen to and respect the other person's opinions. In this conversation, where various positions are examined, correct understanding is gained when everyone agrees on a position.

For Grondin (2012, p. 14),

> [...] Hermeneutics does not initially have to do with texts, but with existence itself, which is already penetrated by interpretations, which hermeneutics can clarify. Hermeneutics is then placed at the service of a philosophy of existence, called to a self-awakening.

However, Ribas (2017) argues that hermeneutics necessarily relies on language, dialogue, and discourse as inseparable and indispensable elements, leading the author to propose the concept of Dialogical Critical Hermeneutics. In this regard, Ribas, Donato, and Ens (2024) explain that hermeneutics, grounded in Gadamer's works (1997, 1998, 2007, 2010), establishes a dialogical relationship between the whole and its parts, and reciprocally between the parts and the whole. For this reason, Ribas (2017) adopted the designation Critical Dialogical. Hermeneutics must incorporate critical reflection to address its epistemological foundations and enable profound interpretation, while dialogicality is essential because understanding unfolds through the movement of the Hermeneutic Circle. In the present study, we refer to this movement as the Hermeneutic Spiral in order to emphasize its open, dynamic, and progressive nature, thereby avoiding the notion of a closed, linear, or circular process.

Accordingly, the hermeneutic method was chosen to understand and interpret whether teachers' interactions with children in an Early Childhood Education setting in a school in Curitiba foster Scientific Literacy. In other words, a hermeneutic approach enabled us to establish a critical dialogue concerning teachers' lived experiences and to interpret their pedagogical actions. To accomplish this, however, it was necessary to adopt a complementary methodological procedure, namely, dialogical observation.

Consequently, research methods must be aligned with the epistemological assumptions of the chosen methodological approach in order to avoid inconsistencies between its foundational principles. For example, qualitative research should not rely on data collection instruments designed primarily to produce numerical results, as these are characteristic of quantitative and positivist paradigms. Therefore, this study employed what we term dialogical observation—an observational approach through which ongoing events are interpreted and understood while these interpretations are continuously examined and refined through informal dialogue with the research participants.

Hermeneutics from dialogical observation: on the way to advances

Action research was adopted within a qualitative research approach. In accordance with Alves and Noguera (2023), we understand that this approach is particularly appropriate for studies involving children. Accordingly, the investigation followed five stages adapted from Dionne (2007) and articulated with the framework proposed by Thiollent (1986): (a) an initial diagnosis based on observations of the school environment and pedagogical activities; (b) an interpretation of the teaching proposal developed by the Early Childhood Education teacher responsible for Sustainable Practices, as the findings from the initial phase (Phase A) indicated that this context offered the greatest potential for fostering Scientific Literacy; (c) observation of the teacher's pedagogical practices; (d) interpretation of teachers' understanding of Scientific Literacy and the impact of research-based learning through observation and dialogue; and (e) following the completion of the process, a dialogical reflection with the research team regarding their observations and interpretations of the experiences throughout the investigation.

For the purposes of this study, the stages of dialogical observation are presented according to the three phases in which they were conducted, as summarized in Table 2.

Chart 2 – Stages of dialogical observation in the field of study

Stage	Observation	Comprehension and interpretation
1 – Pedagogical week	Teachers from all segments of Basic Education, from Kindergarten to High School. We observed the pedagogical week and guidelines for the development of activities aimed at a pedagogical show.	We understand that Scientific Literacy activities are pillars of the school, with well-defined and structured guidelines to occur annually and continuously, in projects separated by class and linked to their teaching materials.
2 – Early Childhood Education Teachers' Meeting	The teachers of Early Childhood Education, eight of whom are regents, the teacher of sustainable practices and the teacher of psychomotricity met to organize the projects for the segment.	We observed that the teachers dialogued with the intention of identifying within the theme of the show how to work the theme in Early Childhood Education, diagnosing a possibility that was favorable to play.
3 – Sustainability Practice Classes	After the meetings, we identified that the teacher of sustainable practices could be a potential to respond to our objective, as he was the teacher of the science club and one of those responsible for structuring the annual pedagogical exhibition.	During stage 2, the teacher was participative and its extracurricular component structured to lead the children to reflect and develop environmental awareness, considering that the school has a large green area, which includes a forest, a vegetable garden and a mini-zoo.

Source: The authors (2025).

The 30 teachers representing all levels of Basic Education began the 2024 academic year with a week of professional development activities. This pedagogical week included sessions conducted by the school administration for the entire teaching staff, meetings organized by educational level with the respective pedagogical coordinators, and professional development workshops provided by the school's educational system, including training delivered by educational consultants from the publishing company that supplies the school's instructional materials.

During the pedagogical week, the publishing company provided educational consultants to support the professional development of Basic Education teachers. As part of this initiative, teachers were challenged to develop a project entitled Covers, which encouraged them to explore the cover of the textbook before opening it. The cover was used as a starting point for problematization, discussion, and dialogue, serving as an initial exploratory strategy. This approach revealed an important indicator of Scientific Literacy by stimulating curiosity, observation, and inquiry before engaging with the text itself.

During the same pedagogical week, the school established the Covers project as the central theme of its annual educational exhibition, which involves students from Early Childhood Education through Upper Secondary Education. The exhibition adopted Brazilian Identities as its overarching theme, since the textbook covers featured elements of Brazil's fauna, flora, culture, and landmarks. In the present study, we focus on the experience developed by the Early Childhood Education teachers. Following the general presentation to the teaching staff, the ten Early Childhood Education teachers met to explore themes related to sensory experiences and interaction with nature. After a

brainstorming session, they decided to implement projects throughout the school year centered on Brazilian fauna and flora, drawing upon the biomes represented on the covers of each class's instructional materials.

During the same pedagogical week, the Early Childhood Education teacher responsible for the Sustainable Practices component collaborated with the classroom teachers in planning their individual projects. These projects were designed to promote knowledge construction through research-based learning by encouraging both individual and collaborative learning experiences. At this stage of the investigation, we identified the Sustainable Practices teacher—who is responsible for an extracurricular component offered in the institution's Early Childhood Education program—as a key participant for addressing our research objectives. Consequently, we closely observed the implementation of this extracurricular component and the pedagogical practices associated with Sustainable Practices.

The development of these Early Childhood Education projects, which were aligned with the principles of research-based learning, demonstrated that the teachers understood children to be capable of acting as researchers. This perspective is consistent with Alderson's (2005, p. 426, emphasis added) assertion that:

> In fact, children are probably more interested than adults in each stage of research. Many of them are used to questioning, investigating, and accepting unexpected results, changing their minds, and assuming that their knowledge is incomplete and provisional.

Among the Early Childhood Education classrooms involved in the study, we observed the pedagogical practices developed with Group 4 (G4) and Group 5 (G5) children. In this section, we focus specifically on the learning process carried out with the teacher and children of the G5B class, whose project centered on the Pampa biome. To initiate the discussions, the teacher explored the cover of the textbook in its printed form. The children identified animals, insects, trees, and a particularly intriguing object, which the teacher intentionally used to stimulate their curiosity by drawing their attention to it and asking whether anyone knew what it was. We interpreted that the teacher had a clear pedagogical purpose and a well-defined instructional pathway, using thought-provoking and guiding questions to foster inquiry. Given the relevance of this stage to addressing the research problem, we chose to describe this experience in greater detail.

Report of experience in Early Childhood Education: between playing, investigating and learning

We chose to report the experience developed with the G5B class, whose project focused on the Pampa biome, one of the institutional themes selected for the school's annual educational exhibition. Following the initial discussion, what most captured the children's attention was a tool used by the teacher—a handheld magnifying glass—which immediately aroused their curiosity as they sought to understand its purpose. This object became the connection that enabled the children to take their "first steps into science." Although simple, it symbolized the expansion of horizons through inquiry and discovery. This experience reinforces the premise that children's actions and expressions are meaningful and should be welcomed as integral components of the pedagogical process (Araújo & Anjos, 2023). The teacher explained that the magnifying glass was a tool commonly used by researchers because it allows us to broaden our perspective when seeking to understand phenomena and investigate questions that arise from curiosity. To ensure participants' anonymity and comply with research ethics, the sixteen children were identified by numerical codes.

At the beginning of the investigative process, the teacher asked the class, "What are you curious about? What would you like to know more about?" One child replied, "I want to be a scientist" (Student 3). This response was soon followed by another question from a classmate: "Teacher, what is that on the windows by the entrance?" (Student 5).

We attribute curiosity not only to the children but also to everyone involved in this experience. By encouraging the exploration of the school environment, the teacher welcomed and listened attentively to the children's questions and observations. From our perspective as researchers, we interpreted this as an intentional pedagogical decision to value children's participation, even when their comments appeared simple or only loosely connected to the topic under discussion. In doing so, the teacher positioned the children at the center of the educational process and encouraged them to express their own ideas.

To move beyond traditional classroom instruction, the teacher guided the children outside the school building. Along the way, they noticed an unusual structure attached to an exterior wall. Although we, as researchers, already

knew what it was, the teacher deliberately chose not to reveal its identity so that it could become the starting point for investigation and inquiry.

The teacher then asked, "What do you think this is? What is it used for? What material is it made of?" The children proposed numerous hypotheses before observing the structure more carefully. Together, they concluded that it was made of mud and resembled what they described as a "little house"—a bird's nest. Rather than providing immediate answers, the teacher encouraged the children to formulate their own explanations, deliberately fostering curiosity and inquiry. Based on our observations and subsequent conversations with the teacher, we interpreted this approach as creating opportunities for children to construct new knowledge through research as an educational process rather than as scientific research itself, consistent with the perspective proposed by Demo (2006, 2021).

The instructional materials also created opportunities for discussions about forests, fruits, and animals through both printed and digital resources provided by the publishing company responsible for the school's learning system.

Within one of the instructional activities, entitled My ... Tree (Meu pé de...), the teacher presented an image of a bird's foot and prompted the children by saying, "This is the foot of the 'resident' of that little house you saw and have been trying to discover who built."

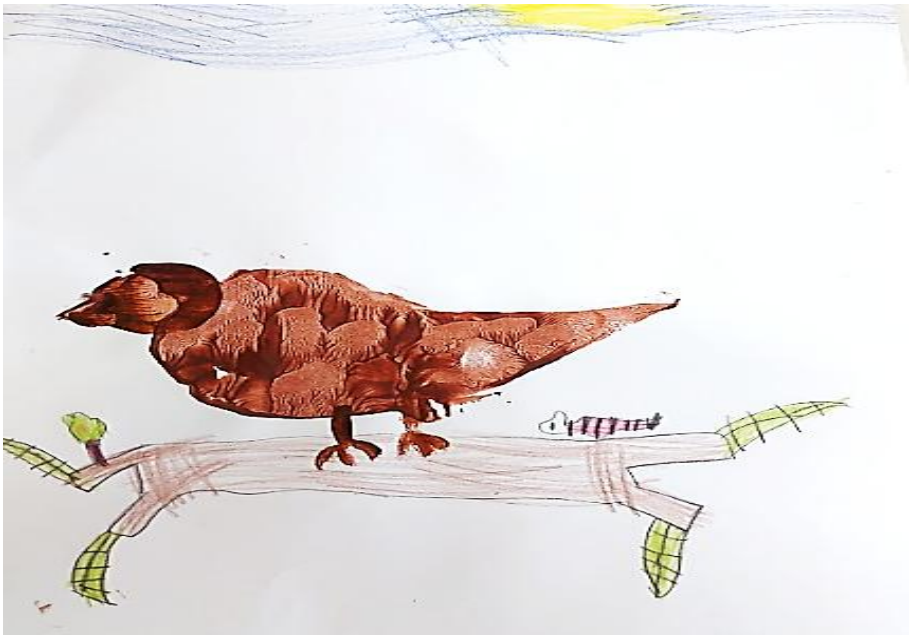
At another point in the project, the teacher showed the children actual nests built by that bird, which were part of the school's museum collection of taxidermied animals and other educational artifacts. Subsequently, the teacher used the digital audio resource available through a QR code in the textbook to help the children distinguish between different animal sounds, specifically comparing the call of a lioness with that of the Rufous Hornero (*Furnarius rufus*). Visiting different learning spaces within the school reinforced our understanding of the educational value of environments beyond the traditional classroom, challenging conservative conceptions of schooling that associate learning exclusively with conventional classrooms and teacher-centered instruction.

During another observed activity, the teacher took the children outdoors to observe birds in their natural environment, encouraging them to identify their physical characteristics and behaviors. On one occasion, the children successfully located the "resident of the little house" by recognizing its call before spotting the small brown bird.

Back in the classroom, the teacher presented images and names of three different bird species and invited the children to compare them in order to identify the correct one: the Black-fronted Piping Guan (*Aburria jacutinga*), an endangered species native to the Atlantic Forest; the Rufous-bellied Thrush (*Turdus rufiventris*), one of the most widespread and recognizable thrushes in South America; and the Rufous Hornero (*Furnarius rufus*).

To reinforce the children's understanding of the bird, the teacher used the animated film Voa, João (Fly, João), directed by Humberto Avelar (MultiRio, 2015), available online. The animation engaged the children through illustrations, storytelling, and playful elements. Subsequently, the children were invited to create artistic representations of the Rufous Hornero using gouache paint, markers, and stamps (Figure 3). From our interpretive perspective, the teacher intentionally adopted an interdisciplinary approach and diversified teaching strategies, guiding the learning process from imagination to concrete experience while integrating play, artistic expression, and direct engagement with nature.

Figure 3 – Clay models of Rufous Hornero nests produced by the children



Source: Authors' record (2024) of a child's activity 3.

From the child's drawing, we were able to interpret that the child had identified the bird's color and habitat, as well as aspects of its feeding behavior and role in pest control. This was evidenced by the inclusion of an insect or earthworm in the illustration, together with the bird perched on a tree branch, reflecting observations made during the outdoor field activity and subsequently represented in the child's artwork. Other drawings highlighted different aspects observed during the experience, such as the Rufous Hornero in flight and the termite mound encountered during the outdoor investigation.

Using an approach that resembled the principles of the flipped classroom, the teacher invited the children to continue the investigation at home with their families by researching additional facts about the Rufous Hornero. We interpreted this strategy as an intentional effort to involve families in the children's learning process, recognizing that, although children in Early Childhood Education are still developing literacy skills, they are fully capable of engaging in simple yet meaningful research experiences.

Back in the classroom, the teacher facilitated a discussion in which the children shared the information they had gathered. They were encouraged to present their findings orally, an important dimension of Scientific Literacy, as it fosters the ability to express ideas, communicate knowledge, and ultimately justify and discuss one's discoveries. Together, the teacher and the children reflected on the ecological contributions of the Rufous Hornero, including its role in pest control, seed dispersal, and other ecosystem functions.

The penultimate activity focused on the challenges the bird faces when building its nest and the importance of protecting the species and its habitat. As a pedagogical strategy, the teacher adopted an approach that closely resembled Problem-Based Learning (PBL), adapted to the context of Early Childhood Education. The central learning challenge consisted of constructing a Rufous Hornero nest using clay. Throughout the activity, children's imagination was stimulated through songs and playful interactions that accompanied the construction process, as illustrated in Figure 4.

Figure 4 – Clay bird nests made of clay by the children

Source: Authors' record (2024) of children 5 and 6.

Finally, the school's infrastructure enabled the teacher to incorporate gamification through the use of Open Educational Resources (OER), allowing the children to engage in counting activities, identify different bird species, and relate each animal to its natural habitat. In addition, we conducted informal conversations with the teacher regarding his pedagogical practices. He reported having a strong background in scientific inquiry throughout his educational trajectory, from Basic Education to Higher Education, culminating in a master's degree in Education. Beyond this teacher, we also engaged in informal dialogues and observations with the Early Childhood Education classroom teachers, who, from our interpretive perspective, were likewise immersed in pedagogical practices aimed at fostering Scientific Literacy, particularly through their participation in the school's annual Educational Exhibition.

Based on these observations, and drawing upon the work of Souza and Bonilla (2023), we inferred that the methodology adopted by teachers who engage children in research should be fundamentally grounded in approaches that value children's voices and recognize their actions as meaningful forms of expression. Consequently, teachers and researchers working with children must understand them as social subjects and active participants, whose lived experiences provide them with the capacity to engage in dialogue with their surroundings and to investigate the world through their natural curiosity. Furthermore, it is essential to value and strengthen children's voices by creating opportunities for them to express their ideas through oral language, writing, drawings, and other forms of representation. This process should also involve the support of families and the wider community, whose participation contributes both to children's development and to the meaningful implementation of research experiences.

The Seven Complex Lessons for the Education of the Future and Children

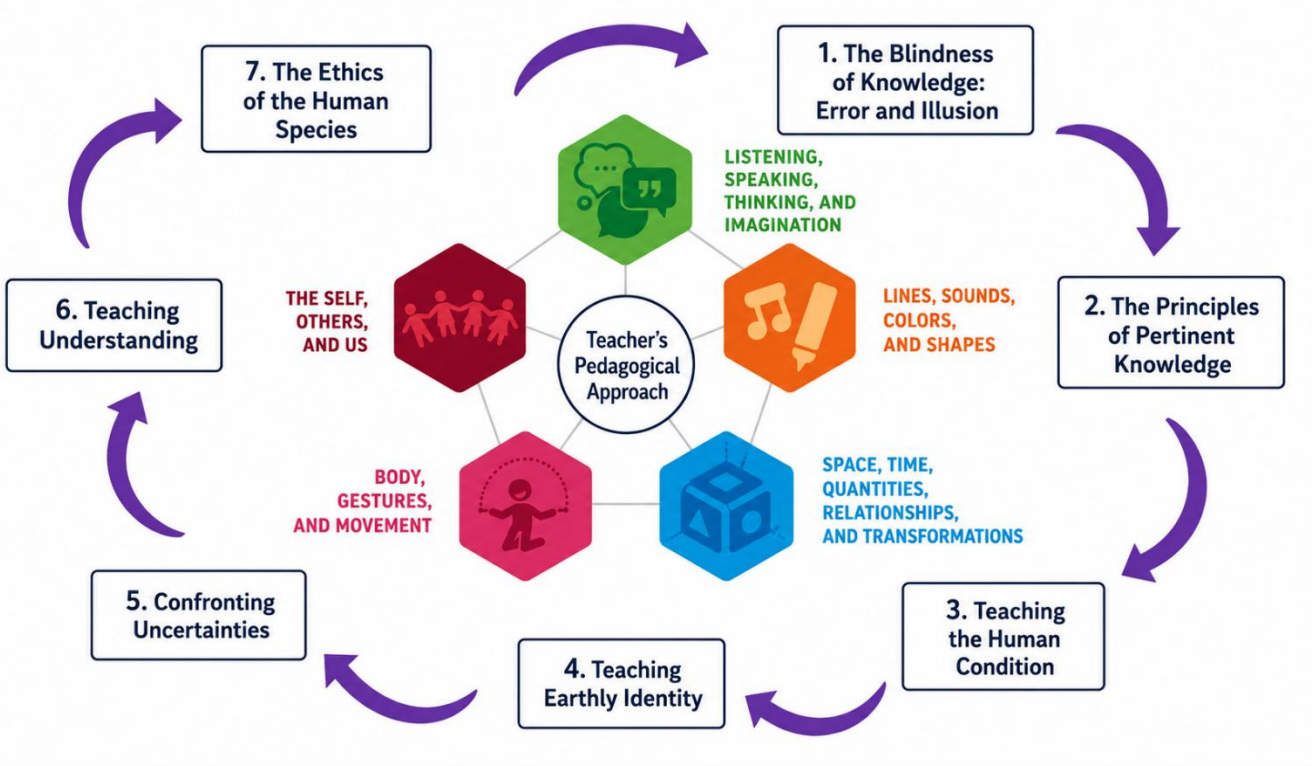
Contemporary education, including Early Childhood Education, faces increasingly complex challenges that require new pedagogical practices supported by robust epistemological paradigms. Within this context, research-based learning and Scientific Literacy emerge as complementary approaches for integrating knowledge and responding more effectively to the demands of contemporary society (Fleury, Behrens, & Kowalski, 2024; Morin, 2000).

Drawing upon a critical reading of Morin's (2000) work on complexity, this study adopted Dialogical Critical Hermeneutics within an action research framework. From this perspective, we infer that research-based learning designed to foster Scientific Literacy in young children extends beyond a pedagogical strategy aimed merely at addressing the five learning and development fields established by Brazil's National Common Curricular Base (BNCC) (Brazil, 2018). Rather, it seeks to promote a profound transformation in the ways knowledge is conceived, constructed, and taught.

By examining the pedagogical approach adopted by the Sustainable Practices teacher, together with the broader institutional framework established by the school to promote Scientific Literacy, we interpreted that these educational practices embodied the principles underlying The Seven Complex Lessons in Education for the Future

proposed by Morin (2000). Moreover, the teacher intentionally incorporated the five learning and development fields established by the BNCC for Early Childhood Education (Brazil, 2018), as illustrated in Figure 5.

Figure 5 – Morin's seven knowledges and fields of experience



Source: The authors, based on Morin (2000) and Brasil (2018).

We therefore conclude that, through his pedagogical approach, the teacher successfully addressed the five learning and development fields established by the BNCC by actively listening to the children and providing opportunities for them to express themselves, whether through artistic activities, outdoor experiences, or the diverse educational resources incorporated into the learning process. In doing so, he created opportunities for children to engage in meaningful experiences beyond the traditional classroom setting. This approach enabled them to understand their relationships with the environment and with the broader world, while fostering learning about sounds, colors, animals, and other themes through a transdisciplinary perspective. Consequently, the pedagogical practices observed embodied the principles of Morin's (2000) paradigm of complexity, particularly the Seven Complex Lessons in Education for the Future.

These seven lessons, illustrated in Figure 5, were also evident throughout the pedagogical process. They became visible, for example, when children tested and revised their own hypotheses, recognizing that making mistakes is an essential part of learning—as illustrated by their attempts to discover the material from which the bird's nest was constructed. Such pedagogical experiences also contribute to teaching the human condition and earthly identity by encouraging reflection on the impact of human actions on the environment and on the relationships established among the self, others, and the natural world.

Evidence and impact on learning

Grounded in Demo's (2006) conception of Research as an Educational Principle, we conclude that the objectives of this study were achieved, as

> The school — which does not work miracles — can play a strategic role with the public instrument of equalization of opportunities, as it becomes a privileged popular space, universalizing in the 1st grade, for the conception and exercise of citizenship. This type of education is one of the few public offers capable of reaching the social universe

> at the respective age and in this it holds central potentiality. This chance, in order to be more congruent in terms of social rights, **should be universalized from preschool onwards (0 to 6 years of age),** in the context of a preventive, emancipatory, redistributive and equalizing social policy for childhood. (Demo, 2006, p. 77).

Among the learning outcomes observed, we highlight the children's ability to explore their surroundings with curiosity, attentiveness, and critical reflection while remaining actively engaged in play. Throughout the project, they demonstrated the capacity to observe elements of the local fauna and flora, as well as to make comparisons based on colors, sounds, sizes, and other observable characteristics. We also observed significant progress in their willingness to express ideas, formulate hypotheses, distinguish geometric shapes, and understand ecological relationships. Consequently, the project extends beyond raising awareness about the Rufous Hornero itself, fostering instead a broader understanding of environmental conservation and the impact of human actions on ecosystems.

We also found that the pedagogical proposal was closely aligned with the General Competencies established by Brazil's National Common Curricular Base (BNCC) (Brazil, 2018). Our findings suggest that Early Childhood Education can provide a learning environment that encourages children to develop autonomy in decision-making, express their opinions, and interact independently with their surroundings while experiencing learning as both enjoyable and intellectually challenging, particularly with regard to logical reasoning and creativity. According to Raymundo and Ribeiro (2025), such experiences contribute to the development of children's identity while strengthening their critical thinking and natural curiosity, encouraging them to seek solutions to questions that emerge during play and through interactions with peers, the environment, and the wider school community.

Kramer (2006) argues that play is an inherent characteristic of childhood and, at the same time, possesses significant pedagogical potential. When intentionally and appropriately incorporated into educational practice, play becomes a powerful pedagogical resource for promoting children's learning and development.

> However, play is often undervalued in the school context, being seen as something separate from the formal learning process. This view, common in some educational approaches, disregards the potential that play has as a means of development and learning (Santos; Machado, 2025, p. 270).

We also highlight the opportunities children had to express their learning, both orally and through various forms of representation. This was particularly evident when they shared the findings of the investigations conducted with their families, presenting discoveries they recalled through drawings and other expressive resources. These activities enriched the learning process by reinforcing children's understanding of the bird's habitat and its distinguishing characteristics. Learning also emerged through direct engagement with the natural environment surrounding the school, where children explored the sounds of nature—especially birdsong—and observed fruit-bearing trees, thereby deepening their understanding of local biodiversity.

The project also created opportunities for children to make decisions and justify their reasoning. For example, they compared the Rufous Hornero's nest with a termite mound and concluded, through discussion, that although both structures were made of mud, they were not the same. One child noticed the absence of a "door" in the termite mound, while another wondered why a bird would build its home on the ground. These exchanges illustrate the children's developing capacity to observe, compare, question, and construct explanations based on evidence gathered throughout the investigation.

During the clay-modeling activities, the children experienced firsthand the challenges involved in constructing a bird's nest, even when using their own hands. They also reflected on the importance of respecting and preserving the work created by another living being, recognizing that, for the bird, the nest represents far more than a simple construction—it is essential to its survival and reproduction.

Final Considerations

Based on the perspectives of the eight Early Childhood Education teachers involved in the projects, together with their experiences as teacher-researchers and the responses they voluntarily provided to the study questionnaire, we found that four of them were participating in the school's Science Exhibition for the first time. In other words, half of the participants were engaging in Scientific Literacy practices promoted by the institution for the first time. Seven of

the teachers recognized children as capable of acting as researchers, even in Early Childhood Education, and all reported that, after completing the projects, they perceived themselves more strongly as teacher-researchers. These reflections emerged not only among the participating teachers but also throughout our own interpretive process as researchers.

These findings also contribute to a broader understanding of the school's role in fostering research. At all educational levels—and particularly in Early Childhood Education—schools should embrace research as a fundamental principle of teaching and learning. Life itself is characterized by continuous processes of transformation and reconstruction; consequently, learning should be understood as an ongoing process throughout one's development as a historical and social subject. Within this perspective, the family also plays an essential educational role, as children's learning extends beyond the school environment. Cultivating curiosity from early childhood therefore becomes a fundamental educational responsibility.

Accordingly, this study demonstrated that children can engage in play and research simultaneously through pedagogical, instructional, and methodological resources that are aligned with the principles established by the BNCC and by the curricular guidelines adopted in the state of Paraná for Early Childhood Education. The BNCC establishes six rights to learning and development—living together, playing, participating, exploring, expressing oneself, and developing self-awareness—as foundational principles intended to ensure children's learning and development. These rights constitute the basis of the curriculum's two structuring axes, interactions and play, which support meaningful learning experiences (Brazil, 2018, p. 25).

Teachers who intentionally design lesson plans incorporating diverse educational resources, whether digital or printed, create opportunities to implement projects that are appropriate for both the educational stage and the developmental characteristics of children aged four to five years. The integration of multiple learning resources enriches both play and learning, while also preparing children to participate in an increasingly interconnected and digitally mediated world. Since the beginning of the twenty-first century, digital technologies have become an integral part of everyday life. Consequently, children should gradually learn how to investigate and construct knowledge using both traditional sources, such as libraries, and digital environments (Behrens & Prigol, 2024). Equally important is developing the capacity to critically evaluate the reliability and relevance of the information they encounter. Such learning extends beyond formal schooling, encouraging children to move beyond rote memorization and unquestioned certainties while preparing them for an uncertain, rapidly changing, and increasingly complex future.

Finally, our findings indicate that research-based learning represents an innovative educational approach capable of addressing the principles of Morin's (2000) paradigm of complexity, particularly by promoting the reconnection of knowledge and a holistic understanding of reality.

Children's development and learning were assessed according to their developmental stage. Within the scope of this study, particular attention was given to teachers' interpretations of children's learning processes, focusing on peer interactions, communicative abilities, motor development, empathy, and other dimensions associated with the BNCC's learning and development fields. The children became deeply engaged with the project, demonstrating sustained attention and an ability to understand ideas both within and beyond the school context. Parents also reported that their children enthusiastically shared these experiences at home, indicating that learning extended beyond the classroom.

At the conclusion of the project, we observed that the children had learned far more than facts about birds and their nests. They had developed an understanding of the importance of investigating, observing their surroundings, and questioning information before accepting it as true—abilities that closely reflect the principles of Scientific Literacy. We therefore conclude that both children and teachers are already capable of embarking on a genuine scientific journey through the sciences.

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Editor Responsável/Editor-in-Chief: Alboni Marisa Dudeque Pianovski Vieira

Recebido/Received: 28.01.2026 / 01.28.2026

Aprovado/Approved: 10.07.2026 / 07.10.2026