

Article

Teacher and Parent Perception of Biophilic Conditions in Primary-School Environments and Their Impact on Children's Wellbeing

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Abstract: The term “biophilia” refers to the intrinsic affinity that humans have towards nature, natural elements and natural processes. Biophilic design theories suggest that the introduction or representation of natural characteristics or elements into the built environment can help enhance people’s health and wellbeing. Primary school buildings are important environments where children spend considerable time. However, there is limited evidence on the impact of their biophilic features on the children themselves and on perceptions of important facilitators of children’s wellbeing, such as teachers and parents. This research aims to investigate whether teachers and parents perceive children to have a preference or desire for specific biophilic characteristics in their school’s physical environment; and whether teachers perceive some biophilic characteristics as having an effect on children’s performance and behaviour. A framework for evaluating biophilic characteristics in primary schools was developed. Two case study primary schools in London and Bath (England, UK) were audited against this framework, and teachers and parents were surveyed. The results suggest that children do have a preference towards the specific biophilic features studied, which is stronger and more demanding when the exposure is higher. For some aspects, teachers’ perception of benefits is also susceptible to the quality of the environment itself.

Keywords: biophilia; primary school environment; children’s wellbeing; perception; performance; behaviour



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1. Introduction

Evolutionary theories suggest that humans are physiologically and psychologically adapted to natural environments since they emerged and long evolved within nature [1], creating adaptive responses to certain stimuli and configurations, mainly regarding food, water and security [2,3].

In their search for comfort and security, humans learned to modify their own physical environment. Rapid industrialisation and the massive migration to cities have precipitated these transformations, leading to highly modified environments which are more comfortable than our original habitat, but also resulting in a disconnection from nature to which we were originally adapted, physiologically and psychologically.

In environmental sciences, “biophilia” explains the intrinsic affinity that humans have towards nature, natural elements and natural processes. It has been proven that introduction or representation of natural characteristics or elements into the built environment can help enhance people’s health and wellbeing within our contemporary habitat (e.g., the use of daylight, natural materials or images of nature).

Children, in particular, could be more sensitive than adults to their environment. According to the World Health Organization [4], children consume more air, water and food than adults on a weight proportion; several of their body systems are still growing

and therefore very susceptible; they have different behavioural patterns towards the environment which can increase their exposure (to particles and chemicals in dust and soil); and children do not usually control their own environment, since adults do.

Schools are the environment where contemporary children spend up to 60% of their time. Poor school environments can impact children's and teachers' attendance and retention, and therefore also academic performance [5]. The concept of 'school environment' encompasses "physical environment", "educational environment" and "social environment" [6]; however, this research focuses mainly on physical conditions.

From an environmental psychology point of view, the design of the physical environment is believed to affect children's perception, learning and behaviour; and conditions the evolution of motor, cognitive and social skills [7]. An extensive post-occupancy evaluation on UK primary schools by the RIBA [5] found that "more than 9 in 10 teachers believe school design is important, 1 in 5 teachers have considered quitting because of the condition of school buildings and 91% of teachers feel good design is important to good pupil behaviour". More recently, Barrett et al. [8] evaluated the holistic impact of several aspects of primary-school buildings on children's learning performance, highlighting the importance of optimal physical environments.

1.1. Biophilia

Humans have an affinity to those elements and environments which have allowed our development and survival, including sources of water and some landscapes, such as savannah-type settings, forest edges, watercourses, mountains and valleys [2,9]. The Prospect-Refuge Theory proposed by Appleton [10] emphasises the psychological affinity humans have for wideness (prospect) and hiding possibilities (refuge), which emerges from our ancestors' safe exploration and wayfinding. As diurnal species, vision developed as our prominent sense, and is the reason why daylight, views, the possibility to see far, and certain colours and patterns are especially meaningful at an unconscious level [9].

The existing literature has proved the positive effect of the exposure to plants and other elements of nature on emotion [11], physiology [12–15], cognition [16–19], behaviour [20–22] and health [23–26].

There is worldwide research on children's environments related to biophilia. Rice and Torquati [27] surveyed 114 pre-scholars on "preferences for play locations, enjoyment of sensory aspects of nature, exploring nature, and curiosity about nature". Maller [28] studied the importance of children's "hands-on contact to nature" interviewing educators, school principals, and environmental-education-industry professionals, who recognised benefits on "self-esteem, engagement with school and a sense of empowerment". Similarly, Lee and Park [1] evaluated which biophilic design characteristics could apply to a children's library through case studies and surveys, concluding that the needs of these environments are to provide the experience of nature, shelter and open spaces, multi-functional spaces, and to promote sensorial experiences.

1.2. Nature and Restorativeness

The Attention Restoration Theory (ART), introduced by Kaplan and Kaplan in 1995 [29], proposes the concept of 'restorative environment' as that which "promotes (and not merely permits) restoration" [30] (p. 273). Cognitive functioning was proved to be restored with simple interactions with nature, comparing the cognitive response of young adults after a 50–55-min walk through an arboretum to a traffic-heavy street, and after 10 min of watching an image of a natural landscape to an urban landscape [31]. Children exposed to the natural environment presented better and faster responses [32], giving evidence of an association between cognitive restoration and eye focus direction.

In medicine, early studies associated views to nature/quality of the view with patients' faster recovery in hospitals [24,33]. More recent research suggests links between views to nature and the reduction of pain [34,35]. Other studies associate this link to stress recovery [36].

Bagot, Allen and Toukhsati summarise evidence proposing four requirements for an environment to be restorative: “being away (physical or psychological)”, “compatibility (with purpose)”, “fascination (cognitive or physical)”, and “extent (scope and connectedness)” [37]. They examined and scored four studies and concluded that the indoor environment was less restorative than outdoor/natural, with the amount of vegetation being the only meaningful variable determining restorativeness, and that adults’ and children’s restoration might not follow the same environmental determinants.

1.3. Nature Deficit in Contemporary Children

Contemporary children might be suffering from what Louv calls “nature-deficit disorder”: an insufficiency of ‘primary experiences’ in nature, crucial for their development. Multisensory experiences in nature, quietness and ‘space to wander’ are his highlighted aspects. He also suggests that one of the main causes of nature-deficit is parents’ fear of safety [38].

Urban children tend to be more cooperative and creative in their play when exposed to natural settings, in comparison to spaces with less trees and grass or manufactured play areas [21,38]. Chawla et al. found that children identify natural spaces with freedom, happiness and opportunities to confront challenges [39].

Within the learning environment, school playgrounds with the presence of greenery work as refuge for stress-reduction, restoration and enhance children’s social skills. Exposure to nature is proved to be related also to benefits such as “improved focus, vitality, productivity and reduced stress, factors that may enhance the academic performance of children” [40] (p. 16). Views of nature in classrooms were found to generate a positive perception of courses and better grades [41,42]. Han [43] argues that students are vulnerable to suffering from mental fatigue, this being the reason why their “ideal learning environment should promote attention focusing, reduce mental fatigue and psychophysiological stress, and ideally even improve health and encourage better learning” [43] (pp. 659–660). In his study, Han measured the subjective and objective influence and variations of high-school students during one semester in a classroom with plants. Using a control group, the students were surveyed, and their examination scores and behavioural records were collected. They concluded that “six limitedly visible plants in the classroom had an immediately significant and positive influence on the students’ perceptions of preference, comfort and friendliness” [37] (p. 680). It is relevant to consider that in this type of study there is a possible Hawthorne Effect, where the impact of a positive response may occur only due to the modification of the environment, independently from the characteristics of the modification itself [44] which could play a role as well.

1.4. Existing Frameworks and Classifications for Assessing Biophilia in the Built Environment

In the last two decades, several authors have presented classifications which describe and synthesise those characteristics that define, in their view, biophilic design. These are interpretations of the built environment, where similar strategies and attributes are presented, with some variations in the categories used.

Kellert, also known as the ‘godfather of biophilic design’, presented several frameworks throughout his career. The first one, from 2002 [45], defined three categories for experiencing nature: “direct experience”, which is related to non-human natural settings; “indirect experience”, to refer to human-made natural environments; and “symbolic experience” for the appreciation of nature through books and television. The first two classifications were later used by himself with a different meaning, whereas the appreciation of nature through books and television was not mentioned again by other frameworks.

In a totally different approach, in 2008 [46] Kellert identified 70 “biophilic design attributes”, which were classified into six strategies: “environmental features”; “natural shapes and forms”; “natural patterns and processes”, with attributes such as “growth and efflorescence” and “dynamic balance and tension”; “light and space”, with seven different attributes related to light and five to space; “place-based relationships”, with

attributes such as “avoiding placelessness” or “spirit of space”; and “evolved human-nature relationships”. With this framework, Kellert proposes that the representation of nature and sense of belonging to the place can play a role for biophilia as well, which goes beyond the presence of natural elements per se.

In the same publication, Heerwagen and Gregory [47] examined seven aesthetic qualities from nature which could be evoked by architecture. New proposed attributes are “motion” and “sense of freeness”. The authors claimed that nature is always on the move and that people enjoy watching movement, including watching people move in an urban landscape. Regarding “sense and freeness”, the authors mention two particular aspects: the psychological and physical sense of freedom generated by the lack of boundaries between spaces, and the simple action of being able to open a window in one’s environment, signifying control and therefore freeness. Some attributes from this framework have similarities with Kellert’s from the same publication.

Terrapin Bright Green developed in 2014 [48] an extensive research based on the work of Kellert, Alexander, Heerwagen, Kaplan, Kaplan and Ulrich, among others. Here they presented 14 “patterns of biophilic design” under the categories “nature in the space”, “natural analogues” and “nature of the space”. One of the main novelties of this framework is that for the first time, the attributes (or patterns) are mapped against their effect on people’s health and wellbeing. They classified the evidence into three types: stress reduction, cognitive performance and emotion, mood and preference.

In his last book [9], Kellert presented and described a compacted list of 25 “attributes of biophilic design”. This framework brings the names of the categories from his first classification of 2002 but framed differently. For example, “direct experience” refers to elements from nature and not necessarily “non-human natural spaces”, and “indirect experience” does not refer to botanical gardens of cultivated crops, but to representations of nature such as images, materials, and the simulation of natural elements.

In the same year, biophilic design entered into the field of building certifications. The International Living Future Institute developed a Biophilic Design Toolkit [49], as part of the requirements for the Living Building Challenge Certification. The categories and attributes used reframe Kellert’s, proposing a series of design guidance and tools to implement them at the different project design phases. Simultaneously, the WELL Building Standard [50], which evaluates the impact of buildings on the health and wellbeing of its occupants, also included a few aspects of biophilia under the categories Mind and Light, some as “preconditions” and others as “optimisations”. This is the first framework that introduces criteria for sufficiency.

Overall, the existing frameworks share similar strategies and attributes, with a clear tendency to use the concepts of “direct experience”, “representation” and “spatial configurations”. Except for WELL, which only considers very few aspects of biophilia, existing frameworks work as classifications in the way of checklists without providing priorities or hierarchies. They do not argue whether, for example, the direct presence of daylight or plants have a stronger impact than daylight simulation or nature-like patterns. Most frameworks also have no guidance to sufficiency, with little evidence on how biophilia can be achieved. And there is limited discussion on differences in populations. For instance, in existing frameworks, no particular consideration is taken for the way children perceive or experience the built environment, the physical spaces used mainly by children or how the effect of the built environment on children might vary in comparison to adults. Furthermore, there is limited research on perceptions of parents and teachers on the impact and role of biophilic features in school environments on children. These views are important when considering that parents’ and teachers’ actions and beliefs can directly or indirectly affect children’s wellbeing, for example via impact on exposures (e.g., access to daylight and views might be controlled by teachers in classrooms) or child behaviours or interests.

1.5. Aims and Objectives

The aim of this study is to investigate whether teachers and parents perceive children as having preference or desire for specific biophilic features in their school’s physical environment, and whether teachers perceive certain biophilic characteristics as affecting children’s performance and behaviour.

This study focuses on those biophilic aspects easily identifiable by non-specialist publics. Likewise, ‘preference’, ‘performance’ and ‘behaviour’ are commonly used and widely understood terms that were selected as easily recognisable aspects related to well-being. Teachers’ opinions are particularly relevant since they have some control over the classroom’s environment (e.g., windows and blinds); and parents’ opinions are relevant as they can reflect on what children discuss about their school environment at home.

Specifically, the objectives were as follows:

1. To develop a framework to evaluate biophilic aspects of school environments which allows categorising, comparing, and contrasting different school environments in a way which could be easily communicated with parents and teachers.
2. To evaluate teachers’ perceptions about the role of specific biophilic features in children’s performance and behaviour at school.
3. To identify aspects of children’s preferences towards biophilic features, as perceived by parents and teachers.

2. Methods

2.1. Study Design Overview

The methodology followed involved:

1. The formulation of a bespoke framework for evaluating biophilic conditions in urban primary schools.
2. Audits of two case studies against this framework.
3. Surveys of teachers and parents about their perception about children’s preference, performance and behaviour in relation to certain biophilic attributes. Due to ethics and data protection, participants were not asked to disclose details about specific children or health conditions.

2.2. Development of a Framework for Evaluating Biophilic Conditions in Urban Primary Schools

Based on the existing attributes and classifications from existing frameworks presented in Section 1.4, a new framework with a focus on children and primary school environments was formulated.

A concise selection of practical attributes, which could be suitable for assessing the primary-school physical environment, were identified and classified under “elements” or “spatial experiences”, and “direct experience” or “representation” (see Table 1).

Table 1. Summary of attributes selected and the proposed classification.

	Presence of Elements	Spatial Interactions
Direct experience	Natural light, fresh air, water, plants, animals, natural materials.	Views out, infrastructure for outdoor classes, promotion of healthy commuting, gardening sessions, ‘forest school’ activities.
Representation	Images of nature, textures and patterns, colour palette, shapes and forms.	Spatial variability, prospect, refuge, active design, possibility to run, possibility to climb.

For each of these attributes, criteria were defined to determine what was considered as “achieved”, “partially achieved”, or “not achieved” (see Table 2). This framework does not aim to define minimum performance grades for biophilia (further research is needed to tackle this); nevertheless, it gives a basic evaluation of the school’s biophilic condition.

Table 2. Criteria to evaluate levels of fulfilment for each attribute.

Attribute	● Achieved	● Partially Achieved	● Not Achieved
Natural light	Daylight always present when weather allows it. Most times there are no problems with glare.	Not enough daylight/ daylight is not always present. Too much glare which results in the blinds being down for long periods.	Almost no daylight in the space.
Fresh air	Both conditions are met: <ol style="list-style-type: none"> 1. Natural ventilation. 2. Air perceived as fresh, not being stuffy, and not having disgusting smells. 	Only one of the previous conditions are met.	None of the previous conditions are met.
Water	Any presence of water features (e.g., fountains, constructed wetlands, ponds, swales, etc.) available for all children.	Presence of water features only for some children. A water tap in the playground to which children have access can count.	No presence of any source of water (except in toilets).
Plants	Both conditions are met: <ol style="list-style-type: none"> 1. Indoor plants are present in all classrooms. 2. Outdoor plants are a dominant element in the playground. 	Any of the following conditions are met: <ol style="list-style-type: none"> 1. Existing indoor plants but not in all classrooms. 2. Outdoor plants exist but are not a dominant element in playground. 	Both conditions are met: <ol style="list-style-type: none"> 1. No indoor plants. 2. Outdoor plants are scarce (e.g., isolated planters) or non-existent.
Animals	Both conditions are met: <ol style="list-style-type: none"> 1. All children have access to pet animals (e.g., fish bowl). 2. It is easy to encounter insects or other wild animals (e.g., if there are planters). 	Any of the following conditions are met: <ol style="list-style-type: none"> 1. Only few children have access to pet animals (e.g., fish bowl). 2. There are scarce possibilities for encountering insects or other wild animals (e.g., birds). 	Any of the following conditions are met: <ol style="list-style-type: none"> 1. There are no pet animals at school. 2. There are scarce possibilities for encountering insects or other wild animals (e.g., birds).
Natural materials	Almost no presence of synthetic materials. Dominant presence of natural materials (e.g., timber finishes and furniture, stone, natural fibres, clay-based, unpainted bricks).	Intermediate situation between the other two options (e.g., natural materials are not dominant, some presence of non-synthetic materials, and natural materials painted with synthetic paints).	Almost no presence of natural materials. Great presence of synthetic materials (e.g., plastic furniture, melamine, synthetic fibres, synthetic carpets, and synthetic paint in doors and window frames).
Images of nature	All of the following conditions are met: <ol style="list-style-type: none"> 1. All children have access. 2. Diverse images (photos and/or drawings) showing multiple elements and human experiences. 3. Images created by children. 	Some of the previous conditions are met.	None of the previous conditions are met.
Textures and patterns	All children have access to nature-like textures and patterns in furniture, flooring, walls, other architectural elements.	There are very few nature-like textures and patterns within the building or not all children have access.	Do not exist.

Table 2. Cont.

Attribute	● Achieved	● Partially Achieved	● Not Achieved
Colour palette	Generally, colours are not strident and excessive (e.g., too many different contrasting and vibrant colours); though some bright colours in specific elements exist. Blues, green and/or earth tones stand out. Interior walls are light in colour (preferably white) and not blocked by excessive billboards. Exterior: green stands out.	There is a combination of colours between light walls, earth tones, blues and greens; but also, strident colours stand out.	Overall, the colour palette is not close to blues, green or earth tones. Only strident or grey colours stand out. Interior walls are not light in colour or absolutely blocked by excessive billboards and other elements.
Shapes and forms	All children have access to shapes and forms in the building elements such as: botanical motifs, tree and columnar supports, shells and spirals, oval and tubular forms, arches, vaults, domes, shapes resisting straight lines and right angles.	There are very few nature-like shapes and forms within the building, or not all children have access.	Not existing.
Views out	Both conditions are met: 1. Existing view of natural landscape, far away view (including broad urban views), natural elements (e.g., plants), or intense pedestrian traffic. 2. All children have views out from their seats.	Any of the following conditions are met: 1. Existing view of non-natural close elements or close street without pedestrians. 2. Existing view out but not from all children's seats or not at children's height. 3. Blinds are usually kept down.	Any of the following conditions are met: 1. No views out. 2. Windows to corridors, atriums or to other indoor room. 3. Windows above children's height.
Infrastructure for outdoor classes	There is infrastructure which allows outdoor classes, including shaded areas, space for seating, non-noisy environment, outdoor-boards or other outdoor-equipment.	There is little infrastructure but it is still possible to have classes outdoors.	There is no infrastructure (e.g., no shades or space to sit the whole class, and it is too noisy to work there).
Promotion of healthy commuting	There is enough space dedicated to parking bikes/scooters for more than half the number of children.	There is enough space dedicated to parking bikes/scooters for more than half the number of children.	There is no parking space for bikes/scooters.
Gardening sessions	Activity taking place on a regular basis for all children. The school has planters and/or gardening pots which children are allowed to interact with.	Activity taking place very sporadically or only for some children. The school has planters and/or gardening pots which children are allowed to interact with.	Not existing.
'Forest School' activities	There are 'Forest School' type activities on a regular basis for all children.	There are some 'Forest School' type activities seldom, very sporadically, and/or only for some children.	Do not exist.

Table 2. Cont.

Attribute	● Achieved	● Partially Achieved	● Not Achieved
Spatial variability	<p>At least three of these conditions are met:</p> <ol style="list-style-type: none"> 1. Different accesses from the street to the school. 2. Several routes within the school or circular routes. 3. Winding routes/corridors. 4. Sequences of tight and broad spaces or diversity of circulation areas (e.g., mix between corridors and distribution halls). 	Two or less of the previous conditions are met.	None of the previous conditions are met. There is a lack of spatial complexity (e.g., the access to different spaces is only through a common corridor, unique routes, straight corridors, and only one type of circulation).
Prospect	There are wide views beyond the limits of the school for all children.	There are some wide views within the limits of the school and/or only available for some children.	There are no wide views within the limits of the school or beyond.
Refuge	There are many possibilities for children to find a quiet and relatively out-of-sight spot while playing.	There are a few possibilities for children to find a quiet spot relatively out of sight while playing.	There are almost no possibilities for children to find a spot relatively out of sight while playing.
Active design	<p>There are stairs that all kids use every day or there are:</p> <ol style="list-style-type: none"> 1. Existing opportunities to walk and wander (e.g., spaces not too closely connected). 2. Steps, slopes and/or topographic variations in playgrounds. 	There are stairs but not all children use them every day and/or there are not many opportunities for wandering or there are no topographical variations in the playgrounds.	There are no stairs, no opportunities for wandering (e.g., spaces too close together, all activities during the day take place in the same physical space), and no topographic variations on playgrounds.
Possibility to run	The playground is big enough to allow children to run, there are possibilities for children of different ages to have separated areas/playgrounds, and the paving surface is even and not too hard. There are not too many protruding elements around.	Some of the previous characteristics are not met.	There are no possibilities for children to run because the size of the playgrounds do not allow it or it is too dangerous (e.g., types of surfaces, protruding elements around) or because children of all ages have to share the same area at the same time.
Possibility to climb	The equipment in the playground (or sports room) allows a diversity of possibilities for climbing for all children.	The equipment in the playground (or sports room) allows some possibilities for climbing but not too much variation or they are not available for all children.	There are no possibilities (e.g., no playing equipment in playground).

2.3. Case Studies and Audits

Two case study primary schools were visited and audited against the new framework. The aim of the audits was to establish and compare the overall biophilic situation of the case studies, and to give background context to the data collected in these schools.

At the moment of the study, school A (London) had 300 (approx.) pupils, 18 teachers and teacher assistants and 23 other school staff. School B (Bath) had 210 (approx.) pupils, 22 teachers and teacher assistants and 7 other school staff.

2.4. Surveys

2.4.1. Teachers' Survey

The participants were current main teachers or assistants.

The call for participation was sent by email to the headteachers of the respective schools, who could opt for face-to-face, paper-based, or online-based formats. School A's headteacher handed paper-based versions at a teachers' weekly meeting and collected them two days later. Five responses were obtained from the estimated 15–18 teachers invited. The researcher was later invited to a summer fair where three more teachers participated face-to-face. School B's headteacher delivered paper-based questionnaires to the teachers after the school year ended and returned them to the researcher scanned by email. Six responses were collected from school B.

The questionnaire consisted of four open questions that aimed to evaluate the following:

1. Whether certain biophilic features have a perceived impact on children's preference, performance, and behaviour, through the lens of teachers.
2. What possible mechanisms could be causing the perceived impact.
3. Whether the school physical environment influences teachers' perception of the impact of the biophilic features on children.

Each question on the questionnaire targeted a different physical element from the school environment, associated to one or several biophilic attributes from the framework: "windows", "blinds up", "materials and finishes" and "plants in classrooms" (see Table 3). The questions asked about their perception of the effect of these conditions on children's preference, performance, and behaviour. Other aspects that arose, such as teachers' own preference, were also considered in the analysis.

Table 3. Questions from the teachers' questionnaire, their biophilic physical aspects associated and the relation to the framework.

Physical Aspect	Question as in the Questionnaire	Framework's Attributes Related to the Question
Windows	Q1: Do you notice any changes in performance or behaviour (attention or disruption) when children are seated next to the windows in the classroom?	Natural light, fresh air, and views out.
Blinds up	Q2: Do you usually have your window blinds down during class? How do children react to this? Do you notice a change in behaviour or performance when blinds are down or up, or when artificial light is on/off?	Natural light, views out.
Materials and finishes	Q3: Regarding the range of materials and finishes that could be found in the classroom, some may be more artificial or synthetic (e.g., plastic, melamine, plain colours, geometric patterns) and some might be natural or nature-like (e.g., timber, stone, clay based, natural fibres, nature-like patterns, textures and colours). Have you noticed any differences in children's reactions (preference, performance or behaviour) when interacting with this type of materials/finishes in comparison to artificial?	Natural materials, textures and patterns, and colour palette.
Plants in classroom	Q4: According to your experience, do you think more plants in a classroom could have a positive impact on children's performance and behaviour? Have you noticed changes in behaviour or performance when (if) plants were introduced in the classroom?	Plants

The analysis of this survey consisted of two parts: an overall coding analysis to determine whether the impacts were perceived, and if so whether these were positive or negative and a detailed qualitative analysis to collect the specific perceived effects on children’s preference, performance and behaviour.

2.4.2. Parents’ Survey

Parents were invited to participate through the parents’ social media network and face to face in school social events. Parents from school A were invited in person during the school’s summer fair. Parents from school B were invited through a parents Facebook group which included an introductory note written by one parent and a link to an online form served by SurveyMonkey.com. In total, 17 responses were collected from school A and 6 from school B.

The parents’ questionnaire consisted of three checkbox questions aiming to capture the parents’ perception on children’s preferences, desires, and comments related to 8 attributes selected from the framework: natural light, water, plants, animals, views out, natural materials, images of nature, and colour palette (see Table 4). Question 1 includes options about non-physical aspects (activities and people, which are presumed to be easily mentioned by children) to confirm whether the children talk about their school environment at home.

Table 4. Questions from the parents’ questionnaire and the relation to the framework. The options to be selected were accompanied by checkboxes.

Question as in the Questionnaire	Framework’s Attributes Related to the Question
Q1: Do your children talk about their classroom environment at home (e.g., something they particularly like about their classroom)? Please select: Materials, colours, views, images, natural elements (plants, water features, animals), environmental conditions (daylight, temperature, smells), activities, classmates, teachers, other: _____.	Natural light, water features, plants, animals, views out, natural materials, images of nature, and colour palette.
Q2: What do you think your children would like to change/add/remove in the classroom? Please select: Materials, colours, views, images, natural elements (plants, water features, animals), environmental conditions (daylight, temperature, smells), other: _____.	Natural light, water features, plants, animals, views out, natural materials, images of nature, and colour palette.
Q3: Have your children ever mentioned they would like more natural elements in their school? Please select: Plants, water features, more daylight, trees, especial colours, images of nature or particular views, natural materials (timber, stone, clay, sand), other: _____.	Water features, plants, natural materials, images of nature, and colour palette.

The analysis of this survey consisted of counting the sum of votes on each checkbox in order to

- a. confirm whether children comment on school environments at home;
- b. identify and compare which elements of biophilia are more perceived, commented and desired by the children;
- c. identify differences on these between schools, and to analyse whether the school could have an impact on the type of elements mentioned and on the awareness of biophilia.

3. Results

3.1. Audits

Table 5 summarises the audits’ results. Overall, in School A, 3 attributes were considered achieved (all representational), 11 partially achieved, and 7 were not achieved. Whereas for School B, 15 attributes were achieved, 4 partially achieved, and 2 were not achieved (both representational). Therefore, school A can be considered as a ‘low-biophilic school’ and school B a ‘higher-biophilic school’.

Table 5. Summary of the audit results.

	Attribute	School A	School B
Direct experience (presence of elements)	Natural light		
	Fresh air		
	Water		
	Plants		
	Animals		
	Natural materials		
Direct experience (spatial interactions)	Views out		
	Infrastructure for outdoor classes		
	Promotion of healthy commuting		
	Gardening sessions		
	‘Forest School’ activities		
Representation (presence of elements)	Images of nature		
	Textures and patterns		
	Colour palette		
	Shapes and forms		
Representation (spatial interactions)	Spatial variability		
	Prospect		
	Refuge		
	Active design		
	Possibility to run		
	Possibility to climb		

3.2. Teachers' Surveys

Overall, the results from the survey show the following:


- Teachers from school B had a more unanimous and generally positive opinion about the impact of the biophilic features on children's preference, performance and behaviour than teachers from school A.
- The most conflicting responses were regarding windows and blinds, which were perceived positive by school B teachers and generally not well rated from school A. While teachers from school A used words such as "distraction", "disruption", or "I don't think they notice the blinds are down"; school B teachers used "enjoy", "preferred", "fascinated", "engaged", and "wake their brains up".
- Teachers from school B did not express the perception of negative impact for any condition.
- The most positively rated conditions were "plants in classrooms" for school A, and "plants in classrooms" and "windows" for school B.
- "Materials and finishes" showed greater uncertainty, but interestingly, some teachers commented that children are more respectful with objects and toys made of wood than plastic, which they throw away more easily, considering them disposable.

Figure 1 summarises the teachers' responses decoded. The teachers' responses (T) are expressed in the rows. The different questions (Q, columns) are subdivided into columns, each column referring to the different aspects of wellbeing analysed (teacher's preference, perceived children's preference, perceived children's performance, and perceived children's behaviour). For each question, the coloured icons rating the perceived impacts were allocated under the corresponding wellbeing aspect they were referring to. E.g., the quote of T1 for Q1 who says: "More disruption as they often look out and stare which means we have to stop the lesson and remind them to focus" was decoded as (a) "more disruption": perceived negative impact on children's behaviour; (b) "remind them to focus": perceived negative impact on children performance; and (c) overall: perceived children's positive preference. So, despite the question referring to children's performance and behaviour, positive children's preference was manifested too, marked with a green icon under "children's preference", and red icons under "performance" and "behaviour".

	Q1 Windows				Q2 Blinds up				Q3 Materials & finishings				Q4 Plants in classrooms					
	TP	ChP	Pf	Bh	TP	ChP	Pf	Bh	TP	ChP	Pf	Bh	TP	ChP	Pf	Bh		
School A (SAT)																		
T1		+	-	-			-		-		no	no	no	+	+	no	no	
T2		+	-		+	-					no	no	no			no	no	
T3		+		-	-		-			+	+				+	+		
T4		+	-		+	+				+		+			+	+		
T5				no	no		-	no	no	no		no	no	no			no	no
T6		+	+	-	+				-		N/R			+		+		
T7				no	no		+				N/R			+		+		
T8				N/R					+		N/R					+	+	
School B (SBT)																		
T9			+	no			N/R			+		+		+			+	
T10	+	+	+	+			N/R			+				+	+		+	
T11		+		+			N/R			no	no	no					+	
T12				+	+					+	+						+	
T13				+	+				+	+	+						+	
T14		+		+	+		+		+	no	no	no		+	+	+		

LEGEND: T Participating teacher (rows) Q Question (columns)

Codes for wellbeing aspects analysed:

- TP** TEACHERS' preference
- ChP** Perceived children's PREFERENCE
- Pf** Perceived children's PERFORMANCE
- Bh** Perceived children's BEHAVIOUR
-  Those aspects explicitly asked about in the question

(Note that the perceived impact logos are aligned to the column of the wellbeing aspect they refer to)

Logo-codes for perceived impact:




-  Perceived POSITIVE impact
-  Perceived NEGATIVE impact
-  NO impact perceived /not aware of an impact
- N/R Not relevant
- List When a list of physical elements, not impacts, were mentioned

Figure 1. Comparative analysis of teachers' survey.

3.3. Parents' Surveys

When asked about whether their children talk about their classroom environment at home (Figure 2, Table 6), the most popular responses were related to their classmates, teachers and activities. This confirms the fact that children actually speak about their school environment at home. From the other options, school A parents mentioned aspects not necessarily related to biophilia, whereas school B parents answered yes, and in a larger proportion.

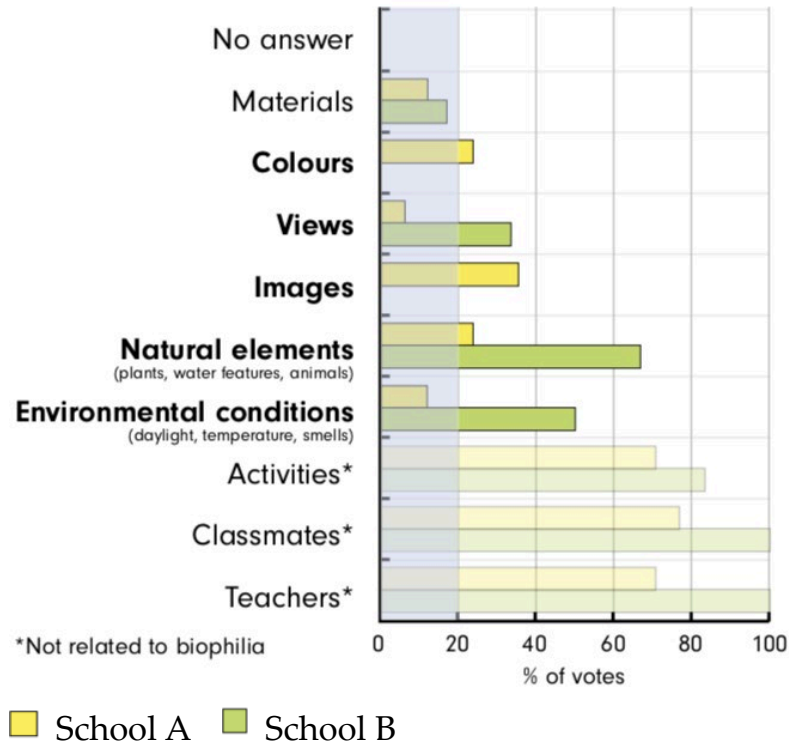


Figure 2. Results from parents' question 1. The grey shade shows answers below a 20% response.

Table 6. Results from parents' question 1: "Do your children talk about their classroom environment at home? Do they mention any of the following?".

	School A (n = 17)		School B (n = 6)	
	Votes	%	Votes	%
No answer	0	0	0	0
Materials	2	12	1	17
Colours	4	24	0	0
Views	1	6	2	33
Images	6	35	0	0
Natural elements	4	24	4	67
Environmental conditions	2	12	3	50
Activities	12	71	5	83
Classmates	13	77	6	100
Teachers	12	71	6	100

- “Images”, “colours”, and “natural elements” were the top three options that parents from school A selected (35%, 24% and 24% of parents respectively).
- For school B, the top three options were “natural elements”, “environmental conditions”, and “views” (67%, 50%, and 33% respectively).
- For school A, the features related to the representation of nature were the most popular. Whereas for school B, the most popular options selected relate to the direct experience of nature, and nobody selected “colours” or “images”.
- Relevant statements at the option “other” were “Food” and “The children do not tend to talk about the fixed features—more on people”.

For question 2, “what do you think your children would like to change, add or remove in their classroom?” (Figure 3, Table 7), a large proportion of parents from school A did not answer the question (41%), whereas all parents from school B responded. The outstanding responses for both groups were “natural elements” (83% of parents from school B and 18% from school A) and “environmental conditions” (67% for school B and 18% for school A).

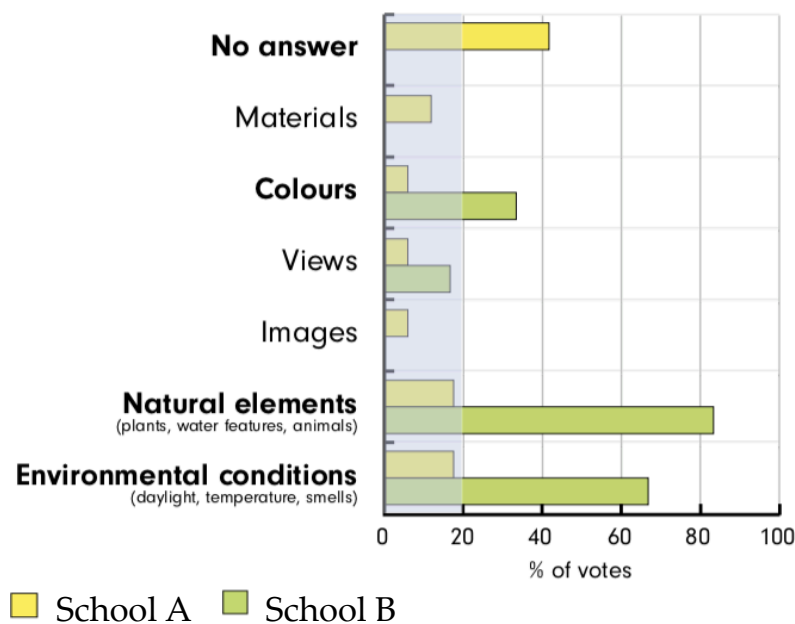


Figure 3. Results from parents’ question 2. The grey shade hides those answer with less than a 20% response.

Table 7. Results from parents’ question 2: “What do you think your children would like to change, add or remove in their classroom?”.

	School A (n = 17)		School B (n = 6)	
	Votes	%	Votes	%
No answer	7	41	0	0
Materials	2	12	0	0
Colours	1	6	2	33
Views	1	6	1	17
Images	1	6	0	0
Natural elements	3	18	5	83
Environmental conditions	3	18	4	67

Relevant statements at the option “other” were “If they had the option to provide views, I am sure they would engage”, “loves water & aquatic plants & animals, and looking after his plants at home”.

When parents were explicitly asked about natural elements (Figure 4, Table 8), the most popular answer was “plants” (24% response rate for school A and 83% for school B). Especially in school B where they actually have plants everywhere in the school. Again, for this question, most parents from school A left it empty and the rest of the options were smoothly distributed. The second most selected options for parents from school B were “water features”, “trees” and “natural materials” (33% each). The only option not selected by school B parents was “images of nature or particular views”.

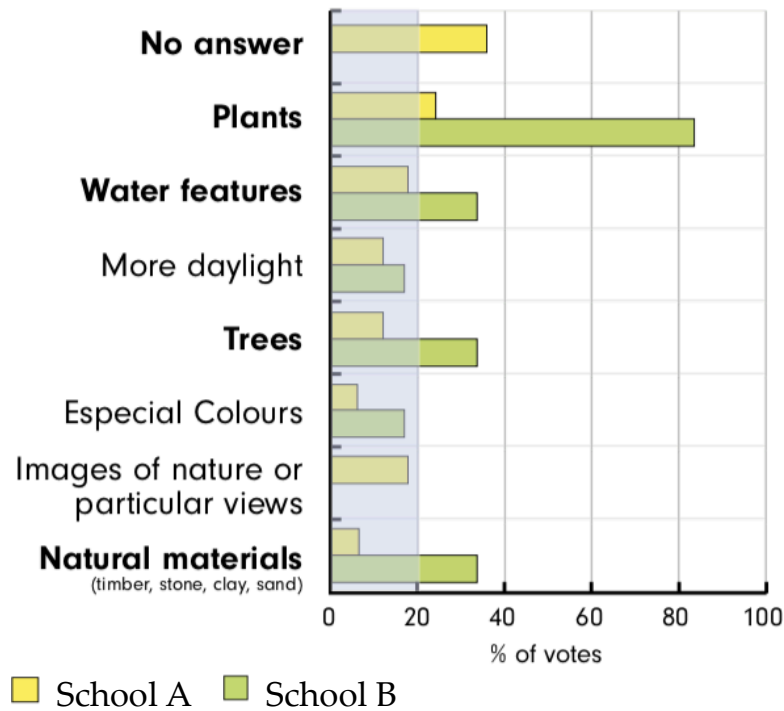


Figure 4. Results from parents’ question 3. The grey shade hides those answer with less than a 20% response.

Table 8. Results from parents’ question 3: “Have your children ever mentioned they would like more natural elements in their school?”.

	School A (n = 17)		School B (n = 6)	
	Votes	%	Votes	%
No answer	6	35	0	0
Plants	4	24	5	83
Water features	3	18	2	33
More daylight	2	12	1	17
Trees	2	12	2	33
Especial colours	1	6	1	17
Images of nature or particular views	3	18	0	0
Natural materials	1	6	2	33

Relevant statements in the option “other” for this question were “an indoor waterfall”, “fish” and “to see the sky”.

4. Discussion

4.1. Overall Comparison of Results

A framework to evaluate primary school environments based on their success in implementing biophilic design (objective 1) was developed, based on the literature review and its adaptation to school environments. Performance and behaviour (objective 2) were analysed through the teachers’ survey and preferences (objective 3) through the surveys to teachers and parents.

4.1.1. In Relation to Objective 2: Teachers’ Perception of Certain Biophilic Features on Children’s Performance and Behaviour

Overall, results suggest that the biophilic features analysed have a perceived impact on children’s performance and behaviour, and that there are differences from “low-biophilic” and “higher-biophilic” schools (represented by school A and school B, respectively).

Performance:

- According to teachers, children have a preference towards windows, which leads to some types of distraction. Therefore, windows were negatively qualified by some teachers from school A, but considered very positive by teachers from school B.
- Views out, natural materials and plants were perceived as promoting observations, curiosity and discussions.

Behaviour:

- Teachers from both schools agree that children behave carefully and respectfully towards plants and objects made of natural materials (i.e., wood). Also, they agree that plants are calming for the children.

4.1.2. In Relation to Objective 3: Children’s Preference towards Biophilic Features, as Perceived by Teachers and Parents

According to parents, children comment more on activities and people than on physical characteristics of the physical environment. A parent’s comment at the survey summarises it: “Children do not tend to talk about the fixed features, more on people”.

However, though to a lesser extent, children do comment on the school’s physical characteristics. Contrasting parents’ perspectives, children from school A mention biophilic features much less often than children from school B. Besides, children from school B comment more on features classified in the framework as “direct experience” (i.e., natural elements, environmental conditions, and views), a category in which this school was highly valued in at the audit; while students from school A comment more on features from the “indirect experience” category (i.e., images and colours).

Regarding children’s desire, 35% of parents from school A do not know what children would want to change or desire at their school environment, while all parents from school B had an answer. Although the audit result considered that school B had a higher biophilic condition compared to school A, 83% of parents from school B expressed that their children would like more plants, while only 24% of parents from school A did.

4.2. Key Findings

4.2.1. Teachers’ Awareness

On some aspects, teachers from the “higher-biophilic” school perceive more benefits and seem more sensitive to the school’s environment conditions and their effect on children than teachers from the “low-biophilic” school. For instance, the former expressed awareness on the benefits of daylight, views out and fresh air, whereas the latter manifested little awareness and made comments such as “I don’t think they notice” regarding whether the blinds were down or up.

4.2.2. Children's Awareness and Demand

Results suggest that children's preference for biophilic features is stronger when the exposure is higher. Hypothetical reasons could be:

- a. The richer the environment, the higher their understanding, awareness of biophilic features and desire for other features and expectations.
- b. The role that teachers play in stimulating awareness. Teachers could be more sensitive too, due to the environment where they work.

4.2.3. Design Effectiveness vs. Impact of the Actual Element

Teachers' perception of the impact of biophilic features on children's wellbeing could be restricted by inadequate building design (e.g., lack of windows shading, leading to glare). In this context, "blinds up" were perceived as undesired and perturbing the general performance of children, when actually glare might have been the cause. On the other hand, parents expressed that children do want more daylight and teachers themselves believe children do have a preference for windows. Another possible justification for the reported misbehaviour could be that children without enough exposure to certain biophilic features, in need of restoration or biophilic fulfilment "get distracted" with the views out and daylight because

- a. they do not usually have them,
- b. their biophilic needs are not satisfied,
- c. they associate these biophilic features with the playground environment, space where they experience movement, restoration, and where they have more exposure to biophilic features.

4.2.4. Role of Teachers

The results from the teachers' surveys evidence their fundamental role in the control of the environmental conditions and on the effectiveness of the biophilic attributes through encouragement of observation and the activities performed.

The previous research findings are tentative, since the samples were limited. Further research should tackle these key points to confirm or reject the hypothesis formulated.

4.3. Findings in Relation to the Literature

The findings in this study support Lee and Park's [1] principles for space design in children's libraries based on biophilic design patterns, extending them to the wider school environment (classroom and patio). In particular, the offer of the experience of nature, shelter and open space, and a multisensory approach. This study also evidences the role of "fascination (cognitive or physical)" in restorativeness described by Bagot, Allen and Toukhsati [37] and the positive influence of natural elements in students' performance as described by Han [43]. The literature also suggests that a lack of natural experiences could lead to a lesser care of the natural environment [3,38,51–54], which could somehow be reflected in this study regarding objects made out of natural materials vs. synthetic, since the former are perceived to be more respected. This could also be due to the extended use of disposable plastic that children encounter every day.

Han [43] also emphasises the importance of a learning environment which reduces stress and advocates for children to concentrate; it is evident in this study that an environment of discomfort, such as when glare is present, can lead to misbehaviour. A possible reason for children's reported misbehaviour in the presence of daylight could simply be the impossibility to relocate (i.e., move away) when glare perturbs them. Parpairi [55] found that visual satisfaction of students in Cambridge libraries was not associated to the actual measured light levels and was high even under uncomfortable situations (e.g., glare) if there were good views of landscape and the person had the option to move. Adaptation theories, referring to thermal comfort [56,57], could have a role here too. Baker [58] depicts this situation in his "general theory of environmental comfort" as the relationship between

adaptive opportunities and stress, highlighting the importance of providing relocating opportunities to users. In the case of school A, not having the option of relocation while being affected by glare might be the cause for children's misbehaviour.

Lastly, the data gathered provided some new elements of nature to consider, which had not been covered in the existing biophilia frameworks, such as sky views and shades.

4.4. Contributions, Limitations, and Future Research Directions

This study is relevant to different disciplines including designers, teachers, school authorities, and policy makers. Below there are some reflections that can be of interest to those keen to conduct similar studies to confirm the findings.

4.4.1. About the Proposed Framework

This study developed a new biophilic framework of analysis which focuses on features specifically applicable to primary school environments, and which allows a basic evaluation of the school's biophilic conditions under a fulfilment criterion. However, it needs further testing in a diversity of school environments and with a diverse range of auditors. A quantifiable set of criteria for evaluating the biophilic attributes would benefit this framework. Further research could target ways to quantify the dose and length of exposure of the different features, and the repercussions that these will have on the impact on children. This could include minimum areas of vision, times for exposure, and percentage rates, etc.

4.4.2. Methodological Considerations

- **Sample:** The samples (schools and participants) were limited. A larger number of schools and a broader diversity of biophilic conditions could enrich the results.
- **Demographic information:** Questionnaires in this study were kept short to reduce unresponsiveness; therefore, demographic information was not collected. Gathering information related to gender, age, and socioeconomic context could capture aspects that could impact the results as well.
- **Asking children:** Nobody better than children could know what they prefer or desire. This research suggests that (a) parents are not always sure about children's desire towards their school's physical environment and (b) teachers might confuse children's desire and biophilic needs with discomfort issues caused by inadequate design. Teachers' opinions about the impacts on children wellbeing varies as well (e.g., several teachers consider that views out have a strong impact, while others believe children do not realise whether blinds are down or up). As Bagot, Allen and Toukhsati say: "The inclusion of children in the understanding of their environments is warranted and is likely to give rise to elements not considered by adults thus far" [37] (p. 8).
- **Experimental studies:** Future research could use experimental variables, such as controlling blinds, exposing children to different types of views out, different lighting and glare conditions, options for relocation, testing performance, observing children behaviour and surveying teachers and children. Experimental studies with vulnerable populations (children) would require stricter ethical considerations but would provide very valuable information.

4.4.3. Other Considerations

- **Location and socio-economic factors:** Future research with a larger sample of schools could investigate whether some factors such as city size, socio-economic factors related to location, proximity to green areas or natural landscapes, and/or the biophilic condition of the city itself have a relevant impact on the results.
- **Role of parents:** This research focused on the biophilic conditions of school environments, since it is here where children spend most of their time after home; but further information could have been identified on the time at home and on weekends, in terms of whether children ever experienced "direct nature" (in the sense of Louv [38]). While in this study the role of teachers in encouraging the observation of biophilic features

for children was considered, the role of the parents was not. Research is needed on the parents' own relation to nature and how much this influences the school selection.

4.4.4. Implications for Practice and Policy

- For designers: This research exposes the impact that inadequate design and discomfort can have on teachers' and children's perception of biophilic features. It also highlights the relevance of providing opportunities for restoration and changes of focus, not only in playgrounds but also in classrooms. The framework proposed in this study can be used as a tool to support the design process.
- For teachers and headteachers: the study highlights the significant role of teachers in managing classroom environmental conditions (e.g., use of blinds) and in enhancing biophilia features/awareness through the encouragement of observation and promotion of discussion. Recommendations include incrementing the opportunities of being outside (e.g., outdoor curricular activities) and including more biophilic features in classrooms (e.g., wooden furniture).
- For policy: Biophilic design is suggested to be an essential consideration for the correct development of children's wellbeing. This implies not only infrastructure (e.g., proper space for outdoor classes and required equipment, recondition of playgrounds, and use of natural materials) but also teachers' encouragement of biophilic activities (e.g., gardening, active commuting).

5. Conclusions

This mixed-method study focusing on teachers' and parents' views suggests that the school's physical environment could impact children's preference, performance and behaviour. Results revealed that a higher biophilic environment increases teachers' and children's sensitivity, awareness and demand towards biophilic features themselves. Furthermore, teachers who were exposed to biophilic features had a positive perception of their effects. Similarly, teachers and parents from schools where children are more exposed to biophilic elements perceived that their children are more aware and comment more on these types of elements than children who are less exposed. Additionally, inadequate design of the building (e.g., insufficient windows shading), which may lead to discomfort (e.g., glare), could have an effect on the perception of negative impact of biophilic attributes (e.g., daylight, views out). This study, therefore, has implications for design and for educational policies.

This study's contribution to the research field also includes a bespoke framework for biophilic design in primary school environments which allows biophilia-oriented evaluations of existing school buildings or could be used as a tool to aid the design stage. Furthermore, the combination of audits and surveys can enhance the understanding of how the perception of biophilic features could be conditioned by the physical environment, and how this could impact children's preference, performance and behaviour.

Further research should examine the reasons that determine children's preferences and demands for biophilic features when exposed to higher or lower biophilic environments (e.g., better understanding, expectations, and role of adults). The role of parents on the promotion of biophilia, their own biophilic preferences and any relation to biophilia when choosing their children's school could be considered too.

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References

1. Lee, H.C.; Park, S.J. Assessment of importance and characteristics of biophilic design patterns in a children's library. *Sustainability* **2018**, *10*, 987. [CrossRef]
2. Heerwagen, J.H.; Orians, G.H. Humans, Habitats, and Aesthetics. In *The Biophilia Hypothesis*; Kellert, S.R., Wilson, E.O., Eds.; Island Press: Washington, DC, USA, 1993; pp. 138–172.
3. Ulrich, R.S. Biophilia, Biophobia and Natural Landscapes. In *The Biophilia Hypothesis*; Kellert, S.R., Wilson, E.O., Eds.; Island Press: Washington, DC, USA, 1993; pp. 73–137.
4. Children's Environmental Health—Environmental Risks, World Health Organization. Available online: <https://www.who.int/ceh/risks/en/> (accessed on 19 July 2019).
5. Plotka, E. *Better Spaces for Learning*; Royal Institute of British Architects: London, UK, 2016.
6. Conners, D.A. The School Environment: A Link to Understanding Stress. *Theory Pract.* **1983**, *22*, 15–20. [CrossRef]
7. Kopec, D.A. Schools and Learning Environments. In *Environmental Psychology for Design*; Fairchild: New York, NY, USA, 2006; pp. 188–209.
8. Barrett, P.; Treves, A.; Shmis, T.; Ambasz, D. *The Impact of School Infrastructure on Learning: A Synthesis of the Evidence*; World Bank: Washington, DC, USA, 2019. [CrossRef]
9. Kellert, S.R. *Nature by Design*; Yale University Press: New Haven, CT, USA, 2018.
10. Appleton, J. *The Experience of Landscape*; Wiley: London, UK, 1975.
11. Larsen, L.; Adams, J.; Deal, B.; Kweon, B.S.; Tyler, E. Plants in the Workplace: The Effects of Plant Density on Productivity, Attitudes and Perceptions. *Environ. Behav.* **1998**, *30*, 261–281. [CrossRef]
12. Nakamura, R.; Fujii, E. Studies of the Characteristics of the Electroencephalogram when Observing Potted Plants: Pelargonium Hortorum "Spriner Red" and Begonia Evansiana. *Tech. Bull. Fac. Hortic. Chiba Univ.* **1990**, *43*, 177–183.
13. Lohr, V.I.; Pearson-Mims, C.H.; Goodwin, G.K. Interior plants may improve worker productivity and reduce stress in a windowless environment. *J. Environ. Hortic.* **1996**, *14*, 97–199. [CrossRef]
14. Chang, C.Y.; Chen, P.K. Human response to window views and indoor plants in the workplace. *HortScience* **2005**, *40*, 1354–1359. [CrossRef]
15. Orsega-Smith, E.; Mowen, A.J.; Payne, L.L.; Godbey, G. The Interaction of Stress and Park Use on Psycho-physiological Health in Older Adults. *J. Leis. Res.* **2018**, *36*, 232–256. [CrossRef]
16. Hung, M.F.; Chang, C.Y. The effect of plants on preschool children's attention in the classroom. *Hortic. NCHU* **2002**, *27*, 77–86.
17. Shibata, S.; Suzuki, N. Effects of the foliage plant on task performance and mood. *J. Environ. Psychol.* **2002**, *22*, 265–272. [CrossRef]
18. Kuo, F.E.; Faber Taylor, A. A Potential Natural Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a National Study. *Am. J. Public Health* **2004**, *94*, 1580–1587. [CrossRef]
19. Ottosson, J.; Grahn, P. A comparison of leisure time spent in a garden with leisure time spent indoors: On measures of restoration in residents in geriatric care. *Landsc. Res.* **2005**, *30*, 23–55. [CrossRef]
20. Mooney, P.; Nicell, P.L. The Importance of Exterior Environment for Alzheimer Residents: Effective Care and Risk Management. *Healthc. Manag. Forum. Can. Coll. Health Serv. Exec.* **1992**, *5*, 23–29. [CrossRef]
21. Taylor, A.F.; Wiley, A.; Kuo, F.E.; Sullivan, W.C. Growing up in the Inner City. *Environ. Behav.* **1998**, *30*, 3–27. [CrossRef]
22. Kuo, F.E.; Sullivan, W.C. Aggression and Violence in the Inner City. *Environ. Behav.* **2003**, *33*, 543–571. [CrossRef]
23. Moore, E.O. Prison Environment's Effect on Health Care Service Demands. *J. Environ. Syst.* **1981**, *11*, 17–34. [CrossRef]
24. Ulrich, R.S. View through a Window May Influence Recovery from Surgery. *Science* **1984**, *224*, 420–421. [CrossRef]
25. Fjeld, T.; Veiersted, B.; Sandvik, L.; Riise, G.; Levy, F. The Effect of Indoor Foliage Plants on Health and Discomfort Symptoms among Office Workers. *Indoor Built Environ.* **1988**, *7*, 204–209. [CrossRef]
26. Takano, T.; Nakamura, K.; Watanabe, M. Urban residential environments and senior citizens' longevity in megacity areas: The importance of walkable green spaces. *J. Epidemiol. Community Health* **2002**, *56*, 913–918. [CrossRef]

27. Rice, C.S.; Torquati, J.C. Assessing Connections between Young Children’s Affinity for Nature and Their Experiences in Natural Outdoor Settings in Preschools. *Child. Youth Environ.* **2013**, *23*, 78–102. [CrossRef]
28. Maller, C.J. Promoting children’s mental, emotional and social health through contact with nature: A model. *Health Educ.* **2009**, *109*, 522–543. [CrossRef]
29. Kaplan, R.; Kaplan, S. *The Experience of Nature: A Psychological Perspective*; Ulrich’s Bookstore: Ann Arbor, MI, USA, 1995.
30. Hartig, T. Restorative Environments. *Encycl. Appl. Psychol.* **2004**, *3*, 273–279. [CrossRef]
31. Berman, M.G.; Jonides, J.; Kaplan, S. The Cognitive Benefits of Interacting with Nature | The Center for Health Design. *Psychol. Sci. Res.* **2008**, *19*, 1207–1212. [CrossRef]
32. Stevenson, M.P.; Dewhurst, R.; Schilhab, T.; Bentsen, P. Cognitive restoration in children following exposure to nature: Evidence from the attention network task and mobile eye tracking. *Front. Psychol.* **2019**, *10*, 429820. [CrossRef]
33. Verderber, S. Dimension of Person-Window Transactions in the Hospital Environment. *Environ. Behav.* **1986**, *18*, 450–466. [CrossRef]
34. Malenbaum, S.; Keefe, F.J.; Williams, A.C.D.C.; Ulrich, R.; Somers, T.J. Pain in its environmental context: Implications for designing environments to enhance pain control. *Pain* **2008**, *134*, 241–244. [CrossRef]
35. Ulrich, R.S.; Zimring, C.; Zhu, X.; DuBose, J.; Seo, H.B.; Choi, Y.S.; Quan, X.; Joseph, A. A Review of the Research Literature on Evidence-Based Healthcare Design (Part I) Abstract Introduction Background. *Health Environ. Res. Des. J.* **2008**, *1*, 61–125. [CrossRef]
36. Andrade, C.C.; Devlin, A.S.; Pereira, C.R.; Lima, M.L. Do the hospital rooms make a difference for patients’ stress? A multilevel analysis of the role of perceived control, positive distraction, and social support. *J. Environ. Psychol.* **2017**, *53*, 63–72. [CrossRef]
37. Bagot, K.L.; Allen, F.C.L.; Toukhsati, S. Perceived restorativeness of children’s school playground environments: Nature, playground features and play period experiences. *J. Environ. Psychol.* **2015**, *41*, 1–9. [CrossRef]
38. Louv, R. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*; Algonquin Books of Chapel Hill: Chapel Hill, NC, USA, 2006.
39. Chawla, L.; Keena, K.; Pevec, I.; Stanley, E. Green schoolyards as havens from stress and resources for resilience in childhood and adolescence. *Health Place* **2014**, *28*, 1–13. [CrossRef]
40. Hodson, C.B.; Sander, H.A. Green urban landscapes and school-level academic performance. *Landsc. Urban Plan.* **2016**, *160*, 16–27. [CrossRef]
41. Benfield, J.A.; Rainbolt, G.N.; Bell, P.A.; Donovan, G.H. Classrooms with Nature Views: Evidence of Differing Student Perceptions and Behaviors. *Environ. Behav.* **2015**, *47*, 140–157. [CrossRef]
42. Li, D.; Sullivan, W.C. Impact of views to school landscapes on recovery from stress and mental fatigue. *Landsc. Urban Plan.* **2016**, *148*, 149–158. [CrossRef]
43. Han, K.T. Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan. *Indoor Built Environ.* **2009**, *4*, 658–692. [CrossRef]
44. Oseland, N. The impact of psychological needs on office design. *J. Corp. Real Estate* **2009**, *11*, 244–254. [CrossRef]
45. Kellert, S.R. Experiencing nature: Affective, Cognitive and Evaluative Development in Children. In *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*; Kahn, P.H.J., Kellert, S.R., Eds.; The MIT Press: Cambridge, MA, USA; London, UK, 2002.
46. Kellert, S.R. Dimensions, Elements and Attributes of Biophilic Design. In *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*; Kellert, S.R., Heerwagen, J.H., Mador, M.L., Eds.; Wiley: Hoboken, NJ, USA, 2008; pp. 3–19.
47. Heerwagen, J.H.; Gregory, B. Biophilia and Sensory Aesthetics. In *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*; Kellert, S.R., Heerwagen, J.H., Mador, M.L., Eds.; Wiley: Hoboken, NJ, USA, 2008; pp. 227–241.
48. Browning, W.; Ryan, C.; Clancy, J. *14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment*; Terrapin Bright Green: New York, NY, USA, 2014.
49. Biophilic Design Initiative. Available online: <https://living-future.org/biophilic-design/> (accessed on 26 February 2024).
50. WELL Building Standard v2: Concepts and Features, International WELL Buildings Institute. Available online: <https://dev-wellv2.wellcertified.com/v/en/concepts> (accessed on 22 August 2019).
51. Kellert, S.R.; Wilson, E.O. *The Biophilia Hypothesis*; Island Press: Washington, DC, USA, 1993.
52. Zhang, W.; Goodale, E.; Chen, J. How contact with nature affects children’s biophilia, biophobia and conservation attitude in China. *Biol. Conserv.* **2014**, *177*, 109–116. [CrossRef]
53. Mustapa, N.D.; Maliki, N.Z.; Hamzah, A. Repositioning Children’s Developmental Needs in Space Planning: A Review of Connection to Nature. *Procedia Soc. Behav. Sci.* **2015**, *170*, 330–339. [CrossRef]
54. Preuß, M.; Nieuwenhuisen, M.; Marquez, S.; Cirach, M.; Dadvand, P.; Triguero-Mas, M.; Gidlow, C.; Grazuleviciene, R.; Kruize, H.; Zijlema, W. Low Childhood Nature Exposure is Associated with Worse Mental Health in Adulthood. *Int. J. Environ. Res. Public Health* **2019**, *16*, 1809. [CrossRef]
55. Parpairi, K. *Daylighting in Architecture: Quality and User Preferences*; University of Cambridge: Cambridge, UK, 1999.
56. Baker, N. We are all outdoor animals. In *Architecture, City, Environment, Proceedings of PLEA 2000*; Steemers, K., Yannas, S., Eds.; James & James: London, UK, 2000; pp. 553–555.

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57. Humphreys, M.; Nicol, F.; Roaf, S. *Adaptive Thermal Comfort: Foundations and Analysis*; Routledge: Abingdon, UK; New York, NY, USA, 2016.
 58. Baker, N. Cultural Responses to Primitive Needs. In *Beyond Environmental Comfort*; Ong, B.L., Ed.; Routledge: New York, NY, USA, 2013; pp. 47–59.

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