

## Embracing Biophilic Design in Primary School's Learning Environment to Improve Children's Well-Being

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### **Article Info**

Submission date: 1<sup>st</sup> Feb 2024

Acceptance date: 4<sup>th</sup> July 2024

### **Keywords:**

children, biophilic design, school design, nature experiences, well-being

### **ABSTRACT**

Nature experiences, both direct and indirect, significantly impact children's psychological well-being. However, restrictions on children's ability to spontaneously explore nearby nature at home have been reduced. Hence, it is vital to reconnect children with nature through biophilic design at school to improve their psychological well-being since they spend most of their time there. This study aims to investigate children's preferences towards biophilic elements and the impact of the elements on their well-being. This study involved twelve children aged 10 to 11 from two primary schools (sustainable schools) in the Northern Region of Malaysia, particularly in Kedah and Perlis. A qualitative approach, specifically phenomenology, using observation, focus groups, and projection methods, was used for data collection. The findings indicate that children preferred the implementation of biophilic elements in both indoor and outdoor learning spaces. All biophilic design elements have contributed to children's positive emotions. However, few children exhibited negative affiliations towards water elements and plants. Overall, this study highlights the importance of embracing and implementing biophilic elements through direct and indirect experiences in indoor and outdoor learning spaces at school to improve children's psychological well-being, subsequently contributing to their attention to learning.

## 1.0 INTRODUCTION

Children are shaped by their environment. A good physical environment contributes to children's developmental needs and well-being. For the past few decades, substantial studies have demonstrated that children's contact with nature in both direct and indirect ways positively impacts their psychological well-being (Liu & Green, 2023; Mustapa, 2015). Studies have demonstrated that exposure to nature reduces children's stress, improves their moods, and increases their happiness (Mustapa, 2015; Corraliza et al., 2012). Nowadays, children are facing various mental health issues, which include stress and anxiety (Cardoso-Leite et al., 2021; Mustapa, 2015). Children with mental health issues will have problems with the cognitive aspects of concentration and giving attention (Cardoso-Leite et al., 2021). Recently, 424,000 children aged 10-15 years old in Malaysia have been found to suffer from mental health problems. Hence, studies on the benefits of nature to children have become an increasing issue of concern for the past few years (Liu & Green, 2023; Chawla, 2015; Mustapa, 2015).

However, rapid urbanisation and population growth, mostly in developing countries, have reduced children's nature experiences, especially direct experiences (Chawla & Derr, 2012; Myers, 2012; Hand et al., 2018). Children's spontaneous and unstructured experiences with nature in their neighbourhood's backyard, field, and natural areas have decreased (Freeman & Tranter, 2011; Gundersen et al., 2016; Louv, 2008). Studies have shown that the number of children playing in the outdoor environment where nature exists is rapidly declining (Skår & Krogh, 2009; Hand et al., 2018). Modernization has also caused children's leisure activities to change from being actively involved in outdoor activities to being passively confined to indoor activities, aided by gadgets, which lead to other health issues (Cardoso-Leite et al., 2021).

As children have restrictions on connecting with nature in the outdoor environment at their innermost zone, which is at home, one initiative is to reconnect children with nature in the intermediate zone, which is at school, through biophilic design. A good quality of environment and design at school contributes to children's well-being since they spend most of their time there. Recognising the importance of reconnecting children with nature through biophilic design at school, researchers have started to investigate the impact of biophilic design on children's well-being in children's learning spaces, which include pre-school and primary schools, since the early 2000s (Awad, 2022; Ghaziani et al., 2021; Joo-Young & Sung-Jun, 2020; Mustafa & Yaseen, 2019). Studies have demonstrated that biophilic design significantly impacts children's psychological well-being, further contributing to their focus and attention in learning (Awad, 2022). However, most studies have been conducted in Middle Eastern, Western, and other Eastern countries. Hence, it is worth investigating the application of biophilic design and children's preferences towards the patterns and elements in the Malaysian context as people with different cultures engage with nature differently (Milfond, 2012). Thus, this study aims to investigate children's preferences towards existing and proposed biophilic elements and the impact of the elements on their well-being.

## 2.0 LITERATURE REVIEW

### 2.1. Biophilic Design

The biophilic design originated from the word *biophilia*, coined by Erich Fromm in 1964 to describe the 'love of life'. Then, biologist Edward Wilson in 1984 defined *biophilia* as an innate tendency to affiliate with nature. At the beginning of the 21st century, the notion of *biophilia* was adapted to the built environment. Studies have demonstrated that biophilic design shows a positive impact between people and nature connections within the building environment (Abo Sabaa et al., 2022; Aristizabal et al., 2021; Cheng & Marzuki, 2023; Tekin et al., 2023; Yassein & Ebrahiem, 2018; Zhong et al., 2022). There are three main frameworks or conceptualisation of nature-based or biophilic design: two dimensions, six elements, and 72 attributes of biophilic design (Kellert, 2008), three experiences and 25 attributes of biophilic design (Kellert, 2018), and three categories and 15 patterns of biophilic design (Browning & Ryan, 2020). Most researchers used frameworks by Kellert (2018) and Browning and Ryan (2020).

Kellert's (2018) framework includes direct experiences of nature (light, air, water, plants, animals, landscapes, weather, views, and fire), indirect experiences of nature (images, materials, texture, colour, shapes, and forms, information richness, change of time, geometrics, stimulated natural light, air and biomimicry), and experience of space and place (prospect and refuge, organised complexity, mobility, transitional spaces, place and integrating parts to create wholes). On the other hand, Browning and Ryan's (2020) framework includes nature in the space (visual connection with nature, non-visual connection with nature, non-rhythmic sensory

stimuli, thermal & airflow variability, presence of water, dynamic and diffuse light, connection to natural systems), natural analogues (biomorphic forms & patterns, material connection with nature, complexity, and order), and nature of the space (prospect, refuge, mystery, risk/peril, awe).

However, the overlapping of the elements, attributes and classifications is still being debated. Also, some of the elements in the framework are uncertain and difficult to measure (Zhong et al., 2022). Zhong et al. (2022) have proposed a new framework that refines and combines previous frameworks. The new proposed framework categorises biophilic design into three categories, which are nature incorporation (plants, daylight, air, water, animals, landscape, weather, and time seasonal changes), nature inspiration (forms and shapes, patterns and geometrics, mechanisms, images, and material, texture, and colour) and nature interaction (prospect and refuge, complexity and order, enticement, connection to place and connection of spaces). Nevertheless, some elements, such as time, seasonal changes, and weather, are still difficult to measure as biophilic design elements. This study combines Browning and Ryan's (2020) and Kellert's (2018) frameworks.

## **2.2. Biophilic Design at Children's Learning Spaces**

Studies on the importance of children and nature have been conducted since the 1990s. However, those studies focus more on the benefits of the outdoor natural environment for children. As biophilic design was introduced by integrating nature into the built environment in the early 2000s, researchers have recently explored the impact of nature in indoor and outdoor settings in children's spaces since the mid-2000s. Biophilic patterns have been found to contribute to children's mental and physical health and their cognitive development (Ghaziani et al., 2021). Similarly, in another study by Joo-Young & Sung-Jun (2020), visual connection with nature and dynamic and diffuse light have a higher rate of use in children's education spaces. Another study by Determan et al. (2019) found that views towards nature, dynamic and diffuse light, and biomorphic form and pattern are essential in reducing children's stress and can improve their learning outcomes. Lighting, daylight, materials, and natural ventilation are vital for children's well-being. Using natural material provides engaging experiences in children's learning spaces and subsequently increases their mood to learn (Awad, 2022). Substantial studies have found that natural lighting is crucial in children's learning spaces as it is associated with children's well-being (Joo-Young & Sung-Jun, 2020; Determan et al., 2019). Viewing nature also plays an essential role in helping children reduce stress (Li & Sullivan, 2016). However, most studies have been conducted in Western, Middle Eastern, and other Eastern countries, and little is known about Malaysian children's preference for biophilic patterns and elements and their contribution to their well-being. Therefore, this study aims to investigate the application of biophilic design and children's preferences towards patterns and elements in the Malaysian context.

## **3.0 RESEARCH METHODOLOGY**

### **3.1. Participants and Methods**

This study used a qualitative approach, specifically a phenomenology approach, that involved 12 numbers of children aged 10-11 years old from two primary schools (sustainable schools) in the Northern Region of Malaysia, particularly in Kedah and Perlis. The sampling frame was first determined by obtaining the list of schools participating in Sustainable School Program organised by the Department of Environment. Case studies were selected from schools that have participated in Sustainable School Programs to ensure that the selected 10-11 schools meet specific patterns and elements for biophilic design. Even though sustainable schools do not have biophilic criteria requirements, the greening elements are part of the components of sustainable schools. Two schools awarded as the winners of the Sustainable School Program in 2022 and 'Greening Management' by the Department of Environment have been selected as the case studies. The selected schools are Sekolah Kebangsaan Air Merah, Kulim, Kedah (School A), and Sekolah Kebangsaan Kampong Salang, Kangar, Perlis (School B). Before data collection, the researcher abided by the research protocol ethics by asking the relevant authorities for permission to conduct research with children at the selected schools. Permission was obtained from the Malaysian Ministry of Education (MOE), the State Education Department (JPN), and the selected schools before data collection. After receiving permission from the headmaster of the schools, the researcher further discussed a suitable date and time, and selected classes and children, with the teachers assigned by the headmaster in the respective schools. The participants' assent was obtained verbally from the children.

Middle childhood children aged between 10 and 11 because children of this age are at a stage where they can express their opinions and feelings logically and reliably (McDevitt & Ormrod, 2002). Early childhood children (7 to 9 years old) were excluded because they may have difficulty understanding each concept in this qualitative research instrument (Larson, 2009). Children aged 12 years old have been excluded as requested by the schools. The sample was chosen using purposive sampling. The teachers at each school have selected children who can communicate and give opinions and views during the data collection session. Observation, focus groups, and projection methods were used for data collection.

The observation focused on the application of biophilic design in children's learning spaces at both selected schools. The researcher makes field notes, video recordings, and photographs throughout the observation. For the focus group, the children were grouped with three from the 4th year class and three from the 5th year class for each school. Focus group sessions last for 30 to 45 minutes. This focus group session was conducted in Malay. The researcher conducted the focus group discussion and formed part of the group, whereas the assistant took notes (Abebe & Ennew, 2009). The discussions were recorded using a voice recorder. Projective techniques, known as indirect interviewing techniques, have been used as part of focus group discussions as an aid for children to communicate, examining the preferred biophilic design elements from children's perspectives and the impact of the elements on their emotions.

### 3.2. Research Instruments

An observation checklist was utilised to identify the existing biophilic elements at the schools. An observation checklist was developed based on a literature review. Field notes, videos, and photos were taken during the observation. Projective techniques and images with smiley cards were used for the focus group to initiate children's communication. Children evaluated the images using emotions related to the study's five basic emotions: happy, sad, angry, fear, and disgust (Davidson, 2006). The discussions were recorded using a voice recorder.

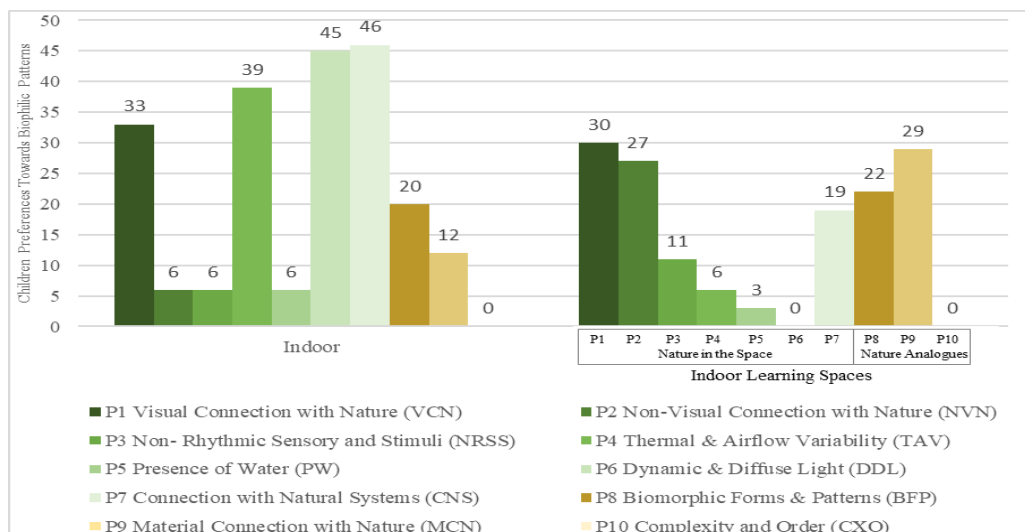
### 3.3. Analyses

This study analysed the observation data using content analysis based on the images captured and the field notes. Meanwhile, the data for focus group discussion and projection techniques was analysed using NVIVO software. Directed and summative content analysis was used for data analysis. First, data were transcribed, codes were derived, and these were grouped into sub-themes and themes. Finally, summative content analysis was conducted by computing the recurring codes, sub-themes, and themes for children's preferences towards biophilic elements.

## 4.0 RESULTS AND ANALYSIS

### 4.1. Children's Preferences Towards Biophilic Pattern





















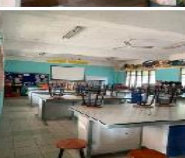















Figure 1 shows the number of children's preferred biophilic patterns in both indoor and outdoor learning spaces for both School A and School B.



**Figure 1.** Numbers of Children's Preferences Towards Biophilic Patterns

Based on Figure 1, for indoor learning spaces, the most preferred biophilic patterns are connection with natural systems, followed by diffuse and dynamic light, thermal and airflow variability, visual connection with nature, biomorphic forms and patterns, material connection with nature, non-visual connection with nature, and the presence of water. Non-rhythmic sensory and complexity patterns have not been in any indoor learning spaces; hence, the children have not mentioned them as their preferred or unpreferred patterns. Meanwhile, for outdoor learning spaces, the most preferred patterns are visual connection with nature, material connection with nature, non-visual connection with nature, biomorphic patterns, connection with the natural system, non-rhythmic sensory stimuli, thermal and airflow variability, and the presence of water. The children have not mentioned dynamic and diffuse light and complexity and order as their preferred or unpreferred patterns. Table 1 and Table 2 further show children’s preferences towards biophilic elements in indoor and outdoor learning spaces for both School A and School B.























**Table 1.** Children’s Preferences Towards Biophilic Elements at Learning Spaces (School A).

		Before	School A After	Biophilic Elements	Preferred	Unpreferred
Indoor Learning Spaces	Classroom	 P4 TAV P6 DDL P7 CNS	 P1 VCN P4 TAV P6 DDL P7 CNS P8 BFV	P1 Plants P4 Natural Ventilation P6 Natural Lighting P7 View towards Nature P8 Nature Image	    	
	Library	 P6 DDL P7 CNS P8 BFV	 P1 VCN P4 TAV P6 DDL P7 CNS P8 BFV P9 MCN	P1 Plants P4 Natural Ventilation P6 Natural Lighting P7 View towards nature P8 Nature Image P9 Nature Pattern P9 Material	      	
	Science Lab	 P6 DDL	 P1 VCN P2 NVN P4 TAV P6 DDL P7 CNS P8 BFV P9 MCN	P1 Plants P4 Natural Ventilation P6 Natural Lighting P7 View towards Nature P8 Nature Image P9 Nature Pattern P9 Material	      	
	Music Classroom	 P2 NVN P6 DDL P9 MCN	 P1 VCN P2 NVN P6 DDL P8 BFV P9 MCN	P1 Plants P2 Natural Material P6 Natural Lighting P8 Nature Image P9 Nature Pattern P9 Material	     	
	Outdoor Learning Spaces	English Corner  P1 VCN P2 NVN P3 NESS P5 PW P7 CNS P8 BFV P9 MCN P10 CXO	 P1 VCN P2 NVN P3 NESS P5 PW P7 CNS P8 BFV P9 MCN P10 CXO	P1 Landscape P2 Nature Sense P3 Nature movement P5 Water P7 Natural system P8 Nature Pattern P9 Material P10 Complexity	        	

**Biophilic Pattern:** P1 Visual Connection with Nature (VCN); P2 Non-Visual Connection with Nature (NVN); P3 Non-Rhythmic Sensory and Stimuli (NRSS); P4 Thermal & Airflow Variability (TAV); P5 Presence of Water (PW); P6 Dynamic & Diffuse Light (DDL); P7 Connection with Natural Systems (CNS); P8 Biomorphic Forms & Patterns (BFV); P9 Material Connection with Nature (MCN) P10 Complexity and Order (CXO)


**Preferred Biophilic Elements:**   
**Unpreferred Biophilic Elements:** 

**Table 2.** Children’s Preferences Towards Biophilic Elements at Learning Spaces (School B).

		School B				
		Before	After	Biophilic Elements		
					Preferred Unpreferred	
Indoor Learning Spaces	Classroom			<b>P4</b> TAV <b>P6</b> DDL  <b>P1</b> VCN <b>P4</b> TAV <b>P6</b> DDL <b>P7</b> CNS <b>P8</b> BFP	<b>P1</b> Plants <b>P4</b> Natural Ventilation <b>P6</b> Natural Lighting <b>P7</b> View towards nature <b>P8</b> Nature Image <b>P8</b> Nature Colour	     
						
	Science Lab			<b>P1</b> VCN <b>P2</b> NVC <b>P6</b> DDL <b>P9</b> MCN	<b>P1</b> Plants <b>P5</b> Water <b>P6</b> Natural Lighting <b>P7</b> View towards Nature <b>P8</b> Nature Pattern <b>P9</b> Material	     
	Computer Lab			None	<b>P1</b> Plants <b>P2</b> Natural Material <b>P8</b> Nature Image <b>P8</b> Nature Pattern <b>P9</b> Material	    
	Art Room			<b>P2</b> NVC <b>P9</b> MCN	<b>P1</b> Plants <b>P2</b> Natural Material <b>P8</b> Nature Image <b>P8</b> Nature Pattern <b>P9</b> Material	    
Minsolla			<b>P1</b> VCN <b>P2</b> NVC	<b>P1</b> Plants <b>P2</b> Natural Material <b>P4</b> TAV <b>P6</b> DDL <b>P7</b> CNS	    	

**Biophilic Pattern:** **P1** Visual Connection with Nature (VCN); **P2** Non-Visual Connection with Nature (NVN); **P3** Non-Rhythmic Sensory and Stimuli (NRSS); **P4** Thermal & Airflow Variability (TAV); **P5** Presence of Water (PW); **P6** Dynamic & Diffuse Light (DDL); **P7** Connection with Natural Systems (CNS); **P8** Biomorphic Forms & Patterns (BFP); **P9** Material Connection with Nature (MCN) **P10** Complexity and Order (CXO)

Preferred Biophilic Elements: 

Unpreferred Biophilic Elements: 

Findings show that children in both schools preferred the existing and proposed biophilic elements in their learning spaces. Children responded positively to all biophilic patterns and elements that include both 'nature in space' and 'nature analogues' categories. Nature in space includes visual connection with nature, non-visual connection with nature, rhythmic sensory stimuli, thermal and airflow variability, the presence of water, dynamic and diffuse light, and connection with the natural system. Meanwhile, nature analogues include biomorphic form and patterns, material connection with nature, and complexity and order. Only two patterns were unpreferred by a few children: visual connection to nature, specifically with elements of plants, and the presence of water with elements of water. The children prefer other elements in each pattern: the plants, view towards nature, nature senses, natural ventilation, water, natural lighting, natural systems, nature image, nature pattern, nature colour, and material.

For the Visual Connection with Nature pattern in both School A and B, most children preferred the application of biophilic elements that consist of indoor plants in all learning spaces. For example, in the classroom, an 11-year-old boy from School A said, "I feel happy to be surrounded by natural elements; I can learn while enjoying the natural environment." Another 11-year-old boy from School B mentioned, "I feel calm being surrounded by green elements in the classroom." As for the library, an 11-year-old boy from School A stated, "I enjoy the seaside background and green elements." However, a few children at School did not prefer to have the elements inside the classroom. An 11-year-old boy from School A stated, "The application of green elements in the classroom will distract my attention and focus while learning." Another 11-year-old boy stated, "I feel fear of the hanging plants in the classroom."

For the 'Non-Visual Connection to Nature' pattern in both schools, all of the children also preferred the application of natural elements that give a sense of hearing, touch, smell, and taste that have been proposed to be included. The elements that make sense include the texture of the natural materials (touch), the sounds of birds (hear), and the fragrance of flowers (smell). A boy aged 11 from School A stated, "I feel excited because there is a water fountain. I like to hear the sound of a water fountain." Another girl aged 11 years old from School B mentioned, "I feel happy when I am at the English Corner because there are lots of flowers, and I like the smell of flowers."

For the 'Non-Rhythmic Sensory Stimuli' pattern in both Schools A and B, all of the children preferred the natural elements that have been proposed, which are fresh, stimulating, and energising. The natural elements include the faint scent of eucalyptus in the air and birds chirping. A girl aged 11 from School A stated, "I feel calm because there are many natural elements." Another 10-year-old boy said, "I feel happy because there are many trees." A 10-year-old girl from School B mentioned, "I feel happy because I can see the clouds and the birds." Another 11-year-old boy from School B stated, "I feel excited if there is a corridor like this. I want to be in the corridor instead of the classroom."

For the 'Thermal and Airflow Variability' pattern in Schools A and B, all the children preferred the natural ventilation that came into the learning spaces, especially in the classroom and Musolla, which made the space feel refreshed, alive, and comfortable. For example, a 10-year-old girl from School A stated she liked the natural ventilation at the Musolla. She stated, "I love the natural lighting and ventilation, with the addition of Islamic murals in this space." Another boy, a 10-year-old from School B, said he liked the natural ventilation coming into the classroom. He said, "It looks calm; there is natural lighting and natural ventilation."

For the 'Presence of Water' pattern in both Schools A and B, most children preferred the presence of water, especially in the outdoor learning environment, such as the water fountain and fish pond. A 10-year-old girl from School B said, "It was fun to play at the Herbs Garden because there is a water fountain." Another girl, a 10-year-old from School A, mentioned, "I feel happy and fun because there is a fish pond where I can play water." However, a few children did not prefer the presence of water design elements for safety reasons. An 11-year-old girl from School A stated, "I feel worried about being near the pond. I think it is dangerous for children."

For 'Dynamic and Diffuse Light' patterns in both schools, all of the children preferred the natural lighting that existed and was proposed in the classroom, library, science lab, music classroom, computer lab, Musolla, and Moral Learning Space. The natural lighting creates shadows and diffuses light in the spaces. An 11-year-old girl from School A said, "I like the space because it becomes spacious when there is natural lighting coming into the library." Meanwhile, an 11-year-old boy from School B said, "I feel happy. I like natural lighting instead of using lamps (artificial lighting) in the classroom." Another 10-year-old girl from School B mentioned, "I like the use of natural lighting and fresh air from outside through the Islamic mural."

For the 'Connection with the Natural System' pattern in both schools, all of the children preferred the natural system that existed and was proposed at the outdoor learning spaces such as English Corner, Education Corner, and Herbs Garden, as well as indoor-outdoor connections from the indoor spaces towards the natural systems. The existence of the natural system evokes a relationship with nature as a whole. Most children feel happy and calm when viewing the natural system in indoor learning spaces such as classrooms, science labs, computer labs, libraries, music rooms, and Musolla. An 11-year-old girl from School B mentioned, "I feel happy, joy and excitement to be in the Herbs Garden because there are many trees and water fountains. It is beautiful". A girl, 11 years old, from School A, stated, 'I feel excited; it is fun to study because I can see the tree outside'. Another child also mentioned, "I like to look at the view outside looking at plants from the classroom."

For the 'Biomorphic Forms and Patterns' pattern in both Schools A and B, all the children preferred the existing and proposed biomorphic forms and patterns, symbolic of the contoured, patterned, or textured that mimic nature in all learning spaces. An 11-year-old girl from School A said, "I feel happy. I love the natural mural painting on the wall at the library." Another 10-year-old girl from School A said, "I feel happy. The space becomes fun with the application of nature elements and the use of science wallpaper at the science lab." Another 11-year-old girl from School B mentioned, "I feel excited with the application of natural elements such as timber, green walls, and landscape wallpaper." An 11-year-old boy from School A said, "I feel happy. It is fun because there are colourful tables and chairs to study. It is a wonderful and colourful environment."

For the 'Material Connection with Nature' patterns in Schools A and B, all children preferred the natural elements. A 10-year-old boy from School A mentioned, "I feel comfortable because of the use of wood material in the science lab." Another 10-year-old boy from School A said, "I feel happy; it is interesting because there is an application of paver stone elements." A 10-year-old girl from School B said, "The classroom environment is clean and calm with the application of a timber floor and ceiling." For the 'Complexity and Order' pattern in both schools, children did not mention that they preferred or unpreferred the elements. Children seem not to have an understanding of the complexity and order pattern, so they did not give any responses related to the pattern.

The overall findings indicate that most children from Schools A and B preferred the application of biophilic elements in both indoor and outdoor learning spaces. The biophilic design elements that include both direct and indirect contribute to children's well-being and help them develop positive emotions. Therefore, it is crucial to implement biophilic design elements in their learning spaces at school.

## 5.0 DISCUSSIONS

This study makes a significant contribution to the knowledge of two groups of children's preferences towards biophilic design elements and the impact of the elements on their well-being. This study indicates that children preferred the implementation of biophilic patterns and elements in both indoor and outdoor learning spaces through direct and indirect experiences. The preferred biophilic elements for indoor and outdoor learning spaces differ since the biophilic elements that can be applied in both indoor and outdoor spaces are different. The most preferred biophilic elements in indoor learning spaces are connection with the natural system (view towards nature) and dynamic and diffuse light, followed by thermal and airflow variability, visual connection with nature, biomorphic forms and patterns, and material connection with nature. This study highlights that the most preferred biophilic patterns and elements are obtained through direct experience. Connection with natural systems directly through a view towards nature besides dynamic and diffuse light, plays an essential role in indoor learning spaces to elevate children's happiness and calmness, which can further boost their mood to learn and increase their attention to learning. Views towards plants and other natural elements, as well as the natural lighting coming into the learning spaces, give children a feeling of calmness and refreshment so they can focus on their learning. Findings support previous studies that view towards nature and natural lighting are essential in indoor learning spaces (Joo-Young & Sung-Jun, 2020; Determan et al., 2019; Li & Sullivan, 2016). Other biophilic elements through direct experiences that are also crucial in indoor learning spaces are natural ventilation and visual connection to nature, which elevate children's positive emotions and reduce stress.

On the other hand, indirect experiences that include biomorphic forms and patterns (nature patterns, nature images, and natural colour) and material connection to nature also play an essential role in enhancing children's positive emotions, which aligns with a previous study by Awad (2022). Biomorphic forms and patterns that



mimic nature through nature wallpaper, nature patterns, and nature colour could create an interesting and exciting learning environment. Children expressed excitement in spaces that had those elements. Meanwhile, the most preferred biophilic elements for outdoor learning spaces are through direct experiences, which are visual connection with nature, material connection with nature, non-visual connection with nature, connection with natural systems, and non-rhythmic sensory stimuli. Interestingly, few children expressed negative affiliation towards water elements and plants, supporting previous studies showing that children exhibit negative affiliation towards natural elements related to safety reasons or traumatic experiences (Mustapa, 2022). Negative affiliation, or biophobia is a negative related to their past bad experiences, especially with water elements (Aaron & Wii, 2011). Another explanation for children's negative feelings is related to their lack of exposure to the natural elements hence, they become unfamiliar and express negative feelings towards the elements. This study suggests that certain biophilic elements need to be carefully understood and considered to be implemented so that they cannot trigger children's negative emotions.

Overall, this study strongly suggests that biophilic elements that include direct (nature in the space) and indirect (nature analogues) experiences with nature should be included in both indoor and outdoor learning spaces at primary schools. It is crucial to include those elements as they elevate children's positive emotions, which will further contribute to their focus on learning and reduce stress (Awad, 2022; Mustapa, 2015). For indoor learning spaces, connection to natural systems (views towards nature) and dynamic and diffuse light are the most crucial biophilic elements needed to be imparted in the spaces to enhance children's well-being, followed by thermal and airflow variability, visual connection with nature, biomorphic forms and patterns, and material connection with nature. Meanwhile, for outdoor learning spaces, visual connection with nature, material connection with nature, non-visual connection with nature, connection with natural systems, and non-rhythmic sensory stimuli are the essential biophilic elements needed to be included in the outdoor spaces. Theoretically, this study also highlights that Browning and Ryan's (2020) and Kellert's (2018) biophilic frameworks can complement each other for biophilic patterns and elements.

## 6.0 CONCLUSION

In conclusion, biophilic design elements must be embraced and implemented in children's indoor and outdoor learning spaces to improve their psychological well-being. Biophilic elements will expose children to direct and indirect nature experiences, elevate their positive emotions, reduce stress, boost their mood for study, and increase their attention during learning. Most importantly, policymakers and practitioners in the built environment and education should reconnect children with nature through biophilic design in their indoor and outdoor learning spaces at schools to promote excellent health and well-being. The existence of biophilic patterns and elements at school could be part of environmental programmes and hands-on activities with the children at school, which will also eliminate fear feelings for children who have biophobia towards certain natural elements. Findings could also be integrated into the components of sustainable school programs as part of the criteria for sustainable schools since biophilic design is an initiative towards sustainable strategies and goals. Future research needs to explore further the built environment practitioners' point of view on implementing biophilic design elements at schools and factors that need to be reconsidered in implementing the elements in school design. Also, future research needs to explore further the influence of cultural context on children's perceptions and preferences towards biophilic patterns and elements, as well as the factors that contribute to children's preferences for biophilic patterns, which could further help in developing criteria for biophilic patterns that meet children's needs and preferences as children view things differently from adults. Providing a good quality environment is vital to contributing to their health and well-being.

## ACKNOWLEDGEMENT

The author would like to thank Universiti Malaysia Kelantan (UMK) and the Faculty of Architecture and Ekistics for their continuous support.

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