

THE SEED IS THE HEART OF THE PLANT

EDUCATIONAL CONTENTS AS POWERFUL ACTIVATORS OF THE RELATIONSHIP BETWEEN NATURAL AND DIGITAL

Rosa BUONANNO

Department of Education and Humanities,
University of Modena and Reggio Emilia, Italy,
68993@studenti.unimore.it

UDK: 582:[37.091.33:004]=111

Maria BARBARA DONNICI

Department of Education and Humanities,
University of Modena and Reggio Emilia, Italy
268289@studenti.unimore.it

Abstract

The aim of this work is to explore the educational environment as a place resonating with harmony, beauty, and curiosity, where the different proposed activities allow natural learning processes in a multisensory and interactive flow. The vast existing literature confirms the interdependence among living beings, animals, and the vegetable world, and the importance of this interdependence for human beings. Plants—both in their behaviours, analysed by neurobiology, and in the psychophysical well-being they transmit—play a crucial role in understanding vital processes. This article analyses what emerged from children’s explorations of the dialog between plants and digital tools. The research adopts a qualitative approach based on pedagogical documentation which keeps track of interpretative processes of children and teachers, continuously reflecting on their learning through different languages: writing, graphics, images, texts, stories, videos. The results show how children understand, supported by digital tools, the vital processes of plants and the similarities between living beings. This paper would like to activate new areas of investigation on plants’ slow growing processes and the role of the educator–space relationship, creating opportunities to deepen ecological themes within Italian school curricula.

KEYWORDS: *educational environment; plants; digital tools; pedagogical documentation*

Introduction

In the learning environment, it is important to build relationships between living beings, objects, materials, and architecture (Ceppi et al., 2003) for the purposes of offering children an ecosystem of possibilities. When considering the social intergenerational exchange, this ecosystem, including the physical and cultural environment, can be defined as a context that becomes part of everyone's learning and knowledge (Giudici, 2011). In the municipal preschools of Reggio Emilia¹, the environment is considered as the *third educator* (Edwards et al., 1998) and is flexible, offering a big ecology of materials, papers, images, and living beings, thus allowing a net intertwined of thinking, interpretation and narration of both adults and children. The idea behind it is that the learning environment should offer 100 languages², so that children can engage in the construction of their learning process, and are able to express their diverse potentialities in different moments and time. In the learning space, there are a lot of open questions that allow everyone to be embedded in it—in relation to children's passions, curiosities, imaginations, and prior-knowledge (Nigris et al., 2019). Human beings interact with the context, they co-evolve with it (Bateson, 2002) and learn from and with it at the same time.

This paper considers a learning environment where children increase awareness of their competencies and of the connection with other living beings and understand how digital tools empower their learning when it comes to the world of plants and the use of digital itself.

Digital media in education connects the potentiality of digital with the potentiality of children. Instruments allow people to better explore the environment and often it gives a key to face issues that otherwise cannot be solved:

“Artificial intelligence, big data, robotics, and technological innovations in general must be used in such a way that they contribute to the richness of human education, the service of peoples and the protection of our common home.”
(Malavasi, p. 30).

The intelligence of the tool meets human intelligence, a dialogue where the two

¹ In Reggio Emilia, Italy, after the Second World War, a movement of citizens, policy makers and educators started what was later recognised as the Reggio Emilia Approach®. The municipal system of preschools and infant toddler centres that has—as core values—the idea of children as protagonists of their own learning processes and citizens birth; the concept of the *100 languages* as a metaphor for the many ways children learn and express themselves; democratic participation; the educational role of school environments; pedagogical documentation (see <https://www.reggiochildren.it/en/reggio-emilia-approach/valori-en/>).

² The 100 languages is a metaphor for the many accesses that children have to learning and expressing themselves, to their cognitive and creative processes.

shape each other, co-evolve. In analogue-digital environments, an imaginary situation (possible world) is created, and we know that, from the perspective of cognitive development, creating an imaginary situation can be considered as a way to develop abstract thinking (Vecchi et al., 2019). In Italy, the debate about the active use of digital technologies is still very far from this idea of dialogue between intelligences. In formal education, digital technologies are often misused in some cases and/or underused for many different reasons such as: lack of training, lack of time and funds, lack of suitable environments (Martinez & Stager, 2013).

From the early time, in the preschools of Reggio Emilia, digital technology (computer, printer, turtle robot floor) functioned as an integrated system; it was in dialogue with the existing tools and materials in space in order to build a complementary and unusual curious connection with other tools and materials (Edwards et al., 1998). This dialogue has enabled new perspectives, which have been recorded and enhanced through documentation, a daily practice in the schools of Reggio Emilia (Giudici, 2011; Rinaldi, 2006).

During Covid-19 emergency in Italy, and as a consequence of it, a topic that found academic interest was *nature*, both in formal and informal environments. Outdoor activities became a daily practice in many school settings, thus enhancing the interest towards the observation and experimentation of plants within spaces. Furthermore, research on contexts with living beings through manipulation, experimentation, play, and observation is constantly evolving. Environmental education, fascinating discoveries that emerge through contact with plants—whether caring for, or playing with them—encourage children to think about a more culturally sustainable future (Antonietti, 2022; Farnè, 2018; Guerra & Bertolino, 2020; Mortari, 2003; 2019; Weyland, 2022).

According to Tunnicliffe & Reiss (2000) the school is a space where children do not learn much about plants, while the role of education could make a big difference in the school to give more motivating tools to learn *Biology* and *Natural Science* and prevent *Plant Blindness*³ (Wandersee, Schussler, 1999).

For the educational approach of Reggio Emilia, the presence and connection with plants, natural materials and living beings is a relevant aspect to consider when educators think about the contexts. Moreover, plants in the environment provide positive effects when it comes to learning and wellbeing, and it has been proven that human beings—in connection with nature—recharge their energy (Dockrill, 2018; Mugion et al., 2021; Hall et al., 2019; Ryan, 2010; Ulrich, 1984). In addition, neurobiology stud-

³ Plant blindness: the inability to see or notice the plants in one's own environment leading to: (a) the inability to recognise the importance of plants in the biosphere, and in human affairs; (b) the inability to appreciate the aesthetic and unique biological features of the life forms belonging to the Plant Kingdom; and (c) the misguided, anthropocentric ranking of plants as inferior to animals, leading to the erroneous conclusion that they are unworthy of human consideration (Wandersee & Schussler, 1998a).

ies (Calvo, 2022; Mancuso et al., 2015) analyse plants as living beings and recognise their abilities that human beings often do not consider. Calvo (2022) suggests that it is important to have another type of education and consideration on plants, and that we need a new approach to understanding plants and recognising their potential.

During the research, children explored an environment enriched with plants and digital tools and were able to recognise the world of plants and its processes, connecting its importance to human beings and discussing their movement and communication with human beings and with other plants. Moreover, children recognised, during the exploration, that the plants—inside their body—have a kind of “matter”, and described that as an important tool that the plants employ in solving problems. Finally, they speculated that—in the plant—there is any kind of green blood. Children emphasised the importance of having a connection and empathic attitude with the world of plants and this resulted in a very anthropocentric point of view. From this connection, they can develop naturalistic intelligence (Gardner, 2006) as a possibility to organise context where the relationship of care, attention and empathy with the natural world is encouraged (Barbiero, 2012).

In order to set the ground for children’s explorations, adults co-designed ideas, purposes and contexts for their work. This activity, identified as “*progettazione*”⁴ is when adults, whose role is to scaffold the learning processes, think and hypothesise about the design intentions that children could develop individually or together with the group. Adults during “*progettazione*” should ensure the possibility for children to express their multiple intelligences (Gardner, 2021), valorise their curiosity, imagine possible scenarios with the objective of having active children in relationship with the environment; i.e., have the courage to give evidence to the relationship between *person-nature* (Foà, Saudino, 2021). In an informal context, the research gave children the possibility of knowing and learning about the world of plants, but in a new and dynamic learning context. As the last report of UNESCO (2021: p.113) assumed:

“Rebalancing our relationships with the living planet requires that we relearn our interdependencies and reimagine our human place and agency.”

We have a responsibility to educate children towards another way to see, understand and come to know living beings, nature, and human beings. This research shows how children could, in a more sustainable manner, think in different ways when it comes to the natural world (Sdg 2019, UNESCO, 2021).

⁴ *Progettazione* – understood also as an attitude of thought, a strategy of relating, and of situating each case within the network—conceived as “the space of others,” the unfinished space of the self that is in this way completed by the thinking of others within the relational process (Rinaldi, C., 1994).

Research setting

The collaboration was activated in the framework of the project *Scuola Diffusa*, born in response to the emergency of the COVID-19 pandemic. In order to comply with sanitary rules related to social distances, the municipality of Reggio Emilia gave the opportunity to local state schools (primary and middle schools) to hold classes at several cultural institutions in town with multi- and inter-disciplinary perspectives (Cannella et al. 2023). Due to the great interest of teachers and children, the project continued even after the health emergency. In the school year 2022-2023, *Scuola diffusa* allowed 100 classes of local primary and middle schools to spend one entire week of their school time at Reggio Emilia cultural institutions, including the Loris Malaguzzi International Center.

This is where our research developed, in particular at *Scintillae-play and learning in the digital age*, a research project and physical space started in 2019 by Fondazione Reggio Children, in collaboration with The LEGO Foundation. The values and philosophy of the Reggio Emilia Approach®, together with the five characteristics of playful learning experiences identified by The Lego Foundation (Zosh et al., 2017), broaden and deepen the work being done by the two partners regarding research and experiences on the themes of play and learning, overlapping in some areas and adding new dimensions to one another. Scintillae's approach to playful learning, which was at the base of exploration and collaboration with children and teachers, is characterised by several key features:

- **Environment/context** – A rich, stimulating environment is essential for the whole learning experience. The environment encompasses physical, digital and cultural spaces that deeply influence the learning process—its quality reflecting the quality of learning itself. Such an environment is to be flexible, open, welcoming (inclusive). The *context* is a wider concept also including the social space and should be seen as an integral part of the learning process, where children and adults are in a continuous dialogue and exchange among themselves and with materials and technology.
- **Learning as individuals and as a group** – Starting from the subjectivity of people means acknowledging their world—their ways of interacting with others, their learning times, their past experiences. It means recognising the diversity of skills, intelligences and different languages that each of us approaches and practices in a different way. The strength of the group is the set of subjectivities that collaborate to face a challenge through reasoning and hypotheses.
- **Playful attitude/atmosphere** – What moves and amuses the human being are the curiosity and the desire to experience and search for significance and mean-

ing attributed to things in life. To avoid hindering this natural predisposition to create and recreate the world, we must take responsibility not to predetermine the answers, not to close the visions and remain open to intuitions. We should give both the group and the individual the freedom and time to experiment, supporting them in the creative process with a sincere attitude of listening and careful observation. Creativity must be nurtured and cared for, and at its core lies a profound trust in the ability of the human being to generate new responses to the challenges of the present.

- **Natural digital** – Through a playful approach—one that welcomes trial and error, borrowing, and the exchange of knowledge—it is possible to promote a *natural digital culture*: one which we act upon and do not suffer from; one which contributes and does not oppose our being part of nature; one which collaborates to promote a complex and systemic vision of the world and of things; and one which seeks a new empathy with and through digital, an empathy that speaks to us about the future of relationships among humans, and between humans and machines.
- **Research approach** – The research approach is a key element of any learning experience, where you contemplate multiple responses and multiple points of view. A strategy to engage in dialogue with the whole group, sharing open goals to ensure that no one—and no idea—is left behind. It requires a welcoming attitude. A research experience must remain open to the unexpected and unforeseen events, as these are always generators of discovery. The human being is an explorer, a researcher by nature; when immersed in a new and challenging context, each individual—supported by the group—will act in their own way to find a strategy, producing ideas, theories, and sparks of change.

Methodology

The collection of data was carried out through audio and video recordings of conversations, as well as the collection of drawings and notes from children's notebooks taken during the daily meetings. All the school groups were from primary schools, and the pupils were mainly between 8 and 10 years old. Each group of children was divided into two small groups of about ten pupils per adult; conversations of these small groups were recorded and transcript by the researchers. During thematic analysis, researchers observed that many of the children's hypotheses were strikingly similar to statements made by scientific researchers. For this reason, some quotations from children were compared with those of scientists. Some examples show how children have an innate connection with the natural world:

“It is hardly an exaggeration to say that the tip of the radicle thus endowed and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of body, receiving impressions from the sense-organs, and directing the several movements.” (Darwin, 1884, p.574)

“They are also able to communicate by touching themselves (usually with their roots, but sometimes also with their aerial part) or by assuming positions in relation to their neighbours.” (Mancuso et al., 2015, p.80)

“Roots of forest trees and other plants are interconnected with each other by a network of fungal mycelia. This so-called ‘wood wide web’ is an integral part of any forest.” (Simard, 2021, p.139)

In addition, the data indicates how context with plants can support some questions and reflections on the natural world. In order to make visible the learning process of children and adults, we used the tool of pedagogical documentation. In this way, we could give evidence to children’s reflections, ideas, and theories. In the same way Rinaldi (2006) asserts the use of the pedagogy of listening, we listened actively to children, their intuitions, and gave value to their work. In this process, adults recognise the children as active constructors of their learning and knowledge. Documentation is a “reflective possibility” where all the individuals can contribute to building a new knowledge. Moreover, the physical space has a key role in the research of meaning carried on by children, whose interpretations, reflections and narrations help building the meaning of school (Ibidem).

In this research project, co-designing with teachers, *pedagogisti*, educators and researchers, has led to identifying some themes of possible further research starting from the idea of transformation in movement. The movement was interpreted through the body’s experience of learning; through life as it engages with living beings and their environments; and through digital tools and instruments that make it possible to observe and research about the world. Through these ideas of movement, children have been able to explore and make hypotheses on what they perceived and theorised from their research into these interweaving between digital and analogue.

At first, adults proposed to children the exploration of movements inside the Malaguzzi International Centre, where all activities were held. Children explored freely, observing and recognising elements of movement, recording short videos and taking notes on their notebooks.

Afterwards, children worked in smaller groups in different contexts. One of the groups investigated the context of plants, movement, and the dialogue that children

had between digital and plants. In this case, our research offers some examples of how children perceive the world of plants and what is their natural thinking on it.

In this exploration, adults set an immersive context where the whole body could be involved. In order to start the dialogue, adults and children watched together a short movie about the movement and growth of plants on time lapse. Calvo (2022) confirms that when we observe time-lapse sequences of plants, we can perceive a behaviour featured systematically. The movie's projection ignited a conversation between children and adults about the movement and communication of plants. The main question was: *Are plants saying or communicating something through their movements?*

The main objective of the research was to stimulate the children to share their ideas and thoughts about plant movements. In a context such as Scintillae, the motive was to collect the different information that children have about plants and how they integrate it with digital. The main objective was to understand how children were able to recognise the role of plants, but also how *the digital* could expand their knowledge and observations.

Data Analysis

The transcribed conversations produced qualitative data which was then subjected to rigorous analysis using the method of content analysis (Braun, 2006; Maxwell, 2013; Tunncliffe, 1996). This methodological approach facilitated the systematic exploration and interpretation of emerging themes and patterns within the dataset. Furthermore, content analysis illuminated multiple insights and perspectives within the conversations. The approach allowed the researchers to dig deep into the richness of the data, uncovering latent meanings and implicit connections that might otherwise have gone unnoticed. Through a meticulous coding process guided by theoretical frameworks and previous literature, the analysis facilitated the extraction of meaningful information, thus contributing to a nuanced understanding of the phenomena under investigation.

Results

Continuous engagement with the research team enhanced the analytical approach, enabling the evaluation of diverse viewpoints and fostering ongoing discourse that concerned the selection of thematic avenues for exploration. Throughout the endeavour, emphasis was placed on delineating overarching categories. This methodological approach facilitated the identification of salient dimensions arising from interactions with the children, with the categories derived through inductive reasoning. The elu-

culated themes underscored the interconnections among the various codes (Rubin, 2012). We identified five categories: Growth, Functions, Anatomical, Communication, Emotions and Collaboration. The results are reported in Table 1.

TABLE 1. Conversations with children

Code	Description	Extracted data
Growth	Children recognise that the plants grow during their lifespan	<i>A plant must have shade, sun, and water to grow. The seed grows because the seed is the heart of the plant, and it is who makes it grow and gives it life. We see it in a slow way, but they also move as they grow.</i>
Functions	Children recognise that plants have important functions for themselves and for human beings	<i>The roots take water from the earth. Must go underground because there are minerals, salts and water. The seed (house-heart) and the roots, which by going underground to look for food (water and mineral salts) causes the plant to grow in the sky and thus take in more oxygen, but, above all, more water, because if it rained it would take it.</i>
Anatomical	Children comment on the anatomical parts of plants and make analogies with human beings	<i>The brain is that tip. The end of each small root is a brain that through vibrations or brain waves makes the other plant talk to you. We relate to plants they do not have brains like us, but they have something like brains to make themselves understood</i>
Communication	Children recognise that plants communicate in different ways	<i>The two roots meet and 'chat'. I believe that they come together and form a single root. Go all over the territory, creating a seed in another place. In my opinion, plants communicate with each other, but without knowing it very well. Have brainwaves and this root feels where the other root is, understands where it is. The tip makes the brainwaves of the roots speak. In my opinion they are not communicating from the outside, but through the roots. There are two little plants and there are two roots and then there are threads that, in my opinion, the roots go underground, and they feel where they are, and they have brain waves. So, the two roots meet and 'chat'. I believe they come together and form a single root and go all over the ground, creating a seed at another point</i>
Emotions	Children talk about plants having emotions and the possibility to feel something	<i>If their leaves are a little dark in colour, they are afraid. If they are light, they are not afraid. They may feel anger when they are pruned. In my opinion, if you water them, they can feel happiness maybe.</i>

Code	Description	Extracted data
Collaborations	Children understand that the plants collaborate to each other and engage in a kind of collaboration under soil	<p><i>They communicate to maybe give advice because maybe some plants don't get along with others and another thing that all plants have is a brain to communicate.</i></p> <p><i>The earth is an element of the plant and therefore the plant with its roots speaks to the earth and tells it how much water it wants and does not want.</i></p> <p><i>The root sends the signal to the earth and the earth gives it as much as it wants and what it has left it gives to the other plants.</i></p> <p><i>The earth is its brain.</i></p>

The data yield intriguing insights into children's comprehension of plants. They demonstrate an awareness not only of plants' capability for communication and locomotion through their roots but also of the intricacies inherent in their behaviour. Moreover, children discern parallelism between the functional role of roots in plants and the cognitive processes observed in animal brains, understanding that roots exert an influence on plant movements (Darwin, 1884). A deeper exploration prompts children to regard plants as sentient entities endowed with intelligence and problem-solving capabilities. They also discern the presence of emotions, aligning with the tenets of plant neurobiology (Mancuso, 2015). These nuanced qualities of plants frequently elude adults, yet children apprehend them with profound sensitivity.

Children additionally grasp the growth of plants as an incremental journey, distinct from the human experience, while acknowledging their capacity to interconnect for enhanced performance. This insight mirrors Susan Simard's *Wood Wide Web* theory (2021). Children readily identify the underground network, which facilitates communication and resource exchange, and is a tangible expression of collaboration within the plant kingdom. Conversations with children reveal a profound comprehension of the plant world, a perspective that often fades in adults, who frequently regard plants as insignificant (Tunnicliffe, 1996).

Conclusions and future implications

The research shows how children understand, helped by digital tools, the vital processes of plants and the similarities between living beings. Moreover, the research shows that the use of technologies allows for new possibilities and new perspectives in the learning process. This paper aims to activate new areas of investigation on plants' slow-growing processes and interdependence established among living beings, but also invite educators to set up a context where children can talk about their knowledge of plants.

The main theme is to help different contexts (formal, informal, non-formal) to create learning spaces with plants and living beings, thus aiding the investigation and understanding of their interdependency. Spreading a new idea of thinking about plants is important as it helps establish a new perspective (Calvo, 2022) and support the growth of ecological thinking. The research highlights how such contexts can stimulate the ideas, imaginations and hypotheses of children and increase their interest in science education.

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SJEMENKA JE SRCE BILJKE

OBRAZOVNI KONTEKST KAO MOĆNI SUDIONIK ODNOSA IZMEĐU PRIRODNOGA I DIGITALNOGA

Sažetak

Cilj ovog rada jest istražiti obrazovni okoliš kao mjesto u kojemu vlada sklad, ljepota i znatiželja, u kojemu različite aktivnosti omogućuju prirodne procese učenja u multisenzornom i interaktivnom tijeku. Postojeća literatura potvrđuje međuovisnost živih bića, životinjskog i biljnog svijeta te koliko je važna za ljudska bića. Biljke, kako zbog svojeg ponašanja, analiziranog neurobiologijom, tako i zbog psihofizičke dobrobiti koju prenose, preuzimaju ključnu ulogu u učenju o vitalnim procesima. Ovaj rad analizira ono što je proizašlo iz dječjih istraživanja o dijalogu između biljaka i digitalnih alata. U istraživanju se rabio kvalitativni pristup temeljen na pedagoškoj dokumentaciji koja prati interpretativne procese djece i učitelja, kontinuirano promišljajući o njihovom učenju kroz različite jezike: pisanje, grafiku, slike, tekstove, priče, videozapise. Rezultati pokazuju kako djeca, s pomoću digitalnih alata, razumiju vitalne procese biljaka i sličnosti među živim bićima. Ovaj rad želi aktivirati nova područja istraživanja o sporim procesima rasta biljaka i važnosti edukacijskog prostora, otvarajući mogućnost produbljivanja ekoloških tema u talijanskim školskim kurikulumima.

KLJUČNE RIJEČI: *obrazovni okoliš, biljke, digitalni alati, pedagoška dokumentacija*