

Biophilic Design of Schools

Dr Rokhshid Ghaziani

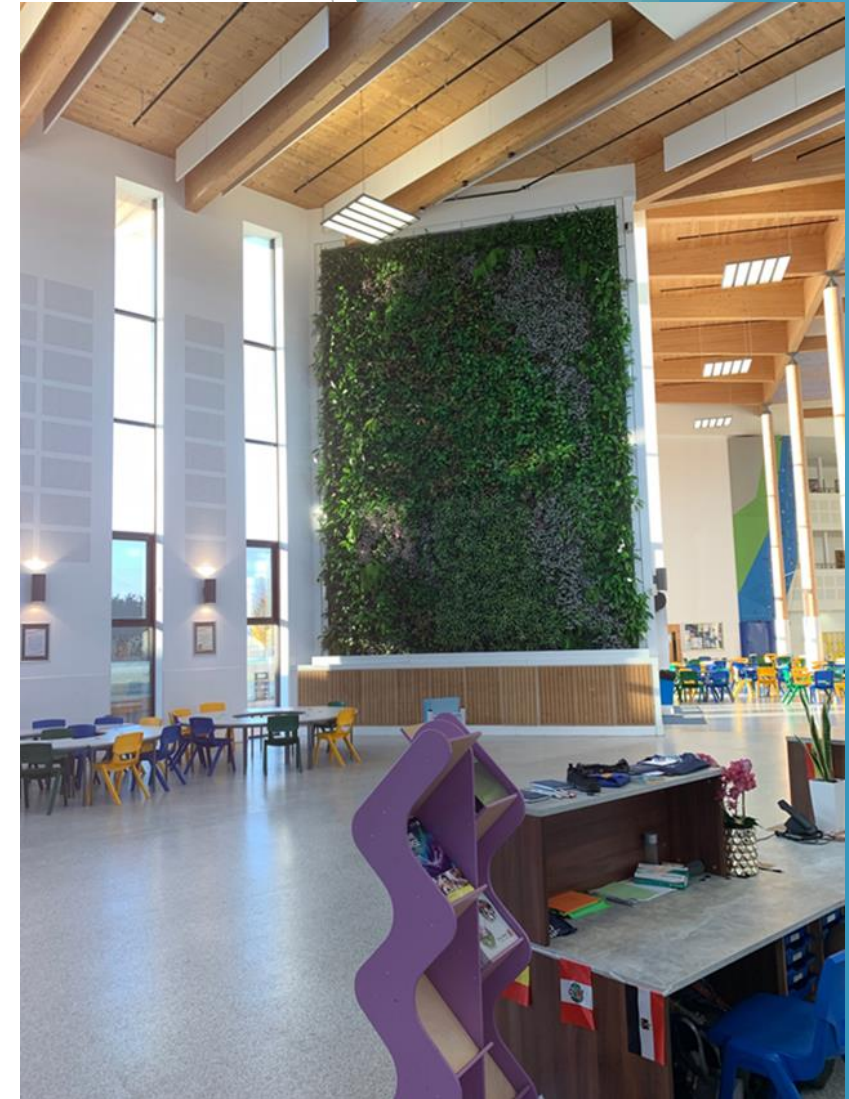
School of Architecture
The University of Portsmouth

Education Estates 2022

19/10/2022

Introduction

- ▶ Children spend over a third of their day at schools.
- ▶ Daily opportunities to experience nature have been shown to positively impact their well-being (Browning & Ryan, 2020; Kahn & Kellert, 2002).
- ▶ The prevalence of mental health problems in children throughout the UK is deeply concerning, with one in 10 young people experiencing a mental health problem at any one time.
- ▶ Application of biophilia would be a design resolution in schools because of its impact on children's mental health and well-being; however, it remains quite unexplored in school designs in the UK.



Thomas Clarkson Academy
Source: <https://www.biotope.uk.com/>

Introduction

- ▶ Growing evidence suggests that incorporating natural elements in built environments can offer satisfying experiences and be beneficial for the health and well-being of children and adults (Chawla, 2015; Faber Taylor & Kuo, 2006; Kellert et al., 2008).
- ▶ Experiences with nature promote children's academic learning (by providing a calmer, quieter, and safer context for learning; a warmer and more cooperative context for learning) and seem to promote children's development as persons and as environmental stewards (Kue et.al., 2019)



The Garden School

Source: <https://www.oliverheath.com/portfolio-item/garden-school-hackney/>

Case Studies



1. Vo Trong Nghia's Farming Kindergarten

- ▶ This kindergarten in Vietnam features a knot-shaped roof with a vegetable garden on top and three protected courtyard playgrounds.
- ▶ The surface of the roof is covered in grass and plants to create an extra garden. It slopes down to the ground at two ends to allow easy access, then rises up over two levels of classrooms.



<https://www.dezeen.com/2014/11/11/farming-kindergarten-vo-trong-nghia-architects-vietnam-vegetable-garden/>

2. Green School, Bali, Indonesia

Repeated and sustained engagement with nature throughout the school building creates a direct connection with nature through the school building (internally and externally).



<https://www.levistrauss.com/2016/03/01/green-school-a-sustainable-utopia-in-bali-and-modern-day-pioneer/>

<https://www.archdaily.com/>

3. Barn Klong Bon School & Art Spaces

Phang-Nga, Thailand

- ▶ Natural materials, open facades and indoor plants
- ▶ Curtains are used to divide spaces and also enable the occupants to connect to nature through non-rhythmic sensory stimuli
- ▶ Openable opaque facades allow the occupants to experience the natural environment from the internal space



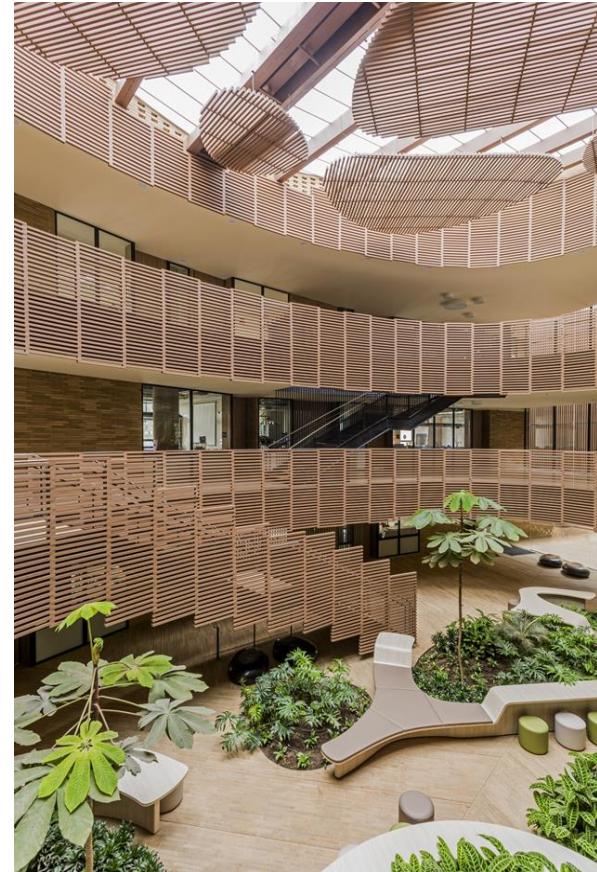
<https://art4d.com/en/2020/07/barn-klong-bon-school-art-spaces#more-39412>

<https://www.facebook.com/VinVaravarnArchitectsLimited/photos/pcb.2838063962907333/2837999346247128>

4. El Colegio Anglo Colombiano

Bogotá, Colombia

- ▶ Natural materials and colour palettes are used alongside planting to the internal spaces creating a material connection with nature
- ▶ Plants to the ground floor can be seen from the circulation space around the atrium, this also allows natural light to penetrate the space from above



<https://www.floornature.es/taller-de-arquitectura-de-bogota-centro-de-investigacion-eur-14962/>

5. Hazelwood School

Hazelwood School in Glasgow is a school for children and young people with sensory impairment and complex learning needs.

It aims to create a bespoke building that designed out long dark corridors, maximised levels of natural light and incorporated visual, sound and tactile clues [multi-sensory].



Cork tiles at corridors

6. The Garden School

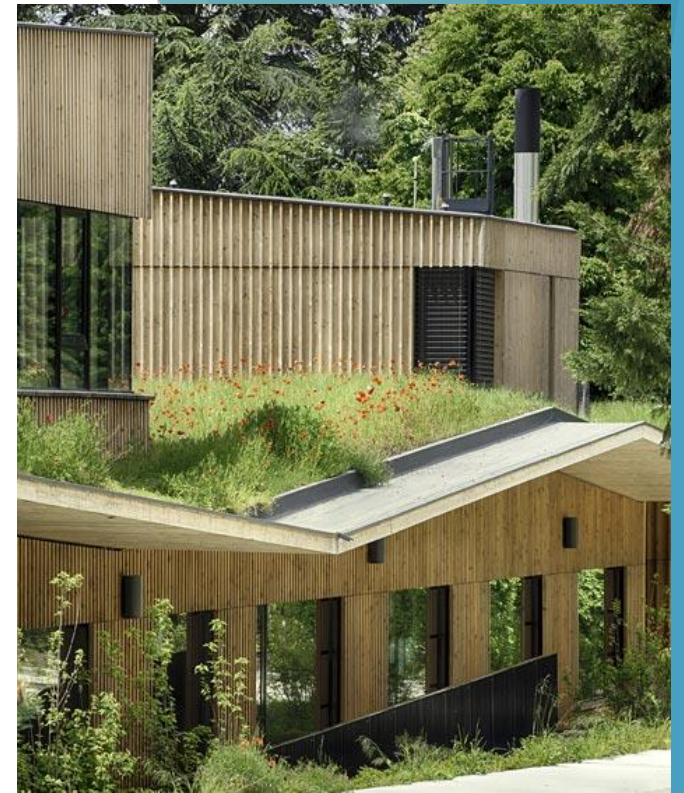
- ▶ The Garden School is a school for four to 16-year olds with special educational needs (especially autism) in Hackney, England.
- ▶ The design includes varied seating, including a window seat that offers views onto the playground as well as playful built-in hexagonal seating for children to relax and restore their energy.
- ▶ Textured carpets with varying pile heights and wallpaper with images of a woodland provide tactile and visual connections to nature.
- ▶ At one end of the space, there is a multi-sensory feature which children can interact with, and control artificial lighting.



Source: <https://www.oliverheath.com/portfolio-item/garden-school-hackney/>

7. Paul Chevallier School

- ▶ It has hilly rooftops carpeted with plants and walkways for children to explore. There is also a vegetable garden. Therefore, the project harmonises vegetation on the upper and lower levels.
- ▶ The volumes in wood are separated by the broad, planted-out roofs, with their waves of colour.
- ▶ Timber cladding covers most of the building's interior and exterior, but is interspersed with a few yellow-painted panels on the walls and ceilings.
- ▶ Spacious corridors run between classrooms and feature floor-to-ceiling windows to increase natural light.
- ▶ From the inside, nature is framed by the large windows of the classrooms, and its close proximity makes it an element of the children's educational needs.
- ▶ Wood is a pre-eminent presence- there are wood panels throughout, for the walls, façades and floors.



<https://www.dezeen.com/2013/09/09/school-complex-in-rillieux-la-pape-by-tectoniques/>

Case studies: outcome

No.	Pattern	How the patterns were applied		
		Hazelwood School	The Garden School	Paul Chevallier School
1	Visual Connection with Nature	Mature trees around site. Are visible and accessible to students	Window seats allow occupants a view to nature outside	-Vegetable garden -Accessible rooftop with plants
2	Non-Visual Connection with Nature	Touching natural materials	Nature sounds are played within the space	Use of natural materials with texture
3	Non-Rhythmic Sensory Stimuli	Not evident	Not evident	Not evident
4	Thermal & Airflow Variability	Natural ventilation	Natural ventilation	Natural ventilation
5	Presence of Water	Indoor pool	Not evident	Not evident
6	Dynamic & Diffuse Light	-High level, height glazing -Louvers to filter sun -Light, shadow varied: replicates nature	-Natural lighting inside controlled with blinds	-Natural light in corridors -Floor to ceiling windows -Façade with holes and wood frame
7	Connection with Natural Systems	Not evident	Visible view from seats	Nature is framed by the large windows

Use of patterns in case studies located in temperate climate related to Nature in the Space (Direct Experience)

Case studies: outcome

No.	Pattern	How the patterns were applied		
		Hazelwood School	The Garden School	Paul Chevallier School
8	Biomorphic Forms & Patterns	Not evident	-Honeycomb like seating -Wallpaper (woodlands)	Panels with circular holes that allow lights to the classrooms
9	Material Connection with Nature	Materials and elements from nature, such as cork and wood	-Materials to evoke nature -Natural colours	Use of wood internally and externally for walls, façades and floors
10	Complexity and Order	Wooden structural elements	Not evident	Visible wooden structures (frames)

Use of patterns in case studies located in tropical climate related to Natural Analogues (Indirect Experience)

No.	Pattern	How the patterns were applied			
		Farming Kindergarten	Green School	Barn Klong Bon School	Eureka Centre in Anglo Colombiano School
1	Visual Connection with Nature	Three sheltered courtyards with visible tree planting	Vast openings to nature	Indoor plants	Plants in the courtyard
2	Non-Visual Connection with Nature	Not evident	Openings allow sound and smell of nature (jungle) inside	Open facades allow light, air, smell and touch inside	Not evident
3	Non-Rhythmic Sensory Stimuli	Not evident	-Open facades allow to see natural movement within nature -Openness of the building allows air to create movement within the space	Open façades allow air movement within interior (plants and curtains that divide spaces)	Not evident
4	Thermal & Airflow Variability	Designed for cross ventilation (naturally ventilated interior)	Air movement creates cooling effect for users and changes in humidity level	Open façades allow air flow, changes in temperature, movement, and humidity	Air circulation is created by opening windows and to the courtyard
5	Presence of Water	Not evident	The open facades connects the occupants to water through rainfall (seen and heard from inside).	Not evident	Not evident
6	Dynamic & Diffuse Light	- Natural lighting through windows to courtyard facing and outer walls -Louvres filter the direct light	Open façade and roof form to provide natural light throughout the day	-Large openable facades and opaque glass panels diffuse the natural light -Internal courtyard allows light to the centre	Varying intensities of light and shadow creates conditions that occur in nature
7	Connection with Natural Systems	-Green roof as an edible garden -Experiencing growth cycle of plants	Open structure, enables occupants to connect to the changes in nature	Openable facades allow the occupants to experience the changes of weather conditions	Not evident

Use of patterns in case studies located in tropical climate related to Nature in the Space (Direct Experience)

No.	Pattern	How the patterns were applied			
		Farming Kindergarten	Green School	Barn Klong Bon School	Eureka Centre in Anglo Colombiano School
8	Biomorphic Forms & Patterns	Curved building with green roof (natural 'hill' shape with access from the ground)	Curves and natural shapes (ranging from the furniture, incorporating the natural features and strength of bamboo)	Images of animals and trees on the walls	-Symbolic references to nature (patterns, textures, numerical arrangements). -Curved walkways and seating.
9	Material Connection with Nature	Bricks and tiles are used within the buildings	Natural materials are used throughout the school	Natural, native materials (bamboo) are used within the building	-Minimal processing materials reflects local ecology or geology - Earth tones to create the look of clay have been used as well as brick
10	Complexity and Order	Not evident	Sustainable features (solar panels, mini hydro vortex, water filtration) are visible to users	Structural elements indoors	Ventilation and power systems are visible to the users.

Use of patterns in case studies located in tropical climate related to Natural Analogues (Indirect Experience)

Application of case studies for data collection

Theme	No.	Patterns	Features
Nature in the Space (Direct Experience)	1	Visual Connection with Nature	• Animals (e.g. birds and pets) • Landscape in school ground • Plants inside the classrooms
	2	Non-Visual Connection with Nature	• Sound of water • Sound of birds' song • Smell of flowers • Natural materials to touch (bamboo, wood, stone)
	3	Non-Rhythmic Sensory Stimuli	None
	4	Thermal & Airflow Variability	• Lots of fresh air from the windows
	5	Presence of Water	• A pond in school ground • An aquarium in the building
	6	Dynamic & Diffuse Light	• Lots of natural light from the windows • Skylight/roof window (in classrooms and school hall)
	7	Connection with Natural Systems	• View to outside to see plants and trees • Plants to grow and look after

Application of case studies for data collection

Natural Analogues (Indirect Experience)	8	Biomorphic Forms & Patterns	• Natural form for seats and spaces • Circular or oval windows • Patterns of plants on walls (flowers, leaves) • Patterns on creatures on walls and floors (butterflies and shells) • Curved forms and spaces • Images of landscape on walls • Images of seaside on walls
	9	Material Connection with Nature	• Natural materials (bamboo, wood) inside the building to see and touch • Natural materials in school ground (bamboo, wood, stone) • Colourful walls and ceiling • Colourful glasses on the windows and doors
	10	Complexity and Order	None

Data Collection

Study 1: Biophilic Design patterns

Children's views in a Primary School

	Features	Image	very happy 	happy 	I do not mind 	Sad 
1	A pond					
2	An aquarium					
3	Animals (birds)					
	Animals (pets)					
4	Landscape in school ground					
5	Plants inside the classrooms					
6	Natural materials (bamboo, wood) inside the building to see and touch					

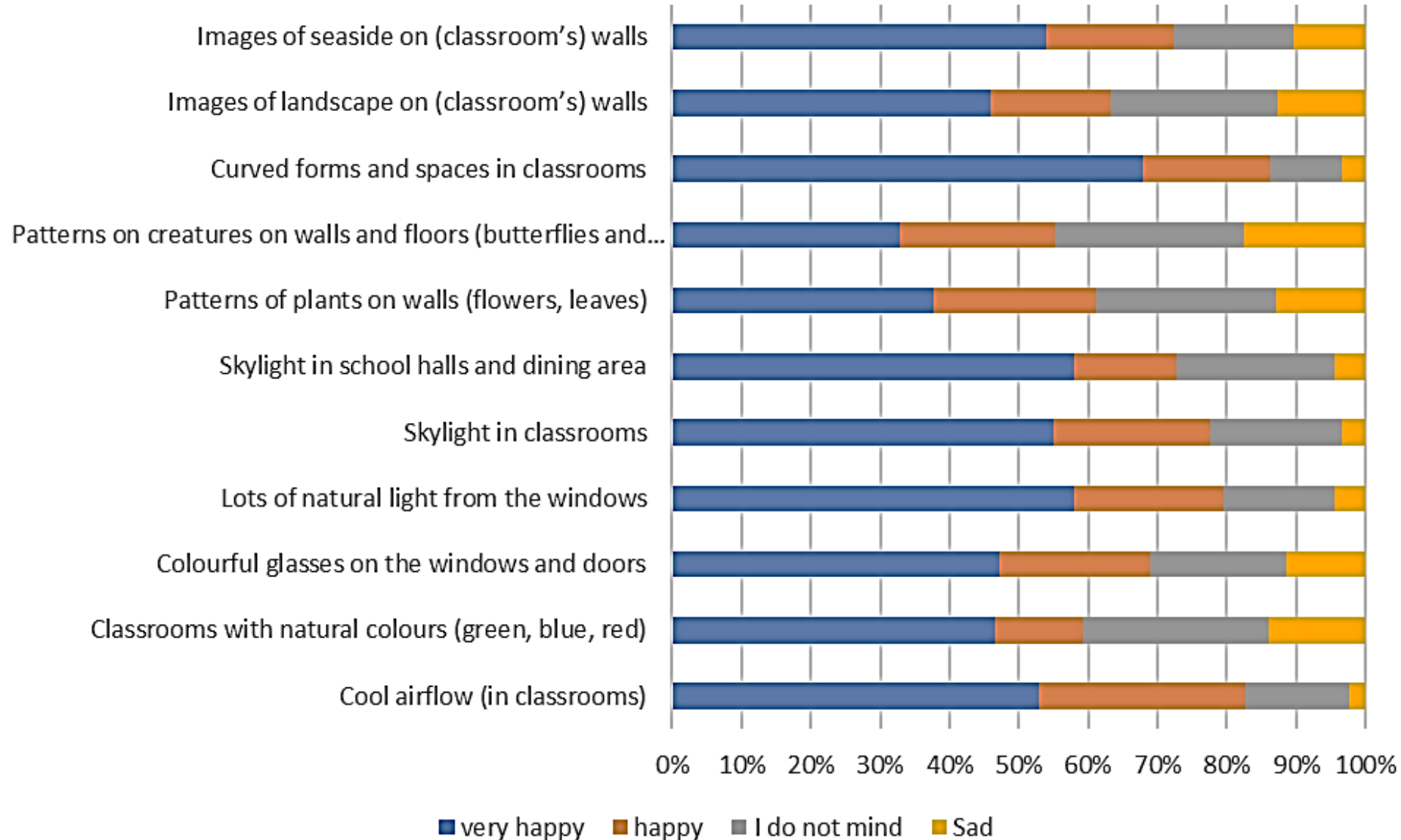
7	Natural materials in school ground (bamboo, wood, stone) to see and touch					
8	View to outside to see plants and trees					
9	Natural form seats and spaces to seat (or rest)					
10	Circular windows					
11	Sound of water					
12	Smell of flowers					
13	Plants for you to look after					
14	Plants to grow					
15	Cool airflow (in classrooms)					

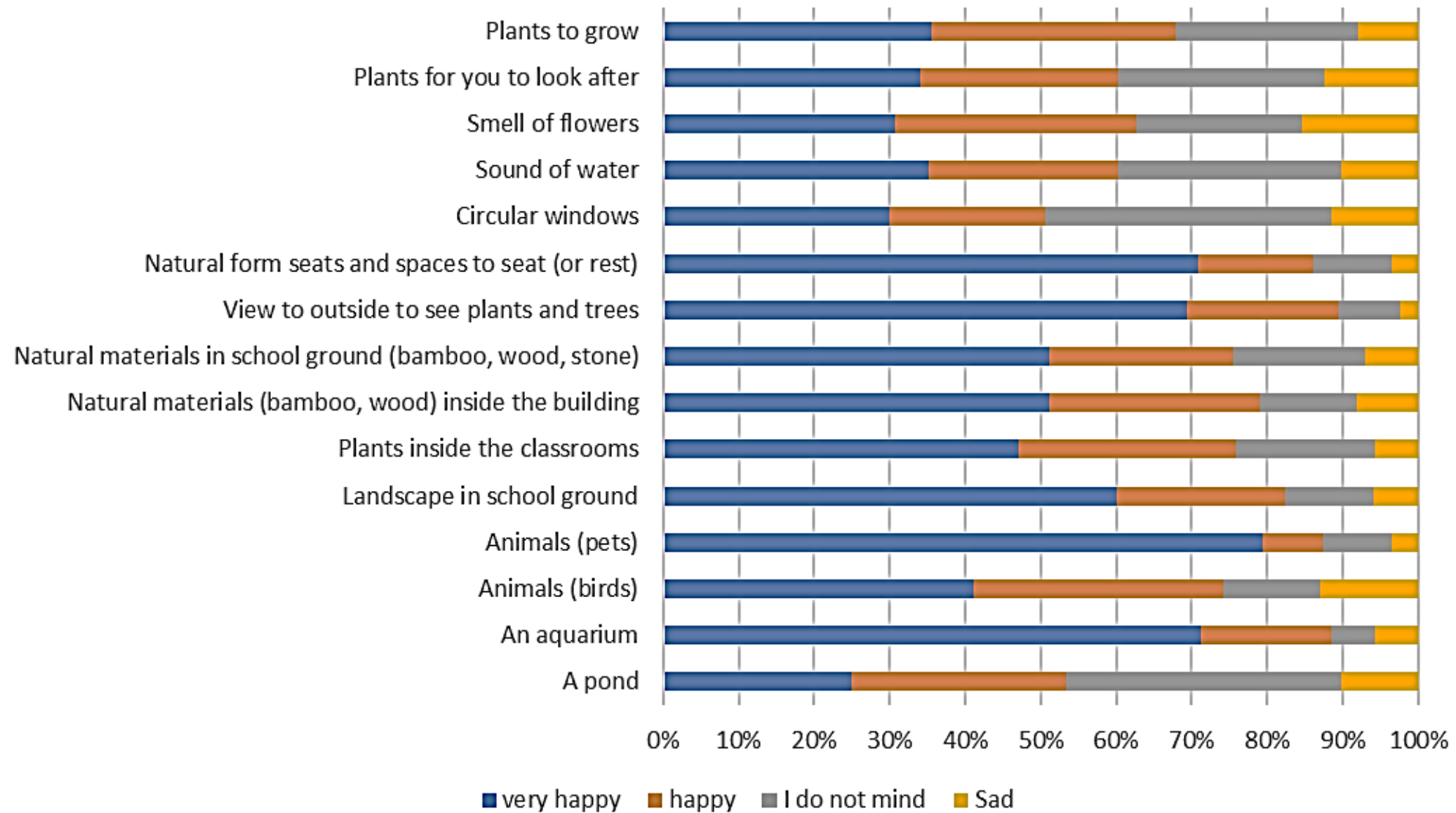
Data Collection

	very happy	happy	I do not mind	Sad
A pond	22	25	32	9
An aquarium	62	15	5	5
Animals (birds)	35	28	11	11
Animals (pets)	69	7	8	3
Landscape in school ground	51	19	10	5
Plants inside the classrooms	41	25	16	5
Natural materials (bamboo, wood) inside the building	44	24	11	7
Natural materials in school ground (bamboo, wood, stone)	44	21	15	6
View to outside to see plants and trees	59	17	7	2
Natural form seats and spaces to seat (or rest)	61	13	9	3
Circular windows	26	18	33	10
Sound of water	31	22	26	9
Smell of flowers	28	29	20	14
Plants for you to look after	30	23	24	11
Plants to grow	31	28	21	7

	very happy	happy	I do not mind	Sad
Cool airflow (in classrooms)	46	26	13	2
Classrooms with natural colours (green, blue, red)	40	11	23	12
Colourful glasses on the windows and doors	41	19	17	10
Lots of natural light from the windows	51	19	14	4
Skylight in classrooms	49	20	17	3
Skylight in school halls and dining area	51	13	20	4
Patterns of plants on walls (flowers, leaves)	32	20	22	11
Patterns on creatures on walls and floors (butterflies and shells)	28	19	23	15
Curved forms and spaces in classrooms	59	16	9	3
Images of landscape on (classroom's) walls	40	15	21	11
Images of seaside on (classroom's) walls	47	16	15	9

16	Classrooms with natural colours (green, blue, red)					
17	Colorful glasses on the windows and doors					
18	Lots of natural light from the windows					
19	Skylight in classrooms					
	Skylight in school halls and dining area					
20	Patterns of plants on walls (flowers, leaves)					
21	Patterns on creatures on walls and floors (butterflies and shells)					
22	Curved forms and spaces in classrooms					
23	Images of landscape on (classroom's) walls					
24	Images of seaside on (classroom's) walls					

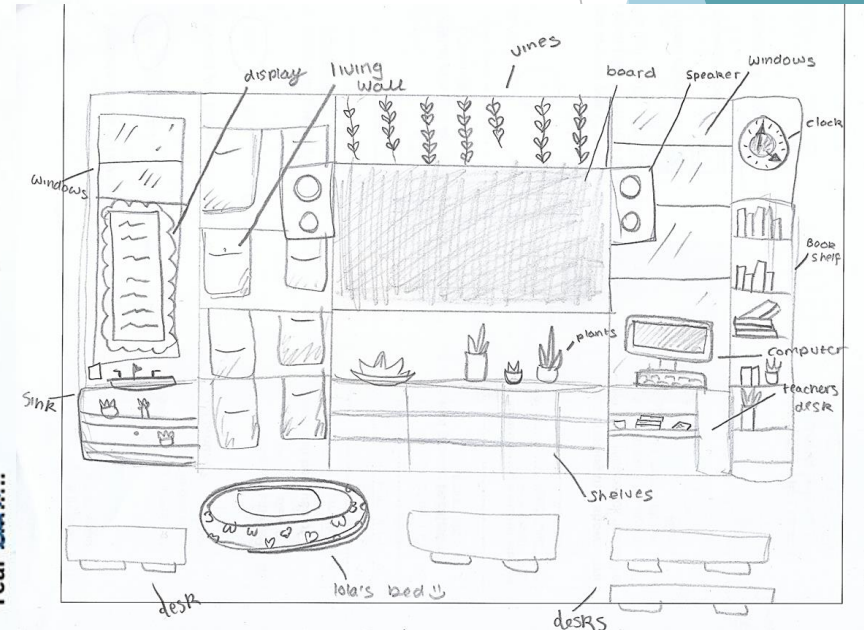




Data Analysis

	Happy & Very Happy (out of 88)
A pond	47
An aquarium	77
Animals (birds)	63
Animals (pets)	76
Landscape in school ground	70
Plants inside the classrooms	66
Natural materials (bamboo, wood) inside the building	68
Natural materials in school ground (bamboo, wood, stone)	65
View to outside to see plants and trees	76
Natural form seats and spaces to seat (or rest)	74
Circular windows	44
Sound of water	53
Smell of flowers	57
Plants for you to look after	53
Plants to grow	59

	Happy and Very Happy
Cool airflow (in classrooms)	72
Classrooms with natural colours (green, blue, red)	51
Colourful glasses on the windows and doors	60
Lots of natural light from the windows	70
Skylight in classrooms	69
Skylight in school halls and dining area	64
Patterns of plants on walls (flowers, leaves)	52
Patterns on creatures on walls and floors (butterflies and shells)	47
Curved forms and spaces in classrooms	75
Images of landscape on (classroom's) walls	55
Images of seaside on (classroom's) walls	63

[illegible]

Boy.....
Age 11.....
Year 654.....

Boy..... Girl.....
Age 10.....
Year 5.....

Study 2: Garden Design

Primary School

30 students in Year 4

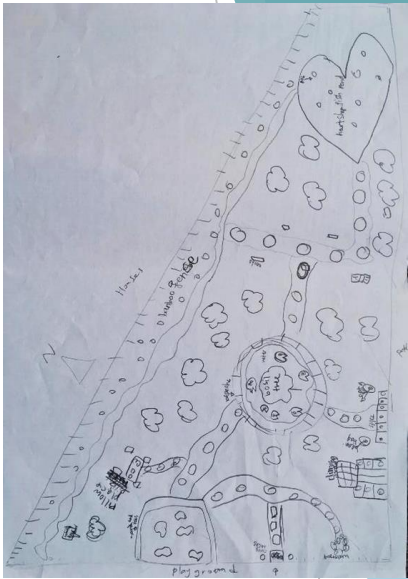
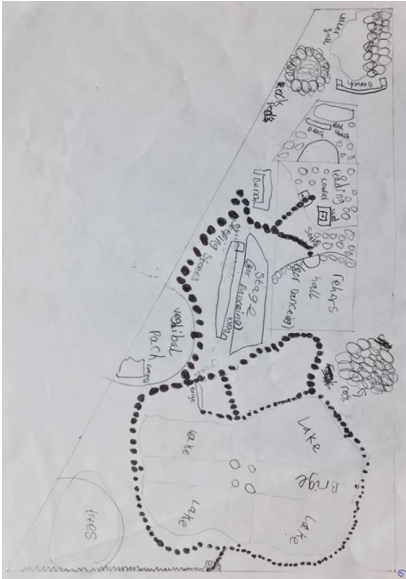
1. Presentation
2. Questionnaires (individuals)
3. Drawings (in pairs)
4. Model Making (in groups of 3)



Questionnaires- Findings

Activities/elements in the garden:

- 1. Water (waterfall, pond, foundation)
- 2. Reading corner, Sports area
- 3. Stepping stones
- 4. Bridge
- 5. Statue



Senses

Sound	Touch	Sight	Smell
1. Running water 2. Birds 3. Waterfall	1. Stones 2. Flowers 3. Trees 4. Rocks 5. Bamboo	1. Animals (birds, Kio fish, squirrel) 2. Water and waterfall 3. Flowers, plants 4. Bridge 5. Trees	1. Flowers

Model Making and Models



Findings

- ▶ The most preferred space in the garden was relaxing area by water (waterfall, pond, foundation) as part of the design.
- ▶ In addition, the main materials suggested to be used in the garden were 'wood' and 'stone'; however, 'bamboo' and 'sand' were chosen by some children.
- ▶ Regarding the features, most children suggested they would like to have 'flower garden' (83%) with the paths (93%) and 'benches/seating' (93%). 'Grass' was suggested by 73%, while 'evergreen plants' were chosen by 63% and 'four season interest' by 50%.
- ▶ Interestingly, sculpture was identified as preferable feature by 73% and 'water features' (including ponds, waterfall and water fountain) were suggested by 60% of children. Finally, a bridge over the pond was preferred by 53% and stepping stones were suggested by 50% of children.
- ▶ Overall, regarding their feelings, children expressed this garden makes them happier (93%) and it can help them feel relax (93%).

Ghaziani, R. (2021), "Primary school design: co-creation with children", Archnet-IJAR, Vol. 15 No. 2, pp. 285-299. <https://doi.org/10.1108/ARCH-07-2020-0132>.

Research Grants

1. GCRFN grant (£25000)- funded by Academy of Medical Sciences

- ▶ It was the collaboration between DMU and University of Indonesia (PI)
- ▶ The project title: “Healing by Nature: Implementation of Biophilic Design Model for the Post-Disaster School Reconstruction in Indonesia to Promote Children’s Wellbeing”
- ▶ started in March 2020 and completed in August 2021 (with the extension)
- ▶ This project explored the possibility for innovative school design model based on biophilic design principles as a means to promote healing by promoting children's connectedness to nature.
- ▶ The project brought together the collaborative network of academic partners from UK (DMU), Indonesia, Malaysia and Thailand.
- ▶ Four international symposiums were organised (two were hosted by DMU)
- ▶ Data collection (children’s views) in three countries
- ▶ <https://architecture.ui.ac.id/gcrf/>
- ▶ <https://rghaziani.our.dmu.ac.uk/>

ONLINE SYMPOSIUM

Biophilic Design in Primary Schools: Impacts on Children's Well-being

Sep. 25th, 2020 (hosted by DMU)

Programme

9:00 - 9:10 Introduction by Prof. Paramita Atmodiwirjo and Dr. Rokhshid Ghaziani

Session (1) Chair: Dr. Rokhshid Ghaziani

9:10 - 9:40 The Value Case for Biophilia in Primary Schools by **Martin Brown**, Fairsnape, Lancashire, UK and **Sonja Bochart**, Arizona, USA

9:40 - 10:00 The Translational Biophilic Design of Primary Schools by **Dr Kenn Fisher**, University of Melbourne, Australia

10:00 - 10:20 Biophilia in the conception of modern Scandinavian schools' design by **Prof. Amjad Al-Musaed**, Jönköping University, Sweden

10:20 - 10:30 Questions and Answers

Session (2) Chair: Prof. Mark Lemon

10:30 - 10:50 The Biophilic Classroom: Putney High School GDST (Girls' Day School Trust) by **Clare Bowman**, RCZM, DMU, UK

10:50 - 11:10 Presence of biophilic elements in schools and their effect on children – A comparative case study approach by **Bethania Lanzaro**, Scala Colab, London, UK

11:10 - 11:30 Promoting Wellbeing of Children with ASD with Biophilic School Design by **Merve Kavaz**, Hacettepe University, Turkey

11:30 - 11:45 Knowledge Garden: Designing the Narratives of Nature Experience in School Environment by **Prof. Paramita Atmodiwirjo** & **Prof. Yandi Andri Yatmo**, Universitas Indonesia

11:45 - 12:00 Questions and Answers

Session (3) Chair: Prof. Paramita Atmodiwirjo

12:00 - 12:20 Exploring Connections between Biophilic Design and a Learning Environment Design (LED) Framework by **Dr. Tiina Mäkelä**, University of Jyväskylä, Finland

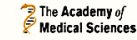
12:20 - 12:35 Primary School Ground: Garden Design with Children by **Dr. Rokhshid Ghaziani**, DMU, UK

12:35 - 12:50 Promoting a connection to nature and a sense of place through Forest School by **Dr. Dave Cudworth**, DMU, UK



ONLINE SYMPOSIUM

Organised by DMU



Biophilic Design of Schools for Children's Health and Well-being



Jan. 27th, 2021 (8:00-12:00 UK Time)

Programme:

8:00 - 8:10 Introduction by **Prof. Paramita Atmodiwirjo** and **Dr. Rokhshid Ghaziani**

8:10 - 8:40 Creating Transformative Spaces for Educating our Children by **Sonja Bochart** IIDA, LEED AP BD&C, WELL AP, LFA, Wellbeing+Design, Arizona, USA

08:40 - 09:10 Biophilic Design: The health benefits of schools connecting to Nature by **Amanda Sturgeon** FAIA, Mott MacDonald, Australia

09:10 - 09:20 Questions and Answers

9:20 - 09:50 Evidence-Based Design of Schools for Health and Wellbeing by **Dr. Kenn Fisher**, University of Melbourne, Australia

09:50 - 10:20 Promoting children's wellness in primary schools by **Michal Cohen** RIBA, Walters & Cohen Architects, UK

10:20 - 10:30 Questions and Answers

10:30 - 10:40 Break Time

10:40 - 11:05 Not elements, but interactions: a novel framework for evaluating biophilic conditions in urban primary schools by **Bethania Lanzaro** WELL, Scala Colab, UK

11:05 - 11:25 Well-being in the Woods: Forest School and the Pathways to Nature Connection by **Dr. Dave Cudworth**, De Montfort University, UK and **Dr. Ryan Lumber**, University of Derby, UK

11:25 - 11:40 Questions and Answers

11:40 - 12:00 Discussion - How biophilic design of schools could support the health and well-being of children now and Post-Pandemic?

Ghaziani, R., Lemon, M., Atmodiwirjo, P. (2021) "Biophilic Design Patterns for Primary Schools", Sustainability 2021, 13(21), 12207; <https://doi.org/10.3390/su132112207>

Symposiums

The two symposiums gathered both academics and practitioners including:

- ▶ Architects
- ▶ Interior designers
- ▶ Educators
- ▶ Psychologists

There were presenters from various countries across the world including:

1) Australia 2) Indonesia 3) Finland 4) USA 5) UK

The symposiums showed that

- ▶ **the multidisciplinary and global nature of biophilia in schools**
- ▶ **how the patterns can be applied in different contexts- cultural, geographic, climatic, pedagogic, architectural, etc.**

Research Grants

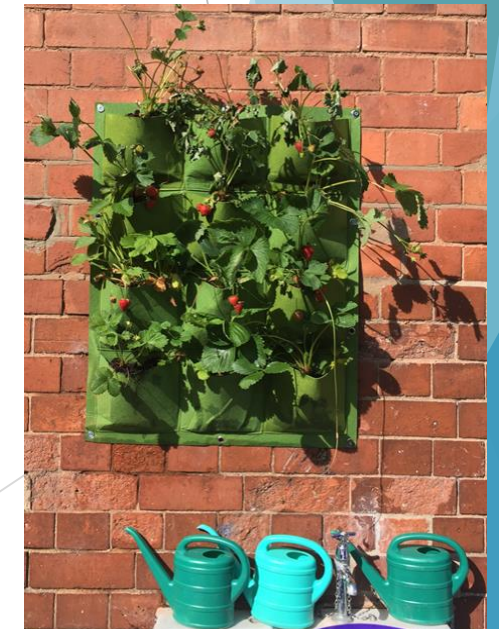
2. QR GCRF (£6000) - March to July 2021

- ▶ The project: Implementation of Biophilic Design Model for the Post-Pandemic School Design to Promote Children's Health and Well-being
- ▶ DMU collaboration with two universities in Indonesia (UI) and Thailand (KU)
- ▶ This project explored a long-term solution for a post-pandemic school typology: an adaptable, flexible and simulating school that considers health and wellbeing of children and staff.
- ▶ Data collection (questionnaires and drawings) from (260) children and teachers in three countries.

Research Grants

3. Partnership Grant: funded by The Royal Society (£2300+ £1000) - 2021

- ▶ Collaboration with Earlsdon Primary School in Coventry
- ▶ The project explored the impacts of growing green walls on learning and wellbeing in the school (data was collected).
- ▶ Additional fund is available for a food growing project (£1500).
- ▶ Three more primary and secondary schools were funded (£9000) for 2022-23.



Summary

- ▶ Overall, biophilic design patterns have positive impacts on children's happiness as the studies present.
- ▶ Biophilic design patterns (Ryan et al, 2012; Browning et al, 2014) can be used in schools for greater connectivity between indoor spaces and nature to achieve health and well-being for children.
- ▶ Children's (and teachers') views are important and need to be considered (co-design/ participatory approach in school design and renovation for post pandemic)
- ▶ The findings highlight the importance of children's connectedness to nature that could then inform design professionals and government agencies, to contribute to improving health and well-being for school children.
- ▶ It is also important to consider the multidisciplinary and global nature of biophilia in schools.
- ▶ More data could be collected from school users regarding their views on different biophilic design. Future research could also explore the impacts biophilic design in secondary schools.

Ghaziani, R., Lemon, M., Atmodiwirjo, P. (2021) "Biophilic Design Patterns for Primary Schools", Sustainability 2021, 13(21), 12207; <https://doi.org/10.3390/su132112207>

Ghaziani, R. (2021), "Primary school design: co-creation with children", Archnet-IJAR, Vol. 15 No. 2, pp. 285-299. <https://doi.org/10.1108/ARCH-07-2020-0132>.



Indoor River

<https://www.archdaily.com/184405/bertschi-school-living-science-building-kmd-architects/bertschi-school-living-science-building>



External water fountains
Sturgeons (2017)

Thank you

Any Questions?

Email:
rokhshid.ghaziani@port.ac.uk

