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EXPERIENCE REPORT: IMMERSION IN OPEN AND FORMAL SPACES IN BASIC EDUCATION

RELATO DE EXPERIÊNCIA: AMBIENTAÇÃO AOS ESPAÇOS ABERTOS E FORMAIS NA EDUCAÇÃO BÁSICA

RELATO DE EXPERIENCIA: AMBIENTACIÓN EN ESPACIOS ABIERTOS Y FORMALES EN LA EDUCACIÓN BÁSICA

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Abstract: Educational regulations concerning extracurricular multidisciplinary activities conducted in informal spaces—such as university laboratories, museums, farm schools, botanical gardens, extractive reserves, and traditional communities—are guided by resolutions from the National Education Council. These settings serve as privileged environments for integrating diverse areas of knowledge. This descriptive research aimed to foster environmental awareness among students in natural spaces, emphasizing the study of ancestral fauna and flora, as well as the recovery of empirical and normative knowledge to be applied throughout their academic and social trajectories. Since 2021, this experiential report reflects a pedagogical intent to connect Science and Biology curricula with field practices in formal and informal environments, promoting critical and contextualized learning.Activities occur during technical visits and open-field outings, in collaboration with research institutes and local universities, with prior permission and scheduling. The main contributions include enhancing observational skills, identifying vocations related to future careers in environmental science communication, and strengthening the retrieval of regional and empirical knowledge from diverse cultures. These cultural insights, rooted in students' genetic and familial backgrounds, are linked to visited environments, enriching the learning experience.Ultimately, this collective educational endeavor advances sustainability, environmental recognition, and appreciation for life in all its forms.

Keywords: Education. Scientific literacy. Social and educational responsibility.

Resumo: As normativas educacionais relativas às atividades multidisciplinares extraescolares, desenvolvidas em espaços não formais — como laboratórios universitários, museus, escolas-fazenda, jardins botânicos, reservas extrativistas e comunidades tradicionais — pautam-se nas resoluções do Conselho Nacional de Educação e constituem dispositivos privilegiados para essa integração. O objetivo da pesquisa descritiva foi promover a ambientalização dos estudantes em espaços naturais, integrados a diferentes áreas do conhecimento, com ênfase no estudo da fauna e da flora ancestrais e no resgate de saberes empíricos e normativos a serem utilizados e aplicados ao longo de suas trajetórias acadêmicas e sociais.

Este relato de experiência, vivenciado desde 2021, tem como intencionalidade pedagógica articular os conteúdos das disciplinas de Ciências e Biologia a práticas de campo em espaços formais e não formais, favorecendo uma aprendizagem crítica e contextualizada para a formação acadêmica dos estudantes. As aulas ocorrem durante visitas técnicas e atividades de campo aberto, em parceria com institutos de pesquisa e universidades locais, mediante autorização prévia dos responsáveis e pré-agendamento. Como principais contribuições, as atividades têm possibilitado o desenvolvimento de múltiplas habilidades de observação, a identificação de vocações para profissões do futuro voltadas à comunicação científica ambiental e o fortalecimento do resgate de saberes empíricos e regionais de diferentes culturas. Tais saberes, vivenciados no contexto genético e familiar dos estudantes, são conectados aos ambientes visitados, ampliando o sentido da aprendizagem. Desse modo, a experiência constrói coletivamente uma aprendizagem

comprometida com a sustentabilidade, o reconhecimento ambiental e a valorização da vida em todas as suas formas.

Palavras-chave: Educação. Letramento científico. Responsabilidade social e educativa.

Resumen: Las normativas educativas relacionadas con actividades multidisciplinarias extraescolares desarrolladas en espacios informales—como laboratorios universitarios, museos, escuelas-ganadería, jardines botánicos, reservas extractivas y comunidades tradicionales—se guían por las resoluciones del Consejo Nacional de Educación. Estos espacios actúan como entornos privilegiados para la integración de diversas áreas del conocimiento.Esta investigación descriptiva tuvo como objetivo promover la sensibilización ambiental de los estudiantes en espacios naturales, poniendo énfasis en el estudio de la fauna y flora ancestrales, además de rescatar saberes empíricos y normativos, para que sean utilizados a lo largo de su trayectoria académica y social. Desde 2021, este relato de experiencia busca vincular las disciplinas de Ciencias y Biología con prácticas de campo en espacios formales e informales, favoreciendo un aprendizaje crítico y contextualizado. Las actividades se realizan durante visitas técnicas y salidas a campo abierto, en colaboración con institutos de investigación y universidades locales, con autorización previa y agendamiento. Las principales contribuciones incluyen el desarrollo de habilidades de observación, identificación de vocaciones para futuras profesiones en comunicación científica ambiental, y el fortalecimiento del rescate de saberes empíricos y culturales regionales. Estos conocimientos, originados en el contexto familiar y genético de los estudiantes, se relacionan con los ambientes visitados, enriqueciendo el proceso de aprendizaje.Así, la experiencia fomenta una educación comprometida con la sostenibilidad, el reconocimiento ambiental y la valoración de la vida en todas sus formas.

Palabras clave: Educación. Alfabetización científica. Responsabilidad social y educativa.

1 INTRODUCTION

Educating for preservation has become a central theme in discussions about the future of humanity, particularly through eco-educational spaces that foster environmentally conscious citizens from early childhood.

Amid recurrent climate crises and increasing demands for improved living conditions, students from Brazilian biomes face migratory pressures toward urban centers, either accompanied by their families or idenpenIdently. This displacement generates cultural, affective, and emotional impacts, while also requiring adaptation to demanding educational systems that may disrupt established routines of empirical and scientific knowledge, thereby challenging socio-emotional balance (Adams & Marshall, 1996).

In this context, school field trips emerge as a pedagogical strategy to mitigate such challenges by promoting sensory interactions with natural and cultural environments. International studies corroborate their impact. Li *et al.* (2024) show that excursions enhance children's perceptions of educational value through concrete experiences; Kleespies *et al.* (2020) demonstrate that guided zoo visits strengthen environmental connection; Sánchez-Fuster *et al.* (2023) highlight interdisciplinary learning in cultural spaces and emphasize that school visits to cultural and educational heritage sites contribute to contextualizing curricular content, strengthening the relationship between school, territory, and community; Parejo (2025) reinforces teacher development; and Nwokocha (2024) points to gains in practical science learning despite logistical constraints. Collectively, these practices integrate theory and experience, sensitizing participants to the preservation of natural resources and collective responsibility.

Field trips also benefit teachers, who expand their pedagogical repertoires through information exchange and reflections during immersion. In teacher training, Parejo (2025) notes that out-of-school

learning experiences in innovative educational institutions significantly contribute to the professional, critical, and reflective development of future educators, strengthening the articulation between theory and practice, enabling engagement with diverse pedagogical approaches in authentic teaching contexts.

Additionally, the promotion of structured technical visits to natural environments and open spaces become essential, as these experiences stimulate critical thinking and foster knowledge construction through observation, guided explanations, and practical field activities. These experiences support the integration of curricular content, strengthening the relationship between theory and practice and broadening students' understanding of studied knowledge.

The present study reports on school field trips conducted between 2021 and 2025 as part of environmental education strategy aimed at promoting meaningful and reflective learning in natural and cultural settings. Specifically, the study sought to: (i) analyze the role of pedagogical mediation, based on the Political-Pedagogical Plan (PPP), within the context of school excursions; (ii) investigate how these activities contribute to the development of pro-environmental attitudes and interdisciplinary knowledge construction; and (iii) compare the effects of guided and unguided visits on the learning process.

2 METHODOLOGY APPLIED DURING CLASSES IN NATURAL SETTINGS

2.1 Research characterization

The organization of classes in natural settings required careful logistical planning, taking into account the individual student's needs and learning pace. Prior orientations sessions and the provision of personal protective equipment were essential to ensure safety and the quality of the educational process. Students were instructed that, despite the actvities took place in an outdoor environments, they were equivalent in status to conventional classroom lessons, with interactions with the landscape and natural surroundings functioning as extensions of the formal school setting.

2.2 Study area and target audience

The experience was developed in partnership with the Museu Vivo, the Experimental Station for Flora and Fauna Species Management, and other educational and research institutions that maintain extensive biological collections. These partnerships enabled the implementation of instructive and informative visits aligned with the pedagogical plans established by the local curricula of state and municipal public schools, in accordance with the bimonthly planning for the disciplines of Biology and Natural Sciences. Over a five-year period, the innitiative involved approximately 1,000 high school students, as well as a smaller number of elementary school students, from public schools in the state of Amazonas.

Institutions such as the Manaus Botanical Garden (MUSA), the Soka-Amazônia Institute, and other spaces reported in this study offer educational models applicable to a wide range of school contexts. Operating across both formal and non-formal educational settings, these institutions play a central role in strengthening educational themes within informational and eco-pedagogical ecosystems.

2.3 Methodology for field trips

Activities were carefully structured with precise instructions to minimize incident risks and prevent student discomfort. Key guidelines included the use of ultraviolet-protective clothing, closed-toe footwear, constinous hydration through personal water bottles, the application of insect repellent, and systematic documentation in reports and summaries. To document observations and perceptions during the learning process, students used pens, pocket notebooks, cameras, or smartphones, with emphasis on developing sensory and observational skills.

Students were oriented to rest prior the day of the activity, prepare their protective gear in advance, and follow guidance ragarding location, conduct, and observational routines. Visits were conducted as part of the formal curriculum, in collaboration with teachers and instructors from partner institutions, an required prior scheduling with the host organizations. Classes were divided by grade level and conducted with one group at a time, comprising no more than 40 students (1st, 2nd, and 3rd years of high school, and occasionally 9th-grade elementary school). General safety and conduct guidelines were provided during all visits along natural trails and during the field-based educational activities. Students were encouraged to use their electronic devices as tools for information retrieval and inquiry.

Although operationally straightforward, the trip logistics proved pedagogically complex due to diverse needs and individual specificities of the students. Accordingly, paeticipants were instructed to: (i) conduct a prior virtual familiarization with the site using digital resources, such institutional websites and explanatory videos; (ii) maintain appropriate observational conduct throughout the itinerary; and (iii) recognize the activity as part of the formal teaching process, despite its outdoor setting. Both traditional tools (notebooks and written reports) and electronic devices were employed for data collection and recording, facilitating systematization and subsequent classroom analysis.

2.4 Methodological approach and ethical considerations

This is a qualitative educational experience report, outlined as collaborative action research between formal spaces (public schools) and non-formal spaces (museums and stations). Participant selection used convenience and intentionality criteria (profile: students aged 13–18 from public schools in Amazonas, mostly low-income, aligned with bimonthly Biology/Science plans).

Instruments: participant observations, field reports, and student reflections. Analysis: reflexive thematic via triangulation of records. The practice complied with Resolution CNS No. 466/2012, with prior guidance to students and guardians and waiver of CEP approval (item VIII.9.c, due to absence of risks) (National Health Council, 2012).

3 RESULTS AND DISCUSSION

The findings of this study derive from field-based activities and descriptive data collection, complemented by student feedback expressed in their statements expressed though written, oral, and practical classroom evaluations. These activities sought to promote awareness of the importance of the ecosystems for environmental balance and for understanding biotic interactions throughout evolutionary processes, while highlighting the need to preserve and value both empirical and academic grounded scientific knowledge in teaching of Biology and Natural Sciences, in accordance with students' experiential backgrounds and levels of expertise.

3.1 Learning guided in natural and non-formal settings

Learning activities conducted during field visits provided students with structured experiences mediated by teachers and institutional instructors. These experiences fostered critical thinking and encouraged the appreciation of nature as a space for personal development and intellectual inspiration. Natural environments proved fundamental in stimulating sensory and cognitive perceptions, enabling students to observe, record, and interpret information crucial to the development of their life projects and future career pathways.

3.2 Tentegration between scientific knowledge, empirical knowledge, and student engagement

During field walks, students showed heightened engagement in educational processes, strengthening connections between scientific knowledge and empirical understanding through direct interaction with plant samples, soils, geological and cultural-historical artifacts, as well as animal and seed collections. This interaction contributed to the understanding that learning extends beyond the formal classroom and it is enriched through practical experiences in direct contact with biodiversity.

Moreover, field-based experiences traditionally enhance subjective dimensions of learning, such as autonomy, a sense of belonging, and recognition of individual identity—factors closely associated with increased student engagement and meaningful learning in non-formal settings (Deci & Ryan, 2000; Sauvé, 2005; Kolb, 1984; Rickinson *et al.*, 2004; Gruenewald, 2003). These findings align with the contextual model proposed by Falk and Dierking (2000, 2016), highlighting that learning in non-formal environments is strenghtened through interactions among the individual's physical, social, and personal dimensions, particularly when learners are afforded freedom of movement, choice of observation sites, minimal rigid strandardization, and more horizontal forms of interaction.

3.3 Pedagogical mediation, logistics, and student leadership

The historical contextualization of the visited spaces as integral componets of the educational process expanded opportunities for sensory perception and development of academic agency. Students reported greater inspiration for their school activities and increased motivation to reflect on their role as engaged

citizens. These outcome align with Marandino (2008), who emphasizes the importance of museums and non-formal environments as cultural and scientific mediation.

The adopted guidelines—such as summaries adapted to the content and study phases, field guides organized as notebooks, assessment of prior knowledge, use of tools such as Google Maps, use of cameras to document field trails, as well as pens, brush pens, highlighters, and basic protective equipment for group mobility—were designed to enhance students' skills, including the use of technological resources for recording and disseminating their experiences.

This process contributed to expanding students' understanding of their life projects, as well as their possibilities for professional integration.

Although structurally straightforward, the conduction of field trips involved complex logistical coordination given individual students demands. Specific equipment and guidelines proved essential in optimizing the educational experience in these settings. Students were oriented on the formative purpose of the activities, which combined pedagocial objectives with interactive engagement with the landscape and environmental educators. These activities were aligned with the bimonthly curricular themes–such as plant diversity, Amazon seed networks, and ecological substations–within the domains of Earth Physics and Natural Sciences and their Technologies.

3.4 Museum spaces and environmental education: the case of the amazon museum (MUSA)

Environmental educators play a fundamental role in teaching and fostering socio-environmental awareness in both formal and non-formal contexts dedicated to the conservation of natural resource for future generations. In this regard, the Museu da Amazônia (MUSA) stands out as an institution that integrates educational and scientific initiatives at valuing Amazonian biodiversity.

MUSA currently maintains an Educational Center responsible for environmental and museum education activities within thematic spaces organized through photographs, exhibition structures, ecological niches, and live specimens housed in environments designed to simulate natural conditions. These strategies foster immersive learning experiences, contributing to the development of critical awareness regarding the preservation of Amazonian fauna, flora, and ecosystems.

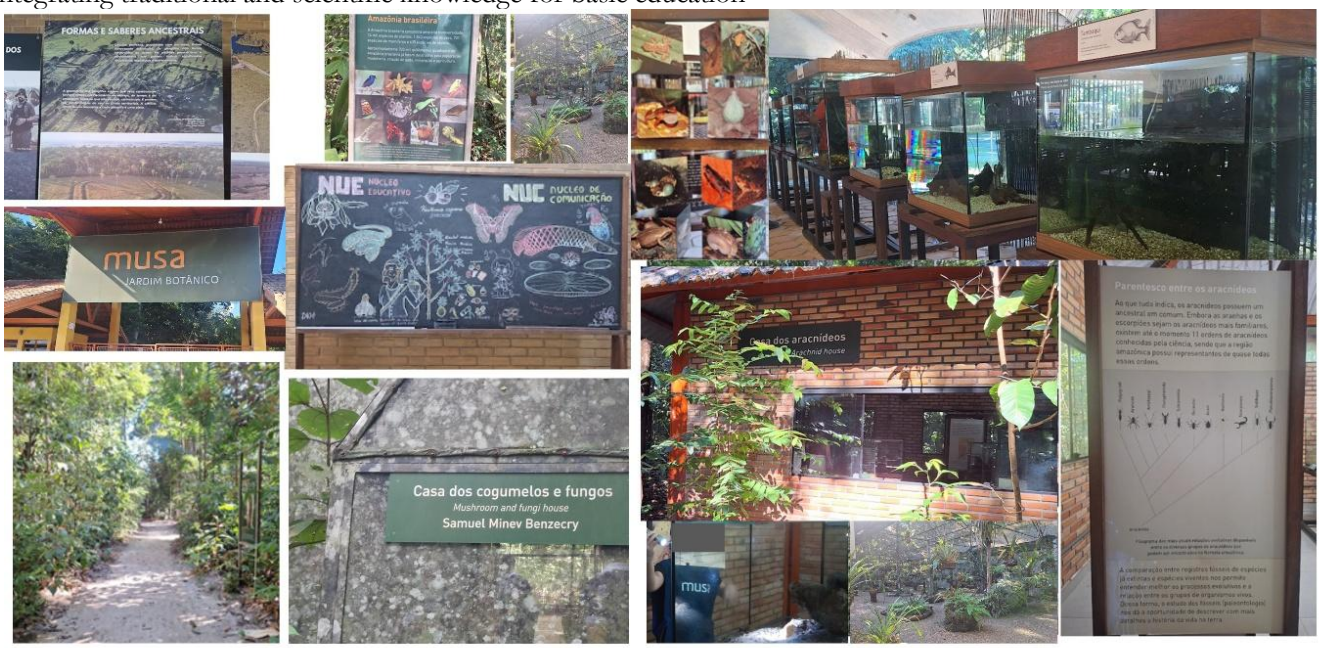
The Educational Center operates activities through scheduled visits, mediating teaching and learning processes grounded in interdisciplinarity and inclusivity. It serves diverse audiences, including early childhood, elementary, secondary, and higher education, as well as non-profit social organizations and elderly groups. Through guided pedagogical mediations, participants are encouraged to explore exhibition spaces and reflect on society-nature relationships, promoting understanding that the environment is not a distant entity but a system of which individuals and urban communities—such as those in Manaus—are integral parts. This perspective strengthens a sense of belonging and socio-environmental responsibility.

Within this framework, education in natural environments transcends occasional visits or simple landscape contemplation. It entails recognizing students' formative interests and professional aspirations,

connecting them to species preservation—including human life—and valuing their lived experiences as integral components of the educational process. Activities in these spaces aim to cultivate environmental awareness while fostering dialogue across multiple areas of knowledge.

In particular, examining historical and cultural relationships between humans, plants, and animals within their habitats aligns with perspectives from ethnoecology and environmental history. The recovery of empirical and traditional knowledge supports meaningful learning and contributes to students' academic and professional formation development, aligning with contemporary approaches to critical and contextualized science education.

Figure 1 – Examples of thematic spaces and interactive, informative panels at the Museu da Amazônia (MUSA), integrating traditional and scientific knowledge for basic education



Source: Images taken from the author's private collection between 2021 and 2025

These environments are consolidated as centers of knowledge production and the appreciation of the region's cultural and scientific diversity, fostering educational experiences that strengthen Amazonian identity and expand dialogue among science, society, and nature.

3.5 Environmental education, amazonian fauna, and scientific mediation

The following account highlights the importance of understanding genus-level diversity in line with leading active researchers in the field. Tiago Carvalho, coordinator of the Arachnid Sector at the Museu da Amazônia (MUSA), demonstrates extensive expertise regarding some of the most representative arachnid genera in MUSA's forested exhibition areas, contributing to the scientific and cultural valuation of these animals and to their relevance to ecosystem functioning and public health.

Interview conducted to validate information regarding field classes and live instructional practices.

This space aims to promote environmental education. We use animals as educational tools to help people understand the importance of forests and fauna, which, in turn, influences our quality of life. Environmental educators work precisely from this perspective by explaining, in accessible terms, ecological relationships and the importance of interactions among different agents, such as animals and plants, to ensure proper ecosystem functioning. This contributes to climate regulation and other environmental benefits. Therefore, it is essential to understand the importance of maintaining the forest in proper functioning, as it positively influences our quality of life.

In the case of the Arachnid House, the space was specifically created to provide environmental education about these animals, which are often perceived by the general public as undesirable, unattractive and heavily stigmatized. The Arachnid House offers an alternative perspective, highlighting their importance within forest system, with particular focus on zoological and ecological aspects. Interesting facts are presented and visitors are encouraged to establish connections and understand that these animals are fundamental to the ecosystem maintenance, which in turn is reflected in human well-being.

- ***Tiago Carvalho**, zoologist and coordinator of the Arthropods Sector and the Arachnid House at the Amazon Museum (MUSA), 2026.*

Animals exhibit strong appeal in environmental education, especially when they possess ecological relevance and offer opportunities to explore aspects of animal physiology, as observed in studies of stinging and stingless bees (i.e., stinging apparatus or venom-inoculation mechanism). These insects have been the subject of scientific research in Amazonian ecosystems for decades and playing a key role in environmental education initiatives.

Foremost, they stand out for the ecological services they provide to biodiversity and for their contributions to local bioeconomies linked to fauna and flora. Bees, along with other pollinators, are featured in the environmental education trails of the Bosque da Ciência (Science Forest), affiliated with the National Institute for Amazonian Research (INPA). This space operates under a research program within the institutions' Bee Molecular Genetics Laboratory and welcome elementary, secondary, and higher education visitors. It provides students with diverse opportunities to access scientific knowledge related to food production, medicine resources, and ecosystem services.

3.6 Collective Memory, Belonging, and Socio-Environmental Well-Being

Students' immersion in natural environments fostered an appreciation of collective memory and local histories, broadening their sense of belonging and strengthening cultural identity. At the conclusion of each activity, individual student perceptions contributed to a shared understanding of environmental education within Amazonian contexts, strengthening collaborative bonds, openness to new external practices, and connections among school, science, and community.

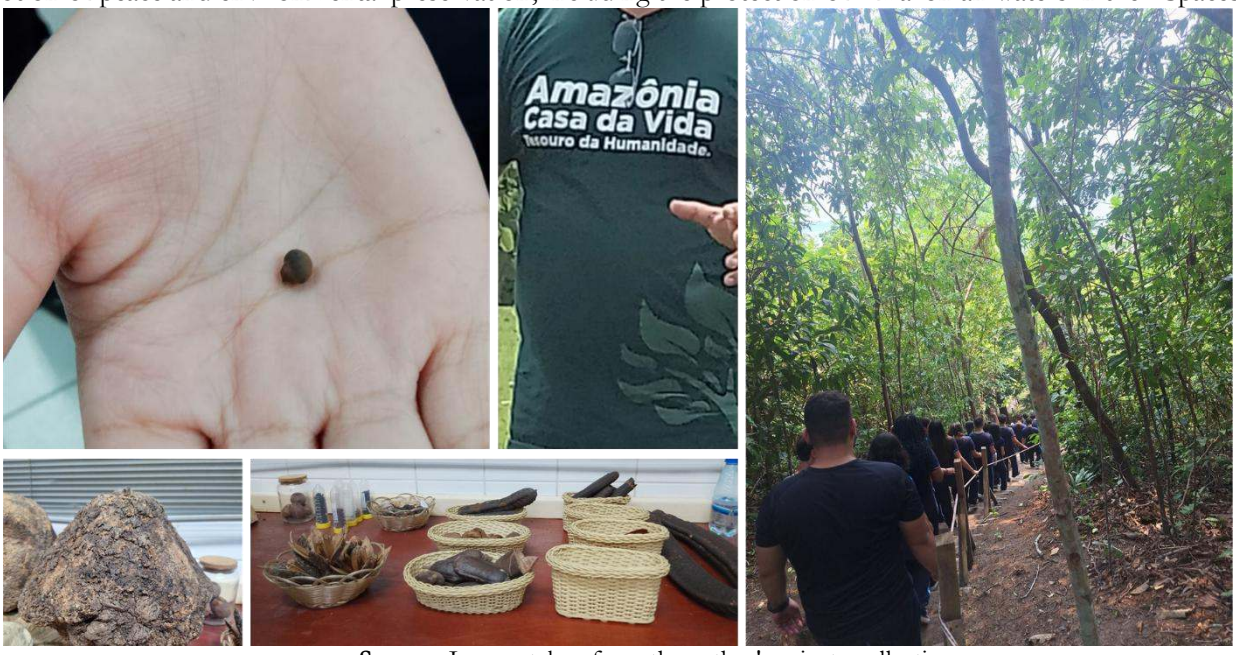
The act of planting may be understood as both a symbolic and concrete practice of knowledge constructing and education.

Engagement with natural spaces expanded students' multiple interests and fields of action, including agroforestry systems, agrobiology, youth entrepreneurship, healthy nutrition, and socio-environmental and spiritual well-being. These dimensions align with the cultural traditions and socioecological realities of local communities. Collectively, they contribute to educational process by fostering holistic development grounded in social and community contexts—that is, within students' own lived environments.

3.7 Partner Institutions and Scientific Initiation: The Case of the Soka Amazon Institute and INPA

Another relevant educational space in our region is the Instituto Soka Amazônia, which, through its structure and landscape design, encompasses small biological niches rich in information across multiple fields of knowledge. Among its notable collections are a seed bank of native species for reforestation and preservation of the site's native matrix trees (Figure 2).

Figure 2 – Socio-educational space within the reserve, founded by Daisaku Ikeda (1928–2023), dedicated to the promotion of peace and environmental preservation, including the protection of Amazonian waters in their Spaces.



Source: Images taken from the author's private collection

In 2024, during the Amazonian climate crisis, high school students visited this site, which enabled them to better understand the hydrological cycles of Amazonian rivers and their fundamental relevance to sustaining life. The Institute operates as an experimental station, offering educational spaces such as the seed banks, plant nurseries, and seedlings of native and economically relevant species—initiatives that promote environmental awareness and reforestation practices. The presence of an apiary further supports understanding of pollinators' ecological roles, particularly in scents and flowers (phanerogam reproduction) and the maintenance microsystems within the reserve.

The site also integrates historical and geological dimensions spanning thousands of years, linked to ancient civilizations and marked by local multicultural heritage. From ancient indigenous artifacts to historical ruins of former inhabitants, the space underscores the responsibility to integrate systems into basic education, strengthening community identity and local engagement.

Natural spaces constitute privileged settings for the development of meaningful pedagogical practices while contributing to students' socio-emotional and spiritual well-being. Many students report a renewed sense of well-being through contact with living elements such plants and animals, as well as through the site's

atmosphere and their own sense of belonging. Such experiences represent a reconnection with their essence in in the regions where they live, especially in rural schools and local communities.

Student testimonials further demonstrate how these experiences foster integration across knowledge areas and prepare future professionals for cross-disciplinary engagement. Moreover, these environments allow participants to experience and understand the forest's complex systems, forging connections that strengthen teaching and learning processes focused on basic and community education.

In gratitude for the kindness and dedication of the professionals who accompanied us on this visit, I would like to highlight the benefits of visiting this place, which is so important to us. The visit was very meaningful and enriching, allowing us to learn a little more about our culture and how to preserve it. This becomes even more relevant in the current context, as we are facing a severe river drought and recurring fires. The trail integrates environmental preservation practices and opens opportunities for people who are interested in the area and wish to contribute to environmental improvement.

A.Z, 2024.

The visit to the Soka Amazon Institute encuraged us, at school level, to deepen our reflection on environmental preservation around us. We explored various aspects promoted by the Institute's, discussed the importance of caring for surrounding biodiversity, and observed the great wonders of the Amazon, such as the magnificent sumaúma tree, which can reach up to 70 meters in height. Seeing the "Meeting of the Waters" up close and learning about the remains of ancient indigenous heritage sites was particularly meaningful. It was very exciting to share this adventure with my classmates and other students. Undoubtedly, it is a remarkable place, with extraordinary flora, that allows us to learn more about and appreciate the richness of the Amazon.

B.A, 2024.

Like other scientific outreach and educational spaces, the Science Forest (Bosque da Ciência), belonging to the National Institute of Amazonian Research (INPA), constitutes an educational environment that fosters scientific immersion across different levels of education, ranging from primary schooling to higher education. The site comprises experimental stations and collective initiatives focused on the teaching–learning process, articulated with research and projects carried out within governmental, private, and social programs, in diverse areas of the Brazilian Legal Amazon as well as in international contexts (Figure 03).

Like other scientific outreach and educational spaces, the Science Forest (Bosque da Ciência), belonging to the National Institute of Amazonian Research (INPA), constitutes an educational environment that promotes scientific immersion across multiple levels of education, ranging from primary education to higher education. The site comprises experimental stations and collaborative initiatives focused on the teaching–learning process, articulated with research conducted in diferente areas of the Brazilian Legal Amazon as well as in international contexts (Figure 03).

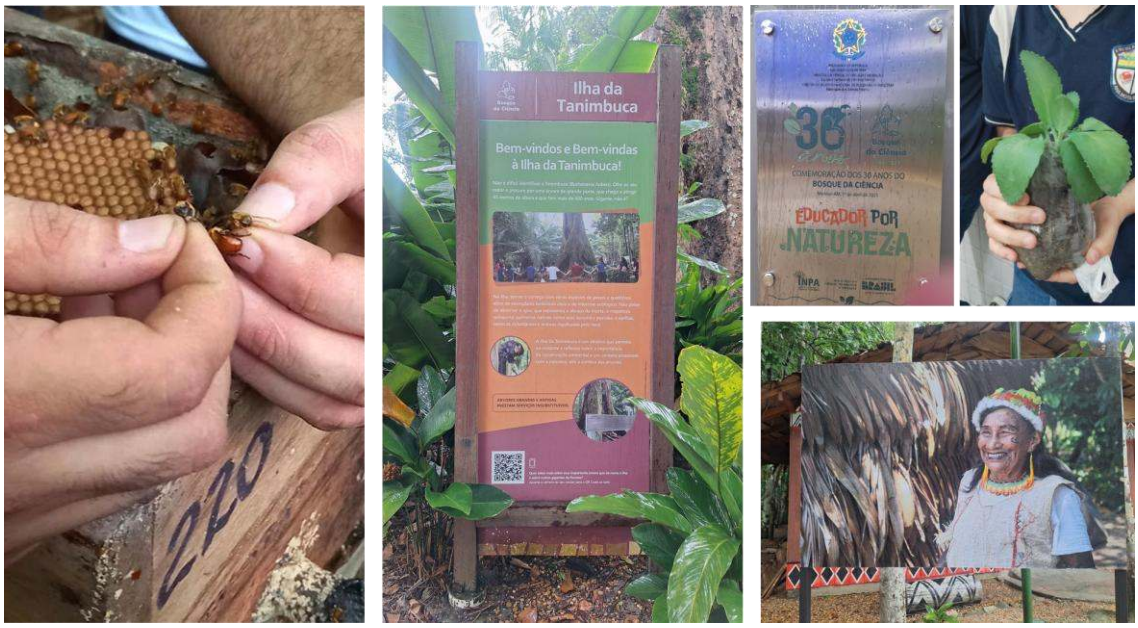
During the implementation of programs and projects carried out within these educational environments at INPA, it was possible to engage students in structured and methodologically guided activities, resulting in successful teaching–learning experiences. The active participation of students in

scientific immersion processes, particularly in projects such as AMAZONFACE, highlighted the importance of these initiatives for academic and scientific training.

Some of the principles that shape the Earth Charter, as described in Brazil (2000), advocate for the preservation of all systems, including duties and scientific knowledge, in favor of the collective and the evolutionary processes of native species on the planet, as well as social concerns.

It is essential to foster, as soon as possible, self-care among vulnerable and at-risk populations in hostile environments caused by ecological and climatic changes in the territories, including the Brazilian Legal Amazon and international border regions. This can be achieved through knowledge technologies present in institutions such as CNPEM-SP, which have been shaping the biodiversity of genetic systems found in molecules and sources of binomial energy matrices.

Figure 3 – Representative spaces designed for field classes and thematic projects addressing the social and scientific dimensions of the Amazon.



Source: Images taken from the author's personal album, captured during the visits.

Activities provided direct exposure to laboratories, analytical equipment, and field research areas where major projects such as AMAZONFACE are conducted. This program investigates the capture and production of atmospheric gases by Amazon rainforest vegetation through Free-Air CO_2 Enrichment (FACE) technology, designed to enrich CO_2 in natural environments (INPA, 2015). During the visit, students observed the installation of experimental towers at the INPA research station located at kilometer 80 north of Manaus.

The knowledge acquired included understanding functional micro- and macromolecules, landscape ecology, and terrestrial systems with economic and social relevance for local communities, agribusiness, and forestry sector. Visits to laboratories, forest trails, and woodlands provided insight into the ecodynamics of integrated biological systems.

Specifically, the visit to the AMAZONFACE facilities provided opportunities for experiential and the acquisition of knowledge regarding the biological dynamics of the Amazonian landscape, with particular emphasis on the processes of CO_2 release, uptake and monitoring in the atmosphere, as well as its interactions with vegeation and soils. These activities involved the use of quantum and functional tools adapted to both small- and large-scale plant systems.

Learning also contributed to the characterization of forest litter—fallen leaves and organic debris—in and its roles in nutrient cycling, composting processes, maintanance of biochemical components in green matter (plants and animals), and contributions to greenhouse gas regulation.

During the participation of students in the *Future Scientists* immersion program, conducted at the Federal University of Amazonas (UFAM) through the project **Future Scientists in Food Technology: Fruit Processing for the Agroindustry in the Amazon**, under the work plan entitled *Future Scientists in Food Technology: A Scientific Immersion*, a deeper understanding of the biochemical and technological foundations of food production was fostered.

The activities encompassed engagement in multiple research lines within the University, providing practical insights into the academic pathways and, more specifically, into the molecular mechanisms underlying flavor and aroma compounds in foods at the level of basic science. This knowledge was subsequently applied to the development of eco-sustainable and socially viable agroindustrial food products.

The advancement in teacher training, through the immersion methodology, expanded the possibilities for teaching Biology in the classroom, fostering awareness of the relevance of the genetic diversity of Amazonian species for the socioeconomic sustainability of regional agriculture and food cultures. There was also an appreciation of both scientific and empirical knowledge, encouraging new professionals to explore the potential of fruits and organic, healthy foods, with positive impacts across different Brazilian states and on the global stage.

3.8 Integration Between Formal and Informal Education and Scientific Literacy

These experiences contribute to a broader understanding of participatory Biology and expand knowledge that is often grounded in textbooks. The first contact with scientific initiation occurs precisely during this transition phase from childhood to pre-adolescence, within the school context, fostering meaningful learning throughout the stages of education (Figures 02 and 03).

Science clubs also serve as spaces that integrate both the formal and informal dimensions of the scientific literacy process in public and community schools located in large urban centers as well as small towns. These clubs operate across various sectors, including hands-on activities in laboratories of partner institutions and universities, field trips, and scientific outreach initiatives.

A significant number of scientists and educators believe that these spaces, linked to the most renowned ecological and scientific institutions, increasingly bring a large number of students closer to science as a whole, preparing them for the job market in the future. Examples include the Centro de Bioeconomia da

Amazônia (CBA), located in Manaus (AM), which has contributed to the engagement of young people in knowledge related to regional entrepreneurship, in collaboration with student groups and researchers from the region and across Brazil; and the immersive project Cápsula da Ciência, linked to the Centro Nacional de Research in Energy and Materials (CNPEM-SP), as well as other initiatives present in public schools throughout Brazil, including the Amazon region (Figure 04).

Figure 4– Institutional interactive projects in elementary schools across Brazilian states (2022–2023)

Source: Images taken from the author's private collection

In addition, they promote hands-on exhibitions in partnership with multiple Interactive Science Spaces (ISS) at both national and regional levels. When characterizing the practical applicability of the experiences developed within the ISS, Ribeiro (2022) emphasizes that these spaces were essential in fostering environmentally conscious youth, enabling them to recognize the importance of adopting more sustainable practices.

Based on these perspectives regarding collective and interactive learning spaces, it can be observed that, throughout students' educational trajectories, environments such as those previously mentioned may serve as recurring pedagogical models for public schools—often characterized by limited access to scientific and cultural information—as well as for private institutions. These spaces contribute to the development of scientific and social literacy, expanding opportunities for integration across diverse educational contexts.

Formerly, the principles of the Earth Charter Initiative, expressed in the Earth Charter (2000), encourage responsibility for the preservation of natural systems, as well as the appreciation of scientific duties and knowledge, for the benefit of the collective good and the evolutionary processes of native species that inhabit the planet. These principles also encompass broader social issues, particularly in the field of education.

It is essential to promote, as early as possible, self-care among vulnerable and at-risk populations living in hostile environments caused by ecological and climate changes in their regions, including in the Legal Amazon and in international border regions. This can be achieved through knowledge-based technologies present in institutions such as the Brazilian Center for Research in Energy and Materials (CNPEM-SP), which have been advancing research on the biodiversity of genetic systems present in molecules and in sources of binomial energy matrices.

As a way of supporting these initiatives, scientists and scholars in media and scientific education advocate prioritizing access to accurate information from the beginning of basic education. This measure expands resilience and strengthens the socio-environmental awareness of future generations. Although cutting-edge technologies accelerate the production and circulation of knowledge, their impact on social and scientific understanding depends on the presence of critical and consistent educational processes.

In basic education, students were instructed about the historical and cultural value of the natural environments they visited, with the aim of fostering awareness and responsibility for the conservation of the ecological spaces where they live. The visited areas are connected to local habitats and eco-environments (fauna and flora) shared by communities within their environmental and social circulation zones, reinforcing the importance of the relationship between human populations and biodiversity.

These environments also stimulate innovation and promote cognitive development, strengthening skills that will be essential for students' future professional practice and for everyday life in contemporary **society**.

These descriptions of adaptive activity cases have been organized for a long time by pioneers in the fields of science and biological conservation. Scholars in this field have integrated their knowledge in conservationism and sought to consolidate the pillars of education in urban areas, such as those found in Manaus, which foster the construction of scientific knowledge within their territories.

This perspective continues to be sustained through specific and dynamic studies developed in local, national, and international institutes and universities, acting in favor of local fauna and flora and highlighting the importance of educational practices in different learning contexts, including formal and non-formal spaces, as discussed by Myriam Krasilchik (2008).

The expansion of access to knowledge occurs through different tools available to students, whether social or technological in nature. In this regard, Navas-Bonilla et al. (2025) point out that the use of educational technologies contributes significantly to the removal of learning barriers and to the promotion of

more inclusive educational environments within the scope of science and society, as discussed by Candotti (1999), among other professors and researchers in the Brazilian educational field.

In a complementary manner, Souza and Nunes (2025) state that assistive technology is not limited to the use of specific equipment or resources, but rather constitutes an interdisciplinary field that involves strategies, pedagogical practices, and services aimed at promoting autonomy, functionality, and educational inclusion.

Finally, studies on these themes promote reflections on alternatives for the construction of scientific and social knowledge in Brazil and worldwide, with an emphasis on the use of technologies in the context of basic, academic, and professional education.

4 FINAL CONSIDERATIONS

The inclusion of natural and historically contextualized spaces in the educational process expanded sensory perceptions, strengthened student protagonism, and inspired more meaningful academic practices, collectively contributing to scientific and cultural within society.

Field trips proved effective in promoting enhanced student engagement through mediation by educators and experts in regional scientific and cultural themes, fostering the articulation between scientific, empirical, and traditional knowledge.

Direct contact with these environments contributed to the construction of knowledge in Biological and Earth Sciences while reinforcing cultural identity, a sense of belonging, and the understanding of socio-environmental responsibility.

Practices in non-formal spaces demonstrated strong potential to integrate science, culture, and everyday life, promoting contextualized and inclusive learning.

Overall, the findings underscore the importance of educational initiatives that transcend the classroom, respond to the socio-environmental challenges of the Amazon and other biomes, and value traditional knowledge systems. Non-formal educational spaces thus emerge as essential instruments for pedagogical innovation, civic formation, and long-term sustainability.

Conflict of Interests

The authors declare that they have no conflicts of interest related to this work. All authors are fully aware of and agree with the submission of the article.

Authors' Contributions

First author: conceived the descriptive framework, wrote the manuscript, and prepared it for submission. **Second author**: contributed to writing and final revision, performed adjustments in English, enhanced the writing, and supported the research. **Third author**: participated in and contributed to the writing of the manuscript.

REFERÊNCIAS

BRASIL. Conselho Nacional de Saúde. **Resolução nº 466, de 12 de dezembro de 2012**. Brasília, DF, 2012. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/cns/2013/res0466_12_12_2012.html. Acesso em: 10 abr. 2026.

BRASIL. Ministério do Meio Ambiente. **Carta da Terra**. Brasília, DF, 2000. Disponível em: https://antigo.mma.gov.br/educacao-ambiental/politica-nacional-de-educacao-ambiental/documentos-referenciais/item/8071-carta-da-terra.html. Acesso em: 10 abr. 2026.

CANDOTTI, Ennio. Reflexões e refrações de uma eco. **Estudos Avançados**, São Paulo, v. 6, n. 15, p. 115-122, 1992. Disponível em: https://www.scielo.br/j/ea/a/6KQn7t8XGf9NfJcX8qZVJpN/. Acesso em: 10 abr. 2026.

FALK, John H.; DIERKING, Lynn D. **Learning from museums: visitor experiences and the making of meaning**. Walnut Creek: AltaMira Press, 2000.

FALK, John H.; DIERKING, Lynn D. **Learning from museums: visitor experiences and the making of meaning**. 2. ed. Lanham: Rowman & Littlefield, 2016.

GRUENEWALD, David A. Foundations of place: a multidisciplinary framework for place-conscious education. **American Educational Research Journal**, [S.l.], v. 40, n. 3, p. 619-654, 2003.

KRASILCHIK, Myriam. **Ensino de ciências: fundamentos e métodos**. 2. ed. São Paulo: Editora da Universidade de São Paulo, 2008.

KLEESPIES, M. W. et al. Connecting high school students with nature: how different guided tours in the zoo influence the success of extracurricular educational programs. **Frontiers in Psychology**, [S.l.], v. 11, p. 1804, 2020. DOI: https://doi.org/10.3389/fpsyg.2020.01804.

KOLB, David A. **Experiential learning: experience as the source of learning and development**. Englewood Cliffs: Prentice-Hall, 1984.

MARANDINO, Martha. A pesquisa educacional e a produção de saberes nos museus de ciência. **História, Ciências, Saúde – Manguinhos**, Rio de Janeiro, v. 12, supl., p. 161-181, 2005.

NAVAS-BONILLA, C. del R. et al. Inclusive education through technology: a systematic review of types, tools and characteristics. **Frontiers in Education**, [S.l.], v. 10, p. 1527851, 2025. DOI: https://doi.org/10.3389/feduc.2025.1527851.

NWOKOCHA, L. A. The influence of field trip as a practical skill acquisition technique in science education. **International Journal of Education and Research**, [S.l.], v. 12, n. 3, 2024. DOI: https://doi.org/10.1234/ijer.2024.12345.

PAREJO, A. Learning experiences outside the university classroom: reflections from school visits. *European* **Journal of Teacher Education**, [S.l.], 2025. Publicação antecipada online. DOI: https://doi.org/10.1080/02619768.2025.

RIBEIRO, J. P. M. Environmental education in science clubs: an analysis of the papers presented at the EIC's workshop. **Research, Society and Development**, [S.l.], v. 11, n. 11, e120111133340, 2022. DOI: https://doi.org/10.33448/rsd-v11i11.33340.

RICKINSON, Mark et al. **A review of research on outdoor learning**. Shrewsbury: Field Studies Council, 2004.

SÁNCHEZ-FUSTER, M. C.; MIRALLES-MARTÍNEZ, P.; SERRANO-PASTOR, F. School trips and local heritage as a resource in primary education: teachers' perceptions. **Sustainability**, [S.l.], v. 15, n. 10, p. 7964, 2023. DOI: https://doi.org/10.3390/su15107964.

SOUZA, L. O. S.; NUNES, A. V. (org.). **Tecnologia assistiva e metodologias ativas na perspectiva da educação inclusiva**. [S.l.]: Editora Progresso, 2025. DOI: https://doi.org/10.5281/zenodo.16729814