



Approaching Biophilia in Designing Children's Educational Environment

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Abstract

In recent decades, several studies started to focus on enhancing connectivity with nature and nurture children's biophilia to improve their mental health and wellbeing especially in their early formative years. However, in design practice, architects involved in designing children educational environment need to have better understanding on how to enhance this tendency for biophilia. this paper begins to explore this growing body of research and emerging biophilic design dimensions, and attributes in architectural terms, which could help in drawing connections between fields of study, highlight potential avenues for future research, evolve understanding of biophilic design patterns, and capture the cognitive benefits afforded by biophilia in designing educational spaces for childhood. A research methodology consisting of a literature review, analysis of worldwide case studies and a one-to-one interview was conducted with a sample of children (3-7 years old) attending a nature-based nursery in Egypt, was designed to accomplish intended objectives. Findings of this study indicated that early childhood have a positive attraction for all-natural environment and features. Results showed that children enjoy being in, which provides a glimpse into the potentials of integrating nature within architectural context, including offering beauty, freedom, efficient learning, relaxation, and a critical life support system.

Keywords: Biophilia; Biophilic design; nature; children; educational space; nature connectedness; wellbeing.

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1. Introduction

In the last decades, humanity has been facing entirely new health threats resulting from being detached from nature. Nature deficit disorder was a term coined by Richard Louv in his book “*Last Child in the Woods*”, because of the human -especially children- disconnect from being in nature and spending most of the time indoors resulting in a wide range of behavioral problems [1]. According to the Environmental protection agency (EPA) in 2006; children spend almost 90% of their time indoors and much of that time is spent in educational environments (e.g., nursery, day-care or school) [2]. In addition, with the advent of the computer, video games, and television children stay indoors, which in turn leads to the production of a new generation subjected to violence, attention disorders, and physiological depression. Unhealthy educational environment can have a negative impact on children’s health, attendance, concentration, and learning abilities [3]. In this sense, social psychologist Erich Fromm coined the term "biophilia", as a solution to the nature disconnection problem, as it emphasizes the importance of a direct connection and interaction with nature for maintaining children’s healthy development and enhancing their wellbeing [4]. Through educational environment, experiencing and interacting with nature can promote children academic performance, social skills, and more importantly their stewardship towards nature and environmental issues [5]. The biophilic approach through design can provide an environment that strengthens and supports the physical, sociological, and psychological life components [6]. Biophilic design attributes can be introduced in the design of educational environment through many strategies for greater connectivity with nature [7]. Accordingly, architects involved in designing children’s educational environment need to have better understanding on how to enhance children’s tendency for biophilia through the biophilic approach. Hence, this research aims at exploring principles of biophilic design, and the impact of their integration in the design of educational environment, and most importantly understanding children’s thoughts and perception of the places they enjoy; to define their relationship with the surrounding environment.

2. Research Structure

For accomplishing the intended objectives of this research, several methods were implemented. Firstly, investigating the concept of biophilia through literature review, and understanding its attributes and the factors affecting their application in children’s educational spaces. Secondly, analysis of several biophilic worldwide case studies was performed. Finally, an exploratory one-to-one interview, was conducted with a sample of about 18 children, from 3-7 years old, who attending a nature-based nursery in Egypt. The interview goal was to understand children’s thoughts and perception about the places they enjoy the most in their educational environment. Findings of this study took the form of guidelines that could help improving design quality of children’s educational environment through reconnecting them with nature.

2.1 Literature Review

Although the term Biophilia is quite uncommon, however, upon breaking down the word, it becomes clear and simple enough. *Bio-* is “anything related to life,” and *-philia* is “means fondness, and love for a specified thing” [8]. Thus, the basic definition for ‘Biophilia’ is the love of life. In the next section, the concept of Biophilia and its application in architectural context will be discussed in detail.

a) *The Concept of Biophilia*

The idea of biophilia has originated since the beginning of human history; where early humans, evolved and lived in intimate connection with the natural world. Table (1) briefly summarizes the development of the term “Biophilia” and its conception in the last century. In this sense, the biophilia hypothesis can be used as a valuable framework to help further the interdisciplinary investigation of human’s affiliation with nature.

Table 1: Timeline for the contribution to the emergence of Biophilia.

Year/Author	Contribution to the emergence of Biophilia
1945 Erich Fromm	The social psychologist coined the term “Biophilia” to describe the innate bond that humans share with other living species. In his book “The Anatomy of Human Destructiveness” he redefines it as <i>‘the passionate love of life and of all that is alive’</i> .
1979 Edward O. Wilson	The evolutionary biologist first used the term biophilia in the field of biology (particularly <i>sociobiology</i>) in an article titled “Biophilia” (Wilson, E. 1979)
1984 Edward O. Wilson	He developed the concept in an entire book once again titled “Biophilia”, describing how positive feelings towards nature are inborn in human beings.
1993 Edward O. Wilson & Stephen R. Kellert	Wilson teams up with the Social Ecologist <i>Stephen R. Kellert</i> to edit a book, entitled “The Biophilia Hypothesis” (Kellert, S and Wilson, E. 1993), stating that biophilia became biologically encoded in our DNA because it helped enhance our existence and survival through physical, emotional, and intellectual fitness (Davidson, D. 2013).

b) *Biophilic Design*

Throughout time, humans have not only relied on nature, but we have copied it. Biophilic design is presented as an innovative approach to design that fosters the positive connection with the natural world through the built environment to create a healthy human life and wellbeing. At the building scale, biophilic design can inspire architects to build connection with nature. At the human scale, following biophilia can enhance their mental and behavioral status. Happiness, satisfaction and higher motivation, less stress and anxiety levels, enhanced problem-solving skills and creativity, increased concentration, and improved social interaction are all examples of mental and behavioral benefits of biophilia on human beings [9]. To assist designers in the practical application of biophilic design, Kellert has broken it down into two dimensions, six elements, and 70 attributes [10]. The first dimension of biophilic design is organic or naturalistic dimension, which represents forms in the built environment that directly, indirectly, or vicariously illicit human’s affinity for the natural environment. The second dimension is the place-based or vernacular dimension, this helps connect people to the culture and ecology of their locality or geographic area to give a sense of security. The six elements and some of the 72 corresponding attributes of biophilic design are briefly described in Table (2).

Table 2 : The six elements and 72 attributes of biophilic design by Kellert.

Environmental features	Natural shapes and forms	Natural patterns and processes
Color Water Air Sunlight Plants Animals Natural material Views and vistas Façade greening Geology and landscape Habitats and ecosystems Fire	Botanical motifs Trees and columnar supports Animal motifs Shells and spirals Egg, oval forms Arches, vaults, domes Shape resisting straight lines and right angles Simulation of natural features Biomorph Geomorphology Biomimicry	Sensory variability Information richness Age and change Growth and efflorescence Central focal point Patterned wholes Bounded spaces Transitional spaces Linked series Integration of parts to wholes Complementary contrasts Dynamic balance Fractals Hierarchically organized ratios and scales
Light and space	Place-based relationships	Human-Nature Relationships
Natural light Filtered and diffused light Light and shadow Reflected light Light pools Warm lights Light as shape and form Spaciousness Spatial variability Space as shape and form Spatial harmony Inside-outside spaces	Geographic connection to place Historic connection to place Ecological connection to place Cultural connection to place Indigenous materials Landscape orientation Landscape features that define building form Landscape ecology Integration of culture and ecology Spirit of place Avoiding place-lessness	Prospect and refuge Order and complexity Curiosity and enticement Change and metamorphosis Security and protection Mastery and control Affection and beauty Exploration and discovery Information and cognition Fear and awe Reverence and spirituality

2.2 Integrating Biophilia into Educational Spaces

Children learn in a very different way than adults. Hands-on sensory experiences must be immersive and open-ended to be effective and engage children based on their talents and learning styles [11]. Concerning the natural environment, children also experience it differently than adults. Adults usually see nature as background for what they are doing, whereas children experience nature holistically as a stimulator and experiential component of their activities. Children judge nature not by its aesthetics, but rather by the manner of their interactions and sensory experiences with it [12]. However, the problem with most young children’s environmental education programs is that they approach education from an adult’s perspective. In his book “Children and Nature: Design principles for educators” [13], David Sobel mentioned the three basic stages for children’s development of their environmental education which are:

- Early childhood (ages 3 – 7)
- Early/ middle grade (ages 7 – 11)
- Adolescences (ages 12 – 17)

This study targets the (early childhood) and (early grade school children), where recent research strongly suggests that the opportunity for children younger than age 11 to explore in wild, natural environments is very important for developing their biophilic tendencies and that the type of play should be child-nature play. In this context, nature-based educational approach started to spread more around the world recently, which is defined as settings with a continuous natural outdoor provision. Nature-based nurseries was originated for the first time in northern Europe, and some of those countries have a large percentage of their educational provision outdoors. Denmark, for example, has led the way, with *udeskole* (outdoor schools) being a regular part of not only early years, but also 7–16 educational provision [14]. Germany introduced more than 1500 *Wald kindergarten* or *Naturkindergarten*, with a regular connection and experiential learning through vast forests [15]. Recently, other types of nature provision have also been developed in Brazil, Italy, Portugal, Slovenia, India, and South Africa [16]. Previous studies on nature-based nurseries have proposed many benefits including increases in self-esteem and self-confidence, motivation, motor skills improvements, development of social skills and relationships, as well as improvements in communication and language skills [17]. Nature-based education such as forest kindergarten generally can also provide opportunities for creative and natural play, confronting fears, taking risks, and developing competencies [18]. Several studies have also referenced to children's meaningful relationships with the natural world, including deep connection and understanding [19]; feelings of being safe and happy in outdoors and natural environments [20]. This concept that represents a positive interaction between people and nature is known in psychology as "nature connectedness," which is also the term used most frequently. The concept is multifaceted and frequently consists of both cognitive and effective strands, such as empathy for the natural world [21], as well as experiential and behavioural aspects [22]. This link is frequently described using terminology like "nature connection," "nature relatedness," and "inclusion of self in nature." [23]. For the purposes of this paper the term "nature-based nursery" will refer to educational settings that have a continuous outdoor provision.

3. Worldwide case studies

As discussed before, based on recent studies, incorporating key principles of biophilic design can make dramatic improvements to educational spaces, improving experiences for children and teaching staff alike. However, there are few case studies of children's educational environment that present biophilic design as a design approach [24]. This part of the paper reviews analyses of three worldwide educational spaces that applied biophilic design principles through fully or partly integration of nature. The case studies were analyzed based upon the six elements of biophilic design outlined earlier.

3.1 The Green School

The Green school is located in Sibang Kaja, Bali. The school was designed by IBUKU, and the layout consists of classrooms, gym, assembly spaces, faculty housing, offices, cafes, and bathrooms. Local bamboo is used in innovative and experimental methods that demonstrate its architectural possibilities [25]. The result is a holistic green community with a strong educational mandate that seeks to inspire students to be more curious, more engaged, and more enthusiastic about the environment and the planet [26]. It incorporates most of the Biophilic Design principles as described in Table (3) and shown in Figure (1).

Table 2: Biophilic design principles in the Green School.

Environmental features	-Open facades allow seeing natural movement within nature. -Giant trees around site are visible and accessible to users.
Natural shapes and forms	- Curves and natural shapes incorporate the natural features and strength of bamboo.
Natural patterns and processes	-Openings allow sound and smell of the surrounding jungle inside. - Air movement creates cooling effect and changes in humidity level.
Light and space	Open façade and roof form to provide natural light throughout the day.
Place-based relationships	-The open facade connects the occupants to water through rainfall. -Open structure enables occupants to connect to the changes in nature.
Evolved human-nature Relationships	Natural materials are used throughout the school



Figure 1: Different views of the bamboo structure of the green school.

3.2 St. Paul Chevallier Complex

It is a wooden nursery and elementary school complex in Lyon, France by French architects, Tectoniques. The complex was designed with the intension of establishing robust relationships between architecture and nature on a sloping site [27], moreover, to allow nature to get the upper hand. It incorporates most of the Biophilic Design principles as described in Table (4) and shown in Figure (2).

Table 3: Biophilic design principles in St. Paul Chevallier Complex.

Environmental features	-Vegetable garden -Accessible hilly rooftop with plants
Natural shapes and forms	- The design takes account of the sloping terrain. - The inclined roof planes energize the building silhouette.
Natural patterns and processes	- Timber cladding and patterns covers most of the building with a few yellow-painted panels on the walls and ceilings. - The ground plan is simple, so children can easily find their way around.
Light and space	Spacious corridors run between classrooms and feature floor-to-ceiling windows to increase natural light.
Place-based relationships	- Views onto the outside world, and superimposed spaces, are always different. - There are multiple changing facets. No two façades are the same.
Evolved human-nature Relationships	-The plant-covered rooftops appear to emerge from the ground and encourage children to investigate. - The presence of a discovery and experimentation path in the landscape.



Figure 2: The plant-covered rooftops and its integration with the natural environment in Lyon (on the left) - the floor to ceiling windows and its effect on the natural day lighting in the classrooms (one the right).

3.3 Vo Trong Nghia’s Farming Kindergarten

The kindergarten is a two-storey building located in Vietnam and designed by Vo Trong Nghia Architects. There is a vegetable garden on the building roof, where children can learn how to grow their own food. The outer walls are shaded behind concrete louvres that encourage the growth of climbing plants, while the green roof above serves as a form of insulation. Windows on both external and courtyard-facing walls offer natural lighting and cross ventilation throughout the building; therefore, the kindergarten operates without air conditioners in the classrooms despite being in a harsh tropical climate [28]. The kindergarten incorporates most of the Biophilic Design principles as described in Table (5) and shown in Figure (3).

Table 4: Biophilic design principles in Vo Trong Nghia’s Farming Kindergarten.

Environmental features	Three sheltered courtyards with visible tree planting.
Natural shapes and forms	Curved building with accessible green roof from the ground.
Natural patterns and processes	-Green roof as an edible garden -Experiencing growth cycle of plants
Light and space	-Natural lighting through windows to courtyard facing and outer walls -Louvres filter the direct light
Place-based relationships	Open structure enables children to move freely with no boundaries.
Evolved human-nature Relationships	The growing planting experience allow children to strengthen the relationship with nature.



Figure 3: The Kindergarten accessible roof (on the left) - Ariel view for the building roof (on the right).

3.4 Fuji Kindergarten

Fuji Kindergarten or the Roof House in Tokyo, Japan, is considered one of the most successful educational biophilic designs. The roof area doubles as a playground and a running track, giving the students an endless ring to chase each other around. The deck was built around the existing zelkova trees, with nets placed around the base to allow for easy climbing [29]. The kindergarten incorporates most of the Biophilic Design principles as described in Table (6) and shown in Figure (4).

Table 5: Biophilic design principles in Fuji Kindergarten.

Environmental features	- Three giant zelkova trees are projecting through the roof. - The presence of water wells in the nursery rooms.
Natural shapes and forms	The shape is a giant oval form with a perimeter of 183m. It is conceived as a single village with endless circulation.
Natural patterns and processes	- Children can run freely with no dead ends. -Children can climb the trees to the classroom.
Light and space	The basic state is with open windows allowing maximum day lighting
Place-based relationships	-The ceiling is merely 2.1 meters (child scale) - The roof is easily accessible and has slides. - There are no boundaries between classrooms.
Evolved human-nature Relationships	There's no boundary between inside and outer playgrounds.



Figure 4: The oval-shaped form of the kindergarten (on the left) - The three Zelkova trees favorable for children to climb (on the right).

4. One-to-one interview

It is only children themselves who can provide personal insight into their relationship and connection with nature.

In this sense, an exploratory one-to-one interview, was conducted with a sample of 18 children, from 3-7 years old, who attending a nature-based nursery in New Cairo, Egypt, as The selected nursery followed the environmental education program; the nursery's main building is less than third the overall plot area, the rest is outdoor areas consisting of: large play yards, semi-shaded outdoor classrooms, animals and pets' zone, large sandbox with small mud kitchen, vegetables, and fruits farm. The data collection was performed in the nursery as a three-days-workshop in April 2022.

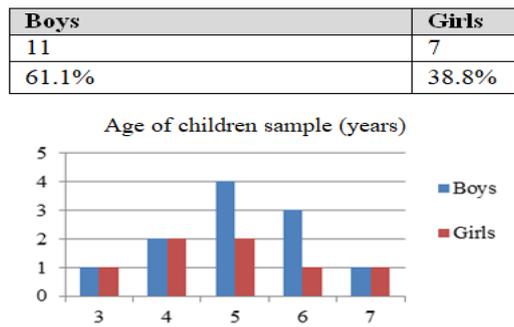


Figure 5: Age & gender of the children taking place in the study.

4.1 Interview Structure

The overall aim of the interview was to answer the research questions: What are children’s perceptions and experiences in nature-based educational spaces? And how do children describe their relationship with nature? Thus, a one-to-one interview process was performed and classified based on the children’s age group:

-3 -4 years old children: the interview was through playing with puppet, who ask children about the places or things they enjoy in their nursery. The answers were just “yes” or “no” or through raising their hands in a fun activity.

-4-7 years old children: the interview was simplified to prevent any kind of fear or stress for children. Through printed colourful photos of many areas in the nurseery, children were asked to select favorite place in their nursery. By the end each child, draw the “places or things they enjoy” and the environments they prefer within the nursery. To facilitate the data collection from the children, a ready-made document was provided for the children to draw on. This document consists of two parts. The first part was for the drawings to be produced by the children. The interviewer used the second section to take notes and to indicate the codes that were in the drawings. A high majority of the children used crayons and wooden pencils, meanwhile some children have chosen a black board in their classroom to draw on it, as shown in Figure (6). The drawings took roughly 40 minutes to complete. Following the completion of the drawings, the researcher questioned the children one at a time about their drawings to identify any codes present, and these codes were then recorded.



Figure 6: Sample of the children’s participation in "Places or things I enjoy" workshop.

5. Generic Findings

Based on the analysis of the worldwide case studies for educational spaces for children and one-to-one interviews with a sample of children of the targeted age group, the authors extracted some findings that underscore the objectives of the research, which can be described as follows:

5.1 Findings of the Case Studies analysis

The design implications gathered from the case studies were numerous for future children's educational spaces design. The major themes among them are the importance of engaging the users through stimulus variation, and these can be accomplished in many ways:

- Having a higher ratio of vegetation has been shown to make a designed space feel more inviting and comfortable.
- Optimize views onto nature by enlarging windows.
- The natural material used for the ground plane, benches, walls, and other elements can all incorporate different colors and textures for visual and tactile variation.
- When designing for children, it can mean the difference between a child user feeling comfortable and understanding that a space has been created specifically for them or giving that user a sense of unease and not knowing if they belong there.
- Natural day lighting creates an energizing environment, helping to increase student's concentration, learning speed and performance levels.
- Freedom is an important aspect for children. When you put children in a quiet small box, some of them get nervous.

5.2 Findings of the one-to-one interview

Transcripts from questionnaires and children's drawings were read and coded for the common themes that appeared. For this initial step in the analysis, this part contains: details about the connection to nature levels of the participants; and an examination of variables that affect such connection. In analyzing the results, children's responses demonstrated the following:

- The different understanding and perception of nature among boys and girls: Girls understood the natural environment in a more illustrative way and, they were more interested to learn about growing plants and watering flowers than boys.
- Animals were of a big interest for most children: Children drew a wide range of the nurseries' animals and focuses on the significant role of these living creatures play in their lives.
- The Perception of children towards "Nature" When the participants were asked to draw the places or things they enjoy in their nursery, the responses demonstrated different conceptions that fit into the two categories as showed in Figure (7). Younger students tended to have a more relational focus, while

older students had a more object focus on the environment.

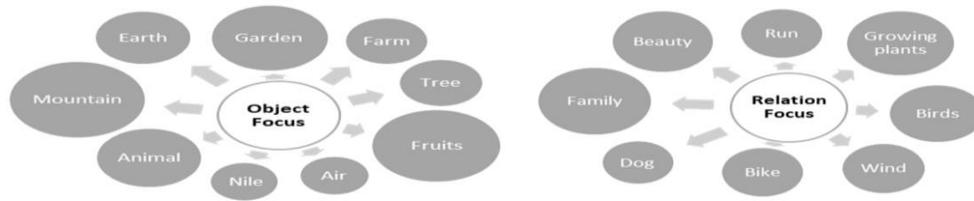


Figure 7: Model of how children describe "Nature" and their relationship with it in the two different categories: (a) object focus and (b) relation focus.

- The children’s nursery experiences and favorite places are shaped mainly around natural elements and features while the artificial environment like classrooms is not frequently involved in their perceptions.
- The children’s nursery experiences and favorite places are shaped mainly around natural elements and features while the artificial environment like classrooms is not frequently involved in their perceptions.
- Children’s perception of the nursery is shaped mainly around the natural elements they experience daily (tree, flower, grass, and animals) and natural features they see and feel through their outdoor playing routine (cloud, air, and sun), as shown in Figure (8).



Figure 8: Children’s drawing samples about the places or things they enjoy in the nursery.

6. Conclusion

This paper aimed to explore "Biophilia" as a growing body of research and emerging design parameters in architectural terms. Through the discussion and findings, it became obvious that environment plays an important role for a child to receive direct nature experiences. The relationship to nature seems normally stronger in childhood, in another words, children are born as “*biophilic beings*”. The results of children interviews indicate the following:

- Children have a positive intellectual and emotional appreciation for nature based on “*having experiences*” in nature and “*playing*” with nature elements as objects. Children simply enjoy being in nature rather than indoor spaces. The predominant themes from the study clearly indicate that nature provides children with opportunities for play/work, home, beauty, freedom, learning, and relaxation as well as a critical life support system.
- Children with rural origins seem to have a stronger relationship to nature. To the contrary, urban children did not necessarily consider themselves to either be part of nature due to the lack of nature

elements, vegetation, and interaction with animals in the city.

- In educational spaces, the children prefer informal and naturalistic outdoor landscapes as a learning environment rather than indoor boring classrooms.
- When children were asked to describe “nature”, the majority expressed their **love** to it through many terms such as: trees, flowers, beauty, garden...etc. This indicates that children have an intellectual and emotional appreciation for all elements of natural environment.

The emphasis in this paper was not about finding causality or generalizing results and therefore, predicting future outcomes. Rather, the main intention was to raise the awareness to promote the relationship between natural spaces and children, this could be accomplished through following a number of guidelines such as: a) nature should be studied within the context of children’s lives; to have better understanding on how to enhance children’s tendency for ‘Biophilia’. b) children must spend sufficient time in naturally healthy environment for biophilia to be fully engaged with them as a lifelong attitude which, in turn, will create a sufficiently large majority of biophilic adults who admire nature and could do everything to protect it. In conclusion, this emerging field claims that even young children, by simply being themselves and reflecting on their experiences, have the potential to change society. Results of this paper showed that children enjoy being in nature rather than in indoor spaces, which provides a glimpse into the potentials of integrating nature within architectural context, including offering beauty, freedom, efficient learning, and relaxation as well as a critical life support system.

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