



**NEAR EAST UNIVERSITY  
INSTITUTE OF GRADUATE STUDIES  
DEPARTMENT OF INTERIOR ARCHITECTURE**

**A BIOPHILIC DESIGN ASSESSMENT TOOL DEVELOPMENT  
FOR PRESCHOOL INTERIORS**

**Ph.D. THESIS**

**Ibtisam MOHAMMED**

**Nicosia  
September, 2023**

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**Ibtisam MOHAMMED**

**Supervisor  
Assist.Prof.Dr. Çiğdem ÇAGNAN  
Co-Supervisor  
Prof.Dr.Zeynep ONUR**

**Nicosia  
September, 2023**

## Approval

We certify that we have read the thesis submitted by Ibtisam Mohammed titled “A Biophilic Design Assessment Tool Development for Preschool Interiors” and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Ph.D. of Interior Architecture.

Examining Committee	Name-Surname	Signature
Head of the Committee:	Assoc. Prof. Dr. Sema UZUNOĞLU	.....
Committee Member*:	Prof. Dr. Özge FULLER	.....
Committee Member*~:	Prof. Dr. Salih Gücel	.....
Committee Member*~:	Assoc. Prof. Dr. Kozan UZUNOĞLU	.....
Committee Member*~:	Assoc. Prof. Dr. Buket ASILSOY	.....
Supervisor:	Assist Prof. Dr. Çiğdem Çağnan	.....
Co. Advisor:	Prof. Dr. Zeynep Onur	.....

Approved by the Head of the Department

04.10/2023  
.....  
Prof. Dr. Zihni TÜRKAN  
Head of Department

Approved by the Institute of Graduate Studies

.....  
Prof. Dr. Kemal Hüsnü Can Başer  
Head of the Institute



## **Declaration**

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Ibtisam Mohammed

11/September/2023

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**Ibtisam Mohammed**

## Abstract

### **A Biophilic Design Assessment Tool Development for Preschool Interiors**

**Mohammed, Ibtisam**

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This study examined the incorporation of biophilic elements in Duhok preschool interiors and integrated them into the Biophilic Interior Design Matrix (BID-M). This approach holds great promise for the development of restorative environments. The literature discusses biophilia, a low-impact design strategy that integrates natural elements into architecture and interiors, promoting human wellbeing and health by encouraging positive interactions with nature. Biophilia balances human needs with natural and cultural environments. According to Kellert's list of biophilic design features, the Biophilic Design Matrix (BDM) has been adjusted to fit preschool interiors. Photos and plan drawings were employed as methods to analyze 59 interior spaces within six preschools, both private and public. The biophilic matrix revealed the presence of 30% of biophilic attributes in the analyzed spaces, with an average score of 16.45 out of 53 total points. Individual scores ranged from 8 to 22 for each space, highlighting variations in biophilic design within the six preschools. Notably, the study identified a lack of biophilic features that foster human–nature relationships in the majority of preschools, albeit minimally observed in some spaces. Conversely, the environmental features scored higher than the average. This research highlights the importance of enhancing biophilic design elements, especially those that strengthen human–nature relationships. The results enhance biophilic design in educational settings, promoting nature-centered, restorative environments for future interventions. Furthermore, an innovative approach for assessing and incorporating biophilia in interiors, recognizing its positive impact on human health and wellbeing, has been proposed. Therefore, some biophilic features have been added to the Kellert matrix specifically for preschools to address the issues highlighted by the examined spaces.

**Key Words:** Biophilia, preschool interiors, biophilic interior design matrix, biophilic design

## Özet

### Okul Öncesi İç Mekanlar İçin Biyofilik Tasarım Değerlendirme Aracı Geliştirme

**Mohammed, Ibtisam**

**Doktora, İç Mimarlık Bölümü**

**Eylül, 2023, 100 Sayfa**

Bu çalışma, Duhok okul öncesi iç mekanlarına biyofilik unsurların dahil edilmesini incelemiş ve bunları Biyofilik İç Tasarım Matrisine (BID-M) entegre etmiştir. Bu yaklaşım, onarıcı ortamların geliştirilmesi için büyük umut vaat etmektedir. Literatürde, doğal unsurları mimariye ve iç mekanlara entegre eden, doğayla olumlu etkileşimleri teşvik ederek insan refahını ve sağlığını destekleyen düşük etkili bir tasarım stratejisi olan biyofili tartışılmaktadır. Biyofili, insan ihtiyaçlarını doğal ve kültürel ortamlarla dengeler. Kellert'in biyofilik tasarım özellikleri listesine göre Biyofilik Tasarım Matrisi (BDM), okul öncesi iç mekanlara uyacak şekilde ayarlandı. Hem özel hem de kamuya ait altı anaokulundaki 59 iç mekanı analiz etmek için fotoğraf ve plan çizimleri yöntem olarak kullanıldı. Biyofilik matris, analiz edilen alanlarda %30 oranında biyofilik niteliklerin varlığını ortaya çıkardı ve toplam 53 puan üzerinden ortalama 16,45 puan aldı. Bireysel puanlar her alan için 8 ila 22 arasında değişiyordu; bu, altı anaokulundaki biyofilik tasarımdaki farklılıkları ortaya koyuyordu. Çalışma, özellikle, bazı alanlarda minimum düzeyde gözlemlense de, anaokullarının çoğunda insan-doğa ilişkilerini destekleyen biyofilik özelliklerin eksikliğini tespit etti. Buna karşılık çevresel özellikler ortalamanın üzerinde puan aldı. Bu araştırma, özellikle insan-doğa ilişkilerini güçlendiren biyofilik tasarım öğelerinin geliştirilmesinin önemini vurgulamaktadır. Sonuçlar, gelecekteki müdahaleler için doğa merkezli, onarıcı ortamları teşvik ederek eğitim ortamlarında biyofilik tasarımı geliştirmektedir. Ayrıca, insan sağlığı ve refahı üzerindeki olumlu etkisi dikkate alınarak, biyofiliyi iç mekanlarda değerlendirmek ve dahil etmek için yenilikçi bir yaklaşım önerilmiştir. Bu nedenle, incelenen alanların vurguladığı sorunları ele almak amacıyla Kellert matrisine özellikle anaokulları için bazı biyofilik özellikler eklenmiştir.

**Anahtar Kelimeler:** Biyofili, okul öncesi iç mekanlar, biyofilik iç tasarım matrisi, biyofilik tasarım

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## List of Abbreviations

<b>BDM:</b>	Biophilic Design Matrix
<b>BID-M:</b>	Biophilic Interior Design Matrix
<b>RED:</b>	Restorative Environmental Design
<b>LEED:</b>	Leadership in Energy and Environmental Design
<b>WELL:</b>	Building and the Living Building Challenge

## CHAPTER I

### Introduction

Modern living has made nature more and more difficult for individuals to access, but the yearning to connect with nature still exists. Children are particularly affected by this, as they have to stay indoors while separated from their parents, which is especially true for them. This lack of connection with nature is troubling, as studies have revealed that humans have an innate urge to be linked with nature, which is known as biophilia. Biophilia is defined as an inherent need to be connected with nature (Wells & Evans, 2003). Biophilia is a natural need to connect with nature that has proven critical for children's cognitive development and general wellbeing (Hand et al., 2017), (Flouri et al., 2014), (Wells & Evans, 2003). Including nature in urban environments created for children is one possible solution to address this issue. Biophilic design strategies require consideration of the people using the place, its location, and its function. Plants are one way to incorporate nature into space, but there are other ways to incorporate nature (Beatley, 2016), (Gillis & Gatersleben, 2015). Kellert (2008) proposed six biophilic characteristics that could be implemented in a given space to aid interior designers. To discover and analyze biophilic features, a trustworthy approach is necessary. Among the six biophilic features are environmental features, light and space, natural patterns and processes, natural shapes and forms, human-nature interactions, and place-based relationships (Marte et al., 2020).

A few studies have been conducted to create a trustworthy coding method for determining biophilic contents in various interior environments. The matrix includes six biophilic design elements and 52 biophilic features, according to Kellert (2008). Twenty of the matrix's initial 72 features were not included. They were unable to be visually inspected and had no link to the interior space, which caused this (Marte et al., 2020). In order to assess the effects of biophilic elements on playrooms in child healthcare facilities on wellbeing (Marte et al., 2020), McGee & Marshall-Baker (2015) developed the BID-M. Because evidence-based design has been more popular as an interdisciplinary method of gathering and sharing knowledge since the beginning of the 1980s, designers have had more and more reasons to incorporate biophilic design into interiors (McGee, 2018). This initial quantification of biophilia will continue to expand as more study is done on the

individual features and expanded applications of the matrix score are made to highlight bigger trends and research possibilities. Additionally, there is a need to find more evidence-based arguments in favor of integrating biophilia into interior spaces like play areas. Future research is necessary to establish the best applications for each feature. By designing and evaluating a range of attribute-friendly design components, it may be feasible to better understand the benefits of biophilia and the optimal applications for it in interior environments.

The following research issues will be addressed in light of the foregoing:

1. What is the average presence of biophilic attributes in the analyzed spaces, and how does this align with the overall score and percentage of biophilic attributes' presence?
2. How does the BID-M identify biophilic design elements in preschool interiors?
3. What is the extent of biophilic element incorporation within the interiors of Duhok preschools, according to the six biophilic design elements suggested by Kellert?

With Kellert's proposed biophilic design features and the BID-M as guiding frameworks, these research questions will direct the investigation of biophilic design elements observed within the interiors of Duhok preschools. This study intends to contribute to the knowledge and use of biophilic design principles in preschool interiors by addressing these research questions, opening the way for the development of healthier and more nurturing settings for young children.

The study used a photographic methodology to document biophilic attributes for preschool interiors in Duhok, using the BID-M to address the study's objective. The BID-M assisted in quantifying the numerous biophilic design features seen in preschool settings. The current study sought to determine if biophilic features were present in the interiors of Duhok preschools and to include them into the BID-M based on the six elements suggested by Kellert (2008).

Biophilic design, despite its potential benefits, remains an area of interior design expertise that has received relatively little attention. By addressing the problem of integrating biophilic design features in interior design, this research contributes to bridging this gap and sheds light on the potential of utilizing the BID-M instrument for the identification and implementation of biophilic design elements (McGee, 2018).

By examining and incorporating biophilic features into the BID-M, this study aims to provide valuable insights into the biophilic attributes present in preschool interiors, high-lighting their significance in promoting a healthier and more nurturing environment for young children. The results of this study will advance our knowledge of and ability to apply biophilic design concepts to preschool interiors, with the ultimate goal of promoting children's welfare and cognitive growth.

Future investigation and use of biophilic design components in interior design practice will be based on the findings of this research. Designers and practitioners may more successfully incorporate features inspired by nature into interior spaces, generating healing and enriching settings for users, by realizing the BID-M's potential as a tool for biophilic design assessment

### **Statement of the Problem**

Although being in close proximity to nature is beneficial for the interior, little study has been done to show how to incorporate biophilic design into the constructed environment. There isn't a single tool created specifically for interior designers that offers a large variety of nature-integration approaches. This research describes the development of a tool to help interior designers identify biophilic design elements in the interiors of Duhok preschools (McGee, 2018).

### **Purpose of the Study**

The objective of this study is to develop the BID-M, a design tool for preschools, to optimize the integration of nature into interior spaces for evidence-based design. It will support the identification and quantification of biophilic interior design elements in preschools by designers and other specialists.

### **Research Question**

1. What is the average presence of biophilic attributes in the analyzed spaces, and how does this align with the overall score and percentage of biophilic attributes' presence?
2. How does the BID-M identify biophilic design elements in preschool interiors?
3. What is the extent of biophilic element incorporation within the interiors of Duhok preschools, according to the six biophilic design elements suggested by Kellert?

## **Hypothesis**

Biophilic architecture understanding provides learning spaces that enable a healthy environment, and consists of sustainable spaces for preschool designs. So, the aim of this research will be developing a biophilic design assessment tool development for preschools interiors.

## **Significance of the Study**

As stated by Marte et al. (2020), it is crucial to expand the application of the matrix to look at biophilia in children's interior design contexts. The evolution of children's environmental understanding and environmental attitudes as adults and the significance of biophilic attributes in the formation of children's environmental identities. This study's contribution is to create a unique biophilic design matrix that will be used in a preschool context. It is based on Kellert's proposal for biophilic elements and the matrix created by McGee and Marshall-Baker. The BID-M additionally provides help with biophilic incorporation at all phases of the process of designing and, as a result, can promote the integration of natural elements more fully in the creation of interior settings.

## **Limitations**

There were no restrictions on carrying out this research because a permit was obtained from the Dohuk Directorate of Education to visit numerous preschools and gather the necessary information. However, because some of the directors of these preschools objected to having their interior spaces and children photographed, the selection of preschools for the analysis and evaluation of the biophilic content of interior design was restricted to these particular preschools.

## **Definition of Terms**

Biophilic design: emphasizes the importance of protecting, enriching, and re-establishing the advantages of nature in the built environment (Kellert, 2008).

## CHAPTER II

### Literature Review

#### Theoretical Framework

##### *1. The Concept of Biophilic Design and its Benefits*

By incorporating natural elements into the built environment, the biophilic design concept for architecture and interior design attempts to bring people closer to nature. The notion is that people are innately connected to nature and that being around natural elements may promote better well-being and health (Kellert et al., 2011). This is to say that there is a connection between nature and human wellbeing. Biophilic design has both health and financial benefits, and neglecting nature can lead to a loss of profit (Browning et al., 2012) (Heerwagen & Hase, 2001). According to an argument made by Browning et al. (2012) (p. 3), “incorporating nature into the built environment is not just a luxury but a sound economic investment in health and productivity, based on well-researched neurological and physiological evidence.” Biophilic design can lead to increased healing, learning, property values, and productivity while decreasing absenteeism, anxiety, and incarceration expenses. It is important to value and safeguard the environment (Kellert, 2008). A strategy known as restorative environmental design (RED) seeks to reduce and alleviate negative effects on the environment while fostering positive interactions between humans and nature in modern architecture and landscapes. According to Kellert (2008), it is a low-impact strategy. Interior environment designers are crucial in the creation of interior/exterior elements and linkages that might increase user exposure to biophilia, which can have advantageous impacts on wellbeing (Kahn, 1997), health (Beute & de Kort, 2014), and health (Hartig et al., 2011). Restorative environmental design connects sustainability and biophilia, generating globally conscious individuals who value nature and desire to return it to its ideal state. The addition of biophilic design and imitating natural settings is clearly the next step in the sustainable design movement (Miller, 2013). However, there is insufficient support for best practices for developing the interior environments that people naturally choose (McGee et al., 2019). A strategy for making settings that are healthy, adaptive, and sustainable is called "biophilic design". According to Cacique & Ou (2022), it also provides advantages including better air quality, decreased stress levels, and higher productivity. The term “biophilia” refers to the emotional bonds that people develop

with other living species. The two dimensions of biophilic design are the organic or naturalistic component, which mixes direct and symbolic elements of nature, and the place-based or vernacular dimension, which emphasizes the fusion of buildings and landscapes with the local environment and culture. This architectural method generates a sense of place and identity, which can increase people's loyalty and responsibility for their built environment and heritage.

## ***2. Sustainability and Biophilia***

The primary premise behind sustainability is that current needs should be met without endangering the ability of future generations to do the same. The strong connection between people and the natural world is crucial to sustainability. According to Downton et al. (2017), biophilia offers a sustainable design approach that incorporates re-engaging people with nature. Sustainable design balances human needs with natural and cultural environments, whereas biophilic design examines how the environment affects our physiology and psychology. Sustainable architecture is created in harmony with the environment and natural resources. Biophilia and sustainability can be achieved by preserving natural and cultural environments and using resources in site and building design to encourage exploration. This knowledge can be used to modify space to enhance human experiences. Biophilic design addresses sustainability through tactile, emotional, and experiential approaches, creating buildings that are resource-saving, energy-efficient, and improve the socialization, productivity, health, and wellbeing of their occupants (Walimbe & Chitgopkar, 2018).

## ***3. Biophilic Interior Design and Tools***

An innovative method of interior design called "biophilic design" aims to incorporate elements of nature into the built environment. Designers may create environments that are not only visually beautiful but also give multiple advantages to the occupants by including biophilic features such as plants, natural sunlight, and organic materials. These biophilic characteristics not only improve the aesthetic attractiveness of the interior space but also improve the physical and emotional wellbeing of those who live in these places. Plants are one biophilic component that may be introduced into interior spaces. Indoor plants have been proven to provide several advantages to people. Plants have been shown in studies to enhance air quality by lowering levels of carbon dioxide and other pollutants.

Environmental features, light and space, natural patterns and processes, natural shapes and forms, human-nature relationships, and place-based relationships are the six essential elements that comprise biophilic design. These six elements encompass over 70 specific design attributes that contribute to creating a stronger connection between humans and nature. A Yale professor has extensively categorized biophilia into these elements and identified 72 specific features within them. For instance, a feature of air has been identified within the environmental features element. This extensive compilation of biophilic design features in landscape and architecture was developed based on the extensive exposure of the professor to a diverse range of authors and researchers in the field (Kellert, 2008), (McGee et al., 2019). An alternate tool that places an emphasis on identifiable patterns, connections between nature and health, and interconnections between nature and design is the Terrapin Bright Green List of 14 Patterns of Biophilic Design (Ryan et al., 2014). A smaller list of 14 features restricts Kellert's initial list of 72 features. Although LEED (Leadership in Energy and Environmental Design) has increased awareness of sustainable design, it hasn't offered comprehensive design techniques for biophilic design. Kellert's initial list of design elements is cited by pioneers in the field of biophilic design, including WELL Building and the Living Building Challenge. The Living Building Challenge and WELL Building have both benefited from the expansion of Kellert's vocabulary for interior designers (McGee et al., 2019).

### ***Identifying Biophilic Features in Interior Spaces***

Color, light, and materiality are all connected design elements that occur together in an interior environment. However, it is unclear how these three attributes are being used in relation to biophilic features and how current research supports biophilic features (McGee & Park, 2022). The BDM was developed by McGee and Marshall-Baker to detect biophilic features within 24 pediatric hospital spaces. A study in the South Atlantic states' child life play areas found consistent biophilic attributes in some settings while lacking in others (McGee & Marshall-Baker, 2015). The BDM is a useful tool for assessing the existence and efficacy of biophilic design in pediatric healthcare settings.

Marte et al. (2020) tested the BID-M in metropolitan settings, by coding photographs from 45 children's playrooms of Manhattan apartment complexes. They evaluated overall and component inter-rater reliability, finding high overall reliability but low reliability in some components. Designers' perceptions of biophilic design



were explored by developing an updated (BID-M) design tool. The results showed that practitioners had a better understanding of biophilic design, enabling designers to incorporate nature-based features in indoor settings (McGee et al., 2019).

McGee & Park (2022) examined biophilic interior design utilizing the BID-M vocabulary and its essential elements. They found that practitioners incorporated a range of biophilic attributes into their work, with color preferences being the top attribute. Abstraction of nature, and natural materials, natural light, and composition were the top attributes that practitioners and the literature review had in common. Additional research is required to completely comprehend how biophilic design might be variedly included for the optimum natural interior environments. McGee et al. (2022) examined the reliability and validity of the BID-M and how Chinese design professionals perceived biophilia. 101 interior designers and architects participated in a pre- and post-questionnaire study, and the results showed that the Chinese designer's interpretation of the BID-M was viewed as valid, trustworthy, and beneficial to the design process.

## **Related Research**

### ***The Importance of Biophilic Design in Preschool Interiors***

Plants, natural materials, and lighting are all essential features of biophilic design in preschool environments. Awad (2022) investigated the significance of incorporating biophilic design principles into elementary school design regulations, such as lighting, daylight, materials, and ventilation, to enhance the wellbeing and health of children. Meanwhile, Ondul et al. (2021) aimed to design a “Refuge Pod” piece of furniture using a biophilic design approach in a preschool setting while taking the demands of the space into consideration for both furniture and space. The research revealed that children are imaginative and like to play in tiny areas, underscoring the significance of establishing personal and engaging places.

Yanez et al. (2017) evaluated young children from urban and rural settings in regard to biophilia and attitudes toward nature in their research. The findings found no significant differences based on geographical area. The study identified common themes, including the definition of nature, awareness of environmental effects, and adherence to natural rules. The researchers suggested that cognitive development and personal preferences might be more accurate indicators in this context. In another study by (Ünal & Özen, 2021) the benefits of exposing preschool children to nature through biophilic design in built environments were investigated. The researchers

used content analysis, cognitive mapping, and semi-structured interviews to assess the overall score. They found that a statistically significant impact was observed when the p -value was less than 0.050. Showing a positive impact through contact with nature, Yassein & Ebrahiem (2018) discussed contemporary biophilic interior design techniques used in residential and workplace settings based on a discussion with architecture students. This situated the notion of biophilic interior design and resulted in a conceptual framework that strengthens and supports the link between humans and nature. This further reinforces the connection between humans and nature.

### ***The Impact of Biophilic Design on Children's Learning and Development***

Higher test scores, improved health, and improved learning are just some of the benefits of incorporating biophilic design into educational institutions. The advantages extend to recreational spaces such as playgrounds, where biophilic design concepts can enhance children's behavior, attention span, and mental health. Biophilic design patterns have been demonstrated to improve stress reduction, cognitive abilities, sensitivity, atmosphere, and preference. According to the research findings, biophilic design boosts liking for the environment, decreases stress, increases happiness, and encourages focus (Ghaziani et al., 2021). McGee measured biophilic design attributes in child life settings to enhance well-being and health. The study utilized a BID-M tool and an open-ended questionnaire to create 24 case studies. The results indicated that there is a correlation between biophilic environments and effective Child Life play areas, with higher scores representing greater effectiveness. In a different research, 90 child life professionals identified elements that should be considered when designing the ideal playrooms for hospitals, using a photographic approach. The findings highlighted the crucial role of Child Life specialists in designing or modifying these settings (McGee, 2012), (Weinberger et al., 2017). A relationship to environment may be fostered in large part through educational institutions like schools. These institutions can benefit from providing a natural environment for young people by encouraging outdoor activities and improving mood, cognition, and attention. Moreover, a natural environment in schools enhances focus and self-discipline while lowering stress responses (Cobrerros et al., 2023). The concept of biophilia might be used in the classroom to contribute to the creation of ecologically sound urban environments (Downton et al., 2017). According to a study by Fadda et al. (2023), biophilic architecture has a positive

impact on toddlers' indoor visual attention. Notably, children's initial attention to art exhibitions lasted longer after being exposed to plants on a desk for even a short period of time—48 seconds.

The concept of incorporating biophilic design elements into preschool interior spaces is not widely researched. By doing this, we can enhance children's cognitive abilities, lessen their stress levels, and foster their creativity. Additionally, it can encourage them to pre-serve nature by fostering a closer connection with it. However, the (BDM) presents a possibility to enhance design research while boosting the safety, enjoyment, and health of consumers. In an effort to address the difficulty of quantitatively evaluating biophilia, the BDM was created in 2011, with a focus on children's and adolescents' play areas. It was effective for the BDM to provide a visual record of biophilic attributes and the extent of their application in hospital facilities intended for patient recreation and leisure. Further study has also looked at the condition of biophilic design practice and research in this environment.

## CHAPTER III

### Methodology

Biophilic design is a recognized methodology used to evaluate and incorporate nature-inspired elements in architectural settings, acknowledging the inherent need of children to be in environments with biophilic design patterns for their wellbeing (Wardhani & Susan, 2021). In accordance with this, the goal of this study was to create the BID-M, which was particularly designed for assessing biophilic contents in preschool interiors, utilizing Kellert's well-established design attributes (Kellert, 2008). These attributes, proposed by Kellert, encompass six biophilic design elements, including environmental features, light and space, natural patterns and processes, natural shapes and forms, human-nature relationships, and place-based relationships (see Appendix A).

This study is based on the BDM, which McGee & Marshall-Baker (2015) created to identify biophilic design elements in children's hospitals' play spaces. Notably, this is the first application of the BDM as an interior design tool. Out of Kellert's 72 biophilic design elements, including those related to landscape and architecture, 53 were deemed appropriate for interior design purposes, while the remaining 19 were considered unsuitable (McGee et al., 2019). This is because the 19 excluded are considered to be more relevant to landscape and architecture (see Table 1).

#### **Data Collection Tools/Materials**

Accordingly, this research sought to increase the possible applications of the BID-M in various contexts within Duhok, with an emphasis on the interiors of preschools. The BID-M methodology uses a quantitative method to assess biophilic features; it assigns a score to each space and describes the existence of attributes both orally and visually. A total of 59 interior spaces from six preschools, consisting of four public and two private institutions, were selected for analysis (see Table 2). Prior to data collection, the research team obtained the necessary approval letter from the Directorate of Education to ensure access to the preschools and the collection of relevant information for the study.

Table 1.

*The Biophilic Design Elements and Attributes*

Environmental Features		Light and Space	
1	Color	32	Natural light
2	Water	33	Filtered and diffused light
3	Air	34	Light and shadow
4	Sunlight	35	Reflected light
5	Plants	36	Light pools
6	Animals	37	Warm light
7	Natural material	38	Light as shape and form
8	Views and vistas	39	Spaciousness
9	Fire	40	Spatial variability
Natural Shapes and Forms		41	Space as shape and form
10	Botanical motifs	42	Spatial harmony
11	Tree and columnar supports	43	Inside/outside spaces
12	Animal	Place-Based Relationships	
13	Shells and spirals (invertebrates)	44	Geographic connection to place
14	Egg, oval, and tubular forms	45	Historic connection to place
15	Arches, vaults, domes	46	Ecological connection to place
16	Shapes resisting straight lines	47	Cultural connection to place
17	Simulation of natural features/biomorphy	48	Indigenous materials
18	Geomorphology	49	Landscape orientation/landscape features
19	Biomimicry	Human–Nature Relationships	
Natural Patterns and Processes		50	Prospect and refuge
20	Sensory variability/information richness	51	Order and complexity
21	Age, change, the patina of time	52	Curiosity and enticement
22	Central focal point	53	Change and metamorphosis
23	Patterned wholes		
24	Bounded spaces		
25	Transitional spaces		
26	Linked series and chains		
27	Integrations of parts to wholes		
28	Complementary contrasts		
29	Dynamic balance and tension		
30	Fractals		
31	Hierarchically organized ratios and scales		

In summary, the materials and methods of this study involved the development and application of the (BID-M), specifically tailored for preschool interiors in Duhok. The BID-M incorporates Kellert's design attributes and was used quantitatively to rate and describe the biophilic contents of each space within the selected preschools. Ethical issues were considered, and permission was acquired from the Directorate of Education to perform the research at the selected preschools.

### **Participants / Population & Sample**

#### ***Site Selection for preschools***

Purposive sampling was used to pick cases (preschools) in this research study. The researchers purposefully chose 6 preschools from a total of 21 accessible in

Duhok that would best fit the research objectives. Purposeful sampling is a non-probability sampling strategy in which cases or participants are intentionally chosen based on certain qualities or attributes important to the research (Palinkas et al., 2015), (Campbell et al., 2020). To guarantee variety in the sample, the researchers carefully picked preschools that represented several types of settings, including both public and private institutions. The researcher was able to guarantee that the selected instances were typical of the target population and could provide significant data for analysis by carefully selecting preschools that might provide important insights and information connected to the study questions. The researchers were able to focus on certain elements that were critical for the study, such as a variety of interior locations within the preschools, according to deliberate sampling. This systematic approach to case selection enabled a comprehensive assessment of biophilic design features in preschool environments, since the chosen cases provided the essential variance and depth of understanding.

Table 2.

*The Selected Preschool's in Duhok City Both Public and Private*

Preschool name and type	Area	Number of children	Number of spaces
Shang preschool (public)		650	9
Daveen preschool (public)		245	9
Avro city preschool (private)		170	13
Zaryland preschool (private)	2000 m <sup>2</sup>	450	10
Kapir preschool (public)		330	9
Chiman preschool (public)		245	9
Total number of spaces			59

The study was able to purposefully select preschools that reflected the required diversity and qualities essential to successfully examine and comprehend biophilic design aspects in preschool interiors by using purposeful sampling in this research. The researchers analyzed each location within the preschools using observation and photography, including the ceiling, walls, floor, and furniture. The objective was to see whether there were any special biophilic features in these places. This evaluation was led by Kellert's framework's six biophilic design elements and their related attributes. The researcher was able to analyze and score each space based on the identified biophilic features through meticulous observation and photographic

recording. The visual attributes and features of the rooms were examined to see whether they displayed biophilic design features. The findings of this study were used to create the BID-M, which revealed the existence and distribution of biophilic features throughout the preschools' different interior areas.

### **Data Analysis Procedures**

The use of observation and photography enabled a thorough analysis of the physical elements of the interior spaces. This method offered a visual record and documentation of the presence or absence of biophilic features within each space (see Figure 2), allowing for a more objective evaluation of the biophilic design features present in the preschool environments.

The biophilic design attributes of each preschool's spaces were determined separately by creating a matrix that included the number of spaces that would be allocated along the columns on the one hand and the set of biophilic features along the rows on the other. By indicating with a (✓) sign if present and a (×) sign if not present, these signs were converted to numbers (✓) = 1 and × = (0), in order to evaluate all of the listed attributes in a specific space. The maximum score for various biophilic features in the matrix was 53. In order to determine the overall biophilic inclusion of any space within the preschool, the biophilic attributes of each of the six biophilic elements were combined to create a sub-score, as shown in Table 3.

### **Study Plan**

#### **Case Studies**

Six preschools, both public and private, were selected to be analyzed in this study. These six preschools were selected from among many existing preschools within Duhok, due to the difficulty of obtaining permission to visit and photograph them for the collection of data required to conduct this research. As a result, 59 spaces were able to be included in the study (Table 2).

#### **1. Shang preschool**

Shang preschool is one of the typical public preschools in Duhok City and is situated in a residential area. It accommodates 650 children to guide the preschool in two periods. Included nine spaces to be analyzed: six classrooms, a multipurpose hall, a cafeteria, and corridors.

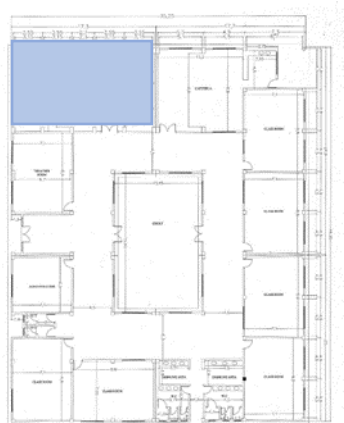
#### **1.1 Multipurpose Hall**

A multipurpose hall is an area that offers a limited selection of items, including a stage for interaction and play, and supports participation activities (Figure

1). Some of the environmental features included in this area are operable windows and the upper window strips, which provide a view of natural features and daylight as well as natural ventilation. Children cannot view the outdoor spaces' natural features due to the height of the windows. Animal representations were found, while most of the biophilic features related to natural shapes and forms were absent in this space. Sensory variability and information richness created through visual sense (natural colors or toys) and auditory sense (music) were the common features in the space. A stage in the multipurpose hall provided the impression of being apart from the main area and a sense of connection between nature and humans through its prospect and refuge attributes. It also offered a central focal point for the space. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole, and bounded space features were found in the area. The multipurpose hall provided artificial light, light and shadow, dispersed and filtered light (curtains), and natural light (windows). The hall's wide expanse gives the impression of spaciousness, and its spatial segmentation generates a variety of play zones that apply biophilic design attributes, with some toys in the form of animals. The space offered geographic and cultural connections to places and landscape features. This space scored 18 of the biophilic attributes, which was higher than the average as shown in Table 3.

Figure 1.

*Multipurpose Hall of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

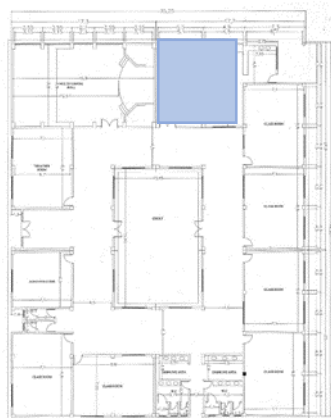


## 1.2 Cafeteria

Children use this space to have the daily meals that are provided to them. Some environmental features that could be found in the cafeteria, such as windows for natural lighting (sunlight), ventilation (natural air), natural views for vegetation, a water feature (a sink), and different natural colors Figure 2. Botanical motifs, representations, or symbolic themes in paintings were found, while most of the biophilic features related to natural shapes and forms were absent in this space. Sensory variability and information richness created through visual sense (natural colors) and auditory sense (music) were the common features in the space. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole, and bounded space features were found in the area. The cafeteria provided artificial light, light and shadow, dispersed and filtered light (blinds), and natural light (windows). The large space of the cafeteria creates a sense of spaciousness and offers geographic and cultural connections to places and landscape features. A lack of human-nature relationships features in this space. This space scored 16 of the biophilic attributes, which was lower than the average as shown in Table 3.

Figure 2.

*Cafeteria of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



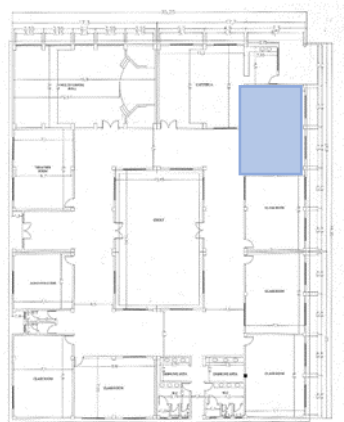
(b)

### 1.3 Classrooms

There are six classrooms, as seen in Figures 3, 4, 5, 6, 7, and 8, in which some educational activities are practiced. All these spaces shared the presence of the same direct biophilic features (i.e., fresh air, sunlight) and indirect features (i.e., various colors, natural views for vegetation) through operable windows. Botanical motifs, shell and spiral representations, or symbolic themes in paintings were found, while most of the biophilic features related to natural shapes and forms were absent in this space. Sensory variability and information richness created through visual sense (natural colors) and auditory sense (music) were the common features in the space. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole, and bounded space features were found in the space. The classroom spaces were divided into two distinct areas: one area used chairs and tables, and the other area used pads stuffed for sitting or activities. The classrooms provided artificial light, light and shadow, dispersed and filtered light (blinds), and natural light (windows). The large space of the classrooms creates a sense of spaciousness and offers geographic and cultural connections to places and landscape features. A lack of human-nature relationships features in these spaces. This space scored 16 of the biophilic attributes, which was lower than the average as shown in Table 3.

Figure 3.

*Classroom 1 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 4.

*Classroom 2 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 5.

*Classroom 3 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 6.

*Classroom 4 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 7.

*Classroom 5 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 8.

*Classroom 6 of Shang Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

#### 1.4 Corridors

Corridors are transitional spaces that provide access between spaces (Figure 9). Some features in this space, including the air, colors, sunlight, plants, views, and vistas, exhibit biophilic inclusion. Botanical motifs, animal representations, or symbolic themes in paintings were found, while most of the biophilic features related to natural shapes and forms were absent in this space. Sensory variability and information richness created through visual sense (natural colors or toys), auditory sense (music), and tactile sense of touch (natural materials) were the common features in all of the spaces. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole. Transitional spaces, linked series and chains, and bounded spaces could be found in the corridors. The corridors provided artificial light, light and shadow, dispersed and filtered light (blinds), and natural light (windows). As well as offering geographic, cultural, and ecological connections to places. A lack of human-nature relationships features in this space. This space scored 19 of the biophilic attributes, which was higher than the average as shown in Table 3.



Table 3 (Continued).										
18	Geomorphology	×	×	×	×	×	×	×	×	0
19	Biomimicry	×	×	×	×	×	×	×	×	0
	Sub score	1	1	2	2	2	2	2	2	16
Natural patterns and processes										
20	Sensory variability/ Information richness	✓	✓	✓	✓	✓	✓	✓	✓	9
21	Age, change, the patina of time	×	×	×	×	×	×	×	×	0
22	Central focal point	✓	×	×	×	×	×	×	×	1
23	Patterned wholes	×	×	×	×	×	×	×	×	0
24	Bounded spaces	✓	✓	✓	✓	✓	✓	✓	✓	9
25	Transitional spaces	×	×	×	×	×	×	×	✓	1
26	Linked series and chains	×	×	×	×	×	×	×	✓	1
27	Integrations of parts to wholes	✓	✓	✓	✓	✓	✓	✓	✓	9
28	Complementary contrasts	×	×	×	×	×	×	×	×	0
29	Dynamic balance and tension	×	×	×	×	×	×	×	×	0
30	Fractals	×	×	×	×	×	×	×	×	0
31	Hierarchically organized ratios & scales	×	×	×	×	×	×	×	×	0
	Sub score	4	3	3	3	3	3	3	5	30
Light and space										
32	Natural light	✓	✓	✓	✓	✓	✓	✓	✓	9
33	Filtered and diffused light	✓	✓	✓	✓	✓	✓	✓	✓	9
34	Light and shadow	✓	✓	✓	✓	✓	✓	✓	✓	9
35	Reflected light	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	×	×	×	×	×	×	×	0
39	Spaciousness	✓	✓	✓	✓	✓	✓	✓	×	8
40	Spatial variability	✓	×	×	×	×	×	×	×	1
41	Space as shape and form	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	×	×	×	×	×	×	×	0
	Sub score	5	4	4	4	4	4	4	3	36
Place-based relationships										
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
45	Historic connection to place	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	×	×	×	×	×	×	×	✓	1
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
48	Indigenous materials	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	✓	✓	✓	✓	✓	✓	✓	×	8
	Sub score	3	3	3	3	3	3	3	3	27
Human-nature relationships										
50	Prospect and refuge	✓	×	×	×	×	×	×	×	1
51	Order and complexity	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	0
	Sub score	1	0	0	0	0	0	0	0	1
	Total score	18	16	16	16	16	16	16	19	149
										16.55

In preschool settings, a sink serves as a water supply, but water can also be a biophilic element like a fountain or aquarium (McGee, 2012).

## ***2. Daveen preschool***

Daveen preschool is one of the typical public preschools in Duhok City, and it is located within a residential area. It accommodates 245 children and consists of six classrooms, a multipurpose hall, a cafeteria, and corridors. It is located in a residential area.

### **2.1 Multipurpose Hall**

The multipurpose hall is a space that is separated from the other components of the preschool by the garden (Figure 10). Direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, views, and vistas) were found in the space. A lot of toys can be seen in the space, as well as small chairs for sitting with various colors and animal representations. Bounded space, sensory diversity, information abundance, and integration of parts into wholes were introduced to this space, whereas the majority of biophilic characteristics relating to natural shapes and forms were missing. Through the space's windows, natural, filtered, and scattered light and shadow features are offered, along with artificial light. There were characteristics of spaciousness throughout the area. Links between geography, culture, and ecology, as well as landscape features and landscape orientation, were discovered in the space. The human–nature relationship element was not present. This space scored 16 of the biophilic attributes, which was lower than the average as shown in Table 4.



Figure 10.

*Multipurpose Hall of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

## 2.2 Cafeteria

The cafeteria is located in a central location, connecting two wings of the classrooms. Direct environmental features (i.e., air, sunlight) and indirect features (i.e., water, color, views, and vistas) were found in the analyzed space. A lot of toys could be seen in space, with animal representations and paintings with botanical motifs hanging on the walls. The cafeteria had several design features, including egg, oval, and tube shapes, as well as tree and columnar supports. Sensory diversity, information abundance, and integration of parts into wholes were added to the space. Linked series and chains were offered for cafeteria. Through the space's windows, natural, dispersed, and filtered light and shadow attributes can be observed together with artificial light. Furthermore, the cafeteria added light in shape and form and a central focal point to the space through the skylight. The space exhibited spatial variability through zones of activity. Geographic and cultural connections to place, landscape orientation, and landscape features were found in all spaces. The human-nature relationship element was not present in space. This space scored 21 of the biophilic attributes, which was higher than the average as shown in Table 4.

Figure 11.

*Cafeteria of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*

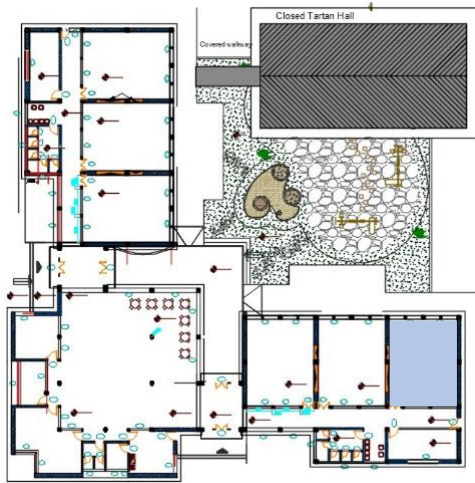


### 2.3 Classrooms

Six classrooms are distributed in the form of two wings in which the educational activities for children are practiced; see Figures 12, 13, 14, 15, 16, and 17. Direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, views, and vistas) were found in the analyzed spaces. The spaces had paintings and posters with botanical motifs hanging on the walls, as well as animal representations. Bounded space was also included, along with sensory diversity, information abundance, and integration of parts into wholes. Through the windows, there is artificial light as well as natural, scattered, and filtered light and shadow attributes. The classroom spaces were divided into two distinct areas: one area used chairs and tables, and the other area used pads stuffed for sitting or activities. Spaciousness features were found in the space and exhibited the spatial variability feature through zones of activity. Geographic and cultural connections to place, landscape orientation, and landscape features were found in all spaces. The human-nature relationship element was not present in all spaces. Generally, the classrooms scored 17 a little higher than the average for the biophilic features in the matrix (Table 4).

Figure 12.

*Classroom 1 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



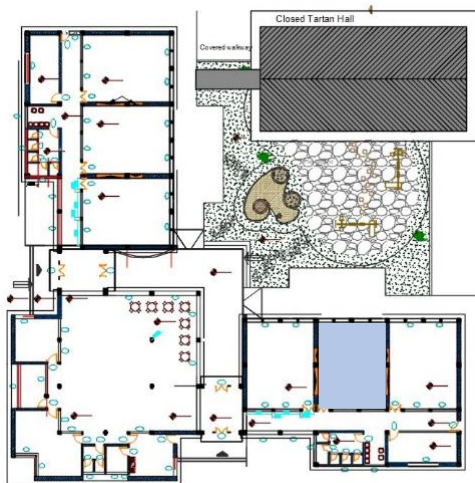
(a)



(b)

Figure 13.

*Classroom 2 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



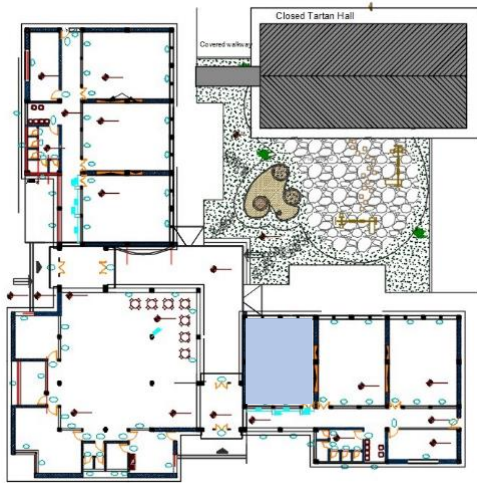
(a)



(b)

Figure 14.

*Classroom 3 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



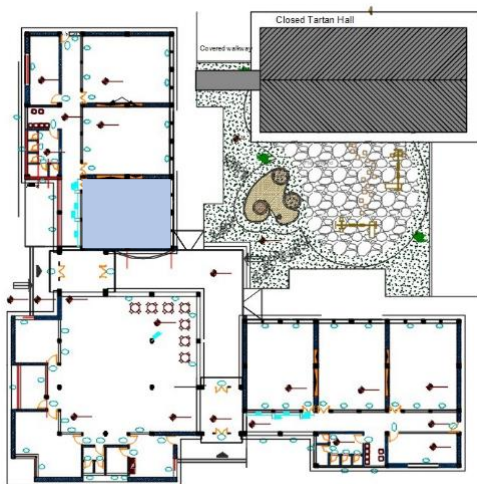
(a)



(b)

Figure 15.

*Classroom 4 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



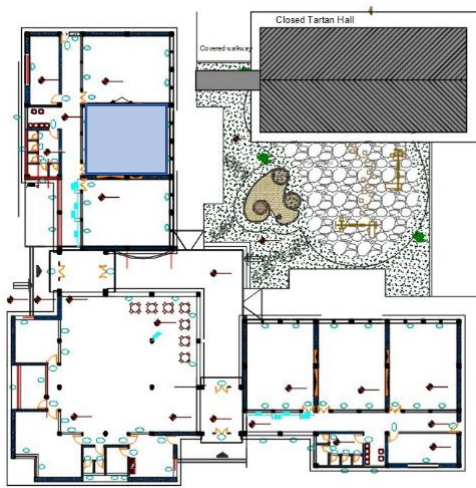
(a)



(b)

Figure 16.

*Classroom 5 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



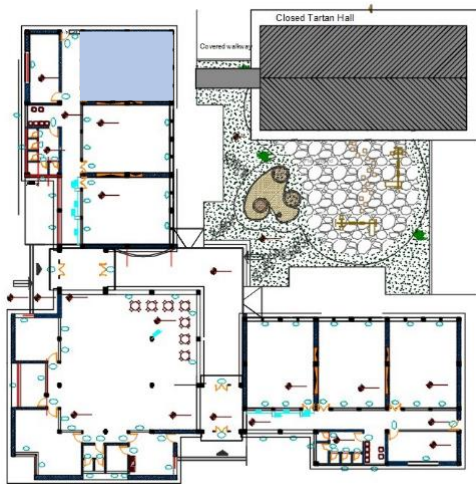
(a)



(b)

Figure 17.

*Classroom 6 of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



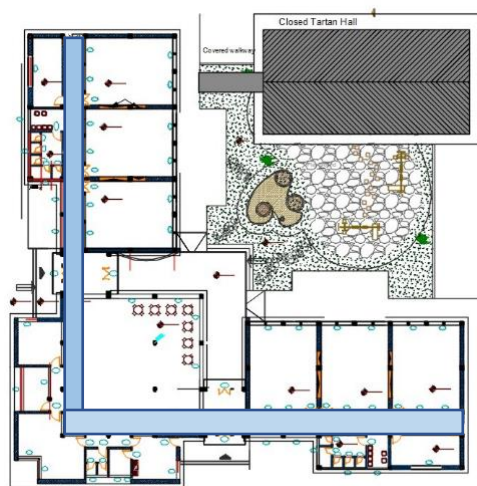
(b)

## 2.4 Corridors

Corridors are transitional spaces that provide access between spaces and end with operable windows and doors that allow access to the outdoor view of the garden (Figure 18). Direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, views, and vistas) were found in the analyzed space. Only plant themes and animal depictions could be observed in the area; most of the natural shapes and forms were missing. The addition of sensory diversity, information abundance, and part-to-whole integration. For the space, linked series, chains, and transitional space features were available. Through the windows, natural, filtered, and scattered light and shadow features are provided together with artificial light. Inside-outside space could be seen in corridors that connect the inside spaces to the outside spaces. Geographic and cultural connections to place, landscape orientation, and landscape features were found in all spaces. The human-nature relationship element was not present in corridors. Generally, the space scored 17 a little higher than the average for the biophilic features in the matrix (Table 4).

Figure 18.

*Corridors of Daveen Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)



Table 4 (Continued).										
33	Filtered and diffused light	✓	✓	✓	✓	✓	✓	✓	✓	9
34	Light and shadow	✓	✓	✓	✓	✓	✓	✓	✓	9
35	Reflected light	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	✓	×	×	×	×	×	×	1
39	Spaciousness	✓	×	✓	✓	✓	✓	✓	×	7
40	Spatial variability	×	✓	✓	✓	✓	✓	✓	×	7
41	Space as shape and form	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	×	×	×	×	×	×	✓	1
Sub score		4	5	5	5	5	5	5	5	43
Place-based relationships										
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
45	Historic connection to place	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	✓	×	×	×	×	×	×	×	1
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
48	Indigenous materials	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	✓	✓	✓	✓	✓	✓	✓	✓	9
Sub score		4	3	3	3	3	3	3	3	28
Human-nature relationships										
50	Prospect and refuge	×	×	×	×	×	×	×	×	0
51	Order and complexity	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	0
Sub score		0	0	0	0	0	0	0	0	0
Total score		16	21	17	17	17	17	17	17	156
17.33										

### 3. Avro city preschool

One of the private preschools is located within an apartment complex and accommodates 170 children. Included 11 classrooms, a cafeteria, and a courtyard distributed over two floors.

#### 3.1 Classrooms

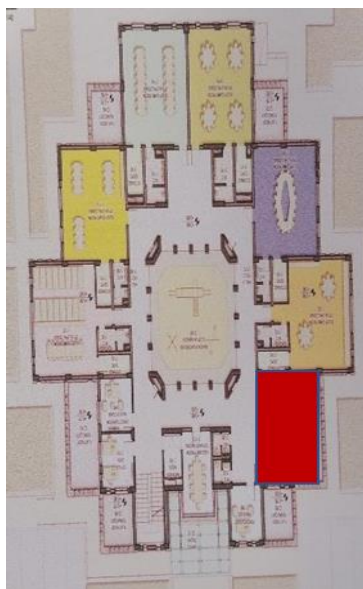
The 11 classrooms are distributed over two floors (five on the ground level and six on the first level), as shown in Figures 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, and 30. The classrooms at Avrocity preschool were mostly smaller than those in the other preschools. These spaces could offer more direct and indirect biophilic variety through operable windows that provide sunlight, natural ventilation, and a view of the natural features. The spaces added water (a sink) and a variety of colors as environmental features. While the height of the windows prevents kids from seeing the natural features of the outdoor environment. A lot of photos or posters hanging on the walls could be seen in the spaces, with animal representations like fish or botanical motifs,



shells, and spirals as natural shapes and forms. These artworks were high and difficult for the children to view, touch, or reach. Classroom tables and/or furniture that deviates from straight lines, such as arches, are employed as natural shapes and forms. A variety of open and closed storage added complementary contrast features. Sensory variability/ information richness are achieved through visual senses such as natural colors, auditory senses (music), and the sense of touch. Integrations of parts to wholes can be seen through the ceiling that divided into parts that connected together to form the whole. As well as bounded space features, these were found in classrooms. Natural light (through windows) added to the visual interest of the space. Filtered light modulated by daylight reduces glare by using blinds, light, and shadow, which are accompanied by artificial light. Geographic, ecological, and cultural connections to place features were found in these spaces. A prospect and refuge feature provided by an open small space separated from the classroom was one of the features of the human-nature relationship. All classrooms indicated 20 scores, which is higher than the overall average of the biophilic design matrix (Table 5).

Figure 19.

*Classroom 1 of Avrocity Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 20.

*Classroom 2 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 21.

*Classroom 3 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 22.

*Classroom 4 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

### 3.2 Cafeteria

The cafeteria is the place where children have their daily meals. Direct environmental features (i.e., air, sunlight) and indirect features (i.e., water, color, views, and vistas) were found in the analyzed space. The absence of the natural shapes and forms only limited their presence to the botanical motifs. Sensory variability/information richness are achieved through visual senses such as natural colors, auditory senses (music), and the sense of touch. Integrations of parts into wholes can be seen through the ceiling, which was divided into parts that connected together to form the whole, bounded spaces were added to the area. Natural, filtered, and diffused light and shadow attributes are provided through the windows in the space, and they are accompanied by artificial light. Geographic, ecological, and cultural connections to place features were found in the space. The human-nature relationship element was not present in space. This space scored 15 of the biophilic attributes, which was lower than the average as shown in Table 5.

Figure 23.

*Cafeteria of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 24.

*Classroom 5 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 25.

*Classroom 6 of Avrocity Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 26.

*Classroom 7 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 27.

*Classroom 8 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 28.

*Classroom 9 of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)

Figure 29.

*Classroom 10 of Avrocity Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



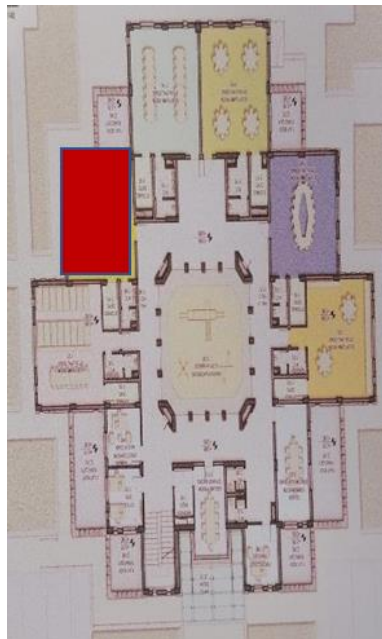
(a)



(b)

Figure 30.

*Classroom 11 of Avrocity Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

### 3.3 Courtyard

The courtyard space is shown as the central location of the preschool in Figure 31. In contrast to other spaces, the courtyard has environmental features like color, air, and light but not water or views of the outdoors. Children are drawn to vibrant, natural hues that resemble flowers; the courtyard's walls are painted with rainbows, blue sky, the sun, fish, water, and balloons. Sensory variability, information richness, and integration of parts into wholes were added to the space; linked series and chains; and bounded spaces were added to the area. Natural, filtered, and diffused light and shadow attributes are provided through the windows and the skylight. Through the skylight, the variation in height, and the balcony on the first floor overlooking the area, the courtyard contributed to multiple features, including light as shape and form, spaciousness, a central focal point, spatial diversity, and inside and outside spaces. Geographic, ecological, and cultural connections to place features were found in the space. The human-nature relationship element was not present in space. The space indicated 18 scores higher than the overall average of the biophilic design matrix (Table 5).

Figure 31.

*Courtyard of Avrocity preschool: (a) Plan drawing from the directorate of the preschool; (b) Photo by the author*



(a)



(b)





Table 5 (Continued).															
29	Dynamic balance and tension	×	×	×	×	×	×	×	×	×	×	×	×	0	
30	Fractals	×	×	×	×	×	×	×	×	×	×	×	×	0	
31	Hierarchically organized ratios & scales	×	×	×	×	×	×	×	×	×	×	×	×	0	
	Sub score	4	4	4	4	3	4	4	4	4	4	4	4	5	52
Light and space															
32	Natural light	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
33	Filtered and diffused light	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	12
34	Light and shadow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
35	Reflected light	×	×	×	×	×	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	×	×	×	×	×	×	×	×	×	×	×	✓	1
39	Spaciousness	×	×	×	×	×	×	×	×	×	×	×	×	✓	1
40	Spatial variability	×	×	×	×	×	×	×	×	×	×	×	×	✓	1
41	Space as shape and form	×	×	×	×	×	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	×	×	×	×	×	×	×	×	×	×	×	✓	1
	Sub score	3	3	3	3	3	3	3	3	3	3	3	3	6	42
Place-based relationships															
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
45	Historic connection to place	×	×	×	×	×	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13
48	Indigenous materials	×	×	×	×	×	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	×	×	×	×	×	×	×	×	×	×	×	×	×	0
	Sub score	3	3	3	3	3	3	3	3	3	3	3	3	3	39
Human-nature relationships															
50	Prospect and refuge	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	×	11
51	Order and complexity	×	×	×	×	×	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	×	×	×	×	×	0
	Sub score	1	1	1	1	0	1	1	1	1	1	1	1	0	11
	Total score	20	20	20	20	15	20	20	18	20	20	18	20	18	249

#### ***4. Zary land Preschool***

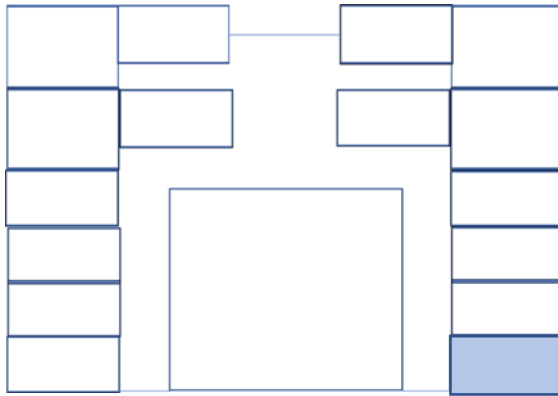
Another private preschool located within an apartment complex and accommodates 450 children. Included seven classrooms, a playroom, a cafeteria, and corridors.

##### **4.1 Classrooms**

The classrooms were the smallest compared to the classrooms of all other preschools. They include chairs and tables, a whiteboard on the wall, and some open and closed storage, some of which is high and not appropriate for children to use. Storage, particularly floor-level storage that children could access, was another frequent necessity. The incorporation of direct biophilic features (i.e., sunlight, air) and indirect features (i.e., views, color) was added to these spaces (Figures 23, 33, 34, 35, 38, 39, and 40). In the classrooms, wall-mounted posters, artwork, and small toys were used. These added biophilic features, including botanical motifs, animals, shells, and spirals, but they were too high and challenging for the kids to reach, view, or touch. Sensory variability/information richness, integration of parts into wholes, and bounded space features were found in these areas. Natural light (through windows), light that has been filtered and diffused (blinds), and shadow, accompanied by artificial light features, were provided in the classrooms. Geographic and cultural connections to places were found in these areas. The lack of human-nature relationships in these spaces. Some classrooms indicated 13 or 14 scores, which are lower than the overall average of the biophilic design matrix (Table 6).

Figure 32.

*Classroom 1 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



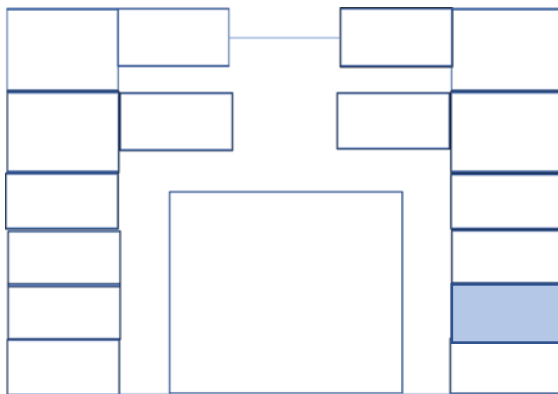
(a)



(b)

Figure 33.

*Classroom 2 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



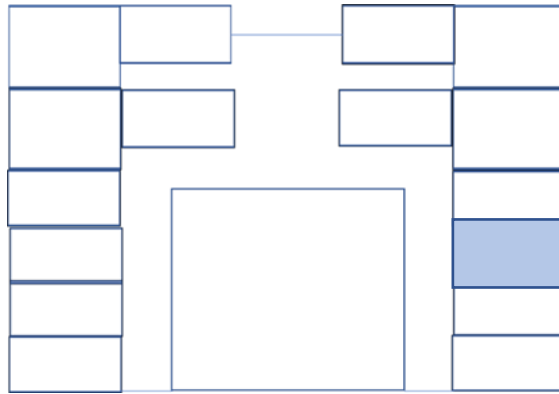
(a)



(b)

Figure 34.

*Classroom 3 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



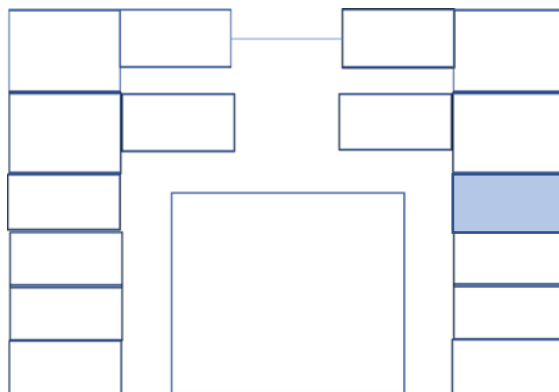
(a)



(b)

Figure 35.

*Classroom 4 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

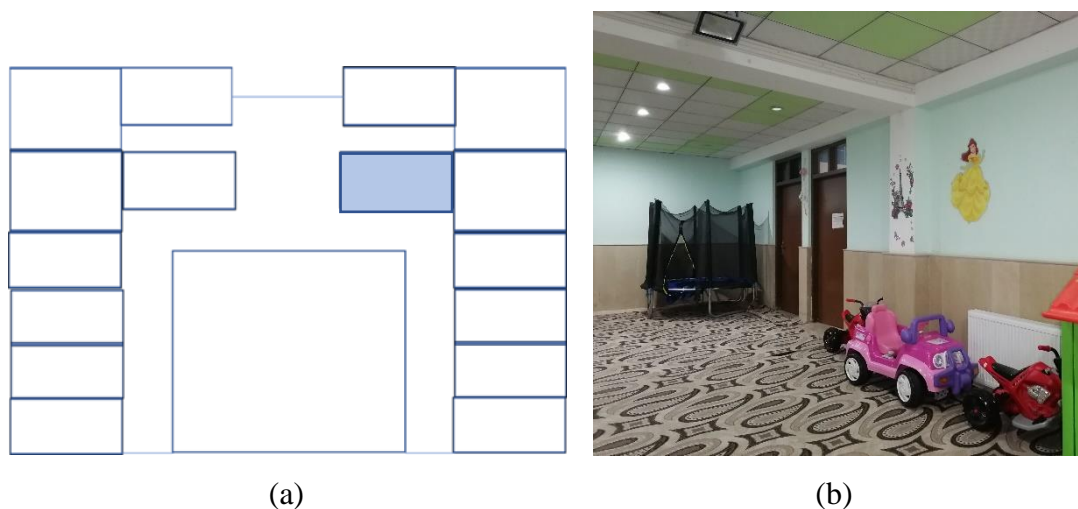
#### 4.2 Playroom

The incorporation of the environmental features in the playroom was missing except for the indirect feature (color) since it lacked windows. Therefore, the playroom is the worst space that can be found due to its small size without windows and the absence of natural light, air, and views (Figure 36). Animal paintings were displayed in

the playroom in their natural forms and shapes. The area exhibits bounded space, part-to-whole integration, sensory diversity, and information abundance. The playroom indicated 8 scores, which are the lowest level in the matrix (Table 6).

Figure 36.

*Playroom of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*

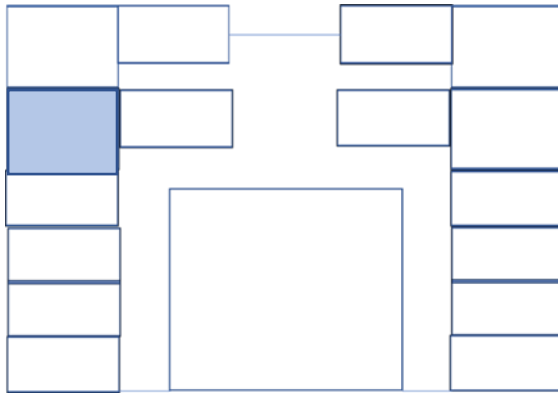


### 4.3 Cafeteria

A cafeteria is a place where daily meals are offered. The space provided indirect biophilic features such as water (a sink), windows (sunlight), ventilation (natural air), and natural views for vegetation. Various colors are present in the furniture, walls, floor, and ceiling (Figure 37). The children found it challenging to reach, see, and touch the wall-mounted posters, toys, and artwork that included natural shapes and forms like shells and spirals and botanical motifs. Sensory variability/information richness, integration of parts into wholes, and bounded space features were found. Natural light, filtered, diffused, and shadow through the operable windows. Geographic and cultural connections to places were found in these areas. The lack of human-nature relationships in these spaces. The cafeteria indicated 14 scores, which is lower than the overall average of the biophilic design matrix (Table 6).

Figure 37.

*Cafeteria of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



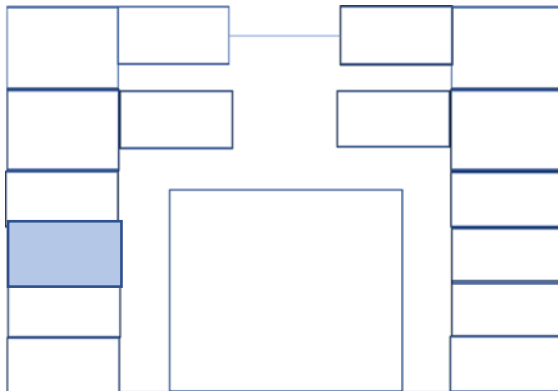
(a)



(b)

Figure 38.

*Classroom 5 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 39.

*Classroom 6 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*

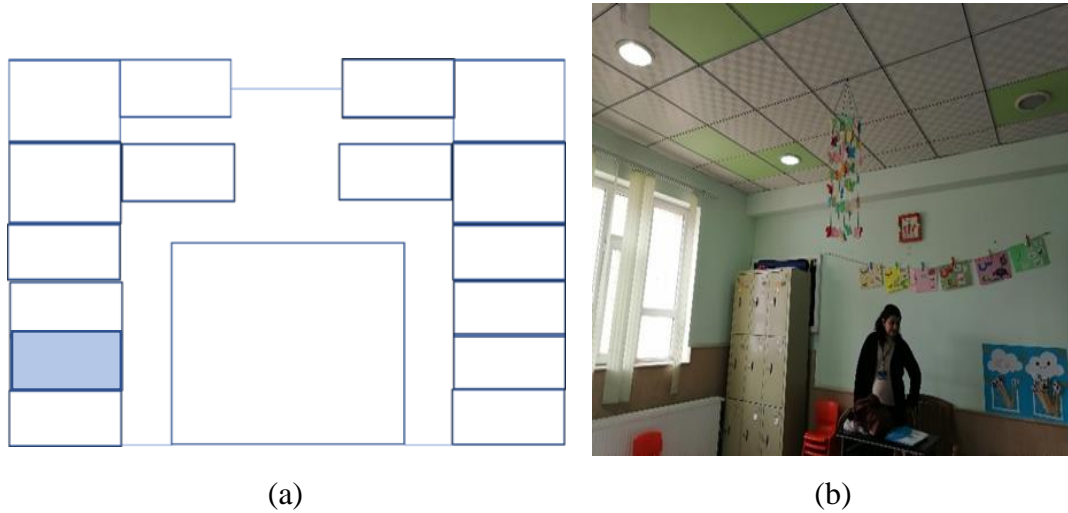
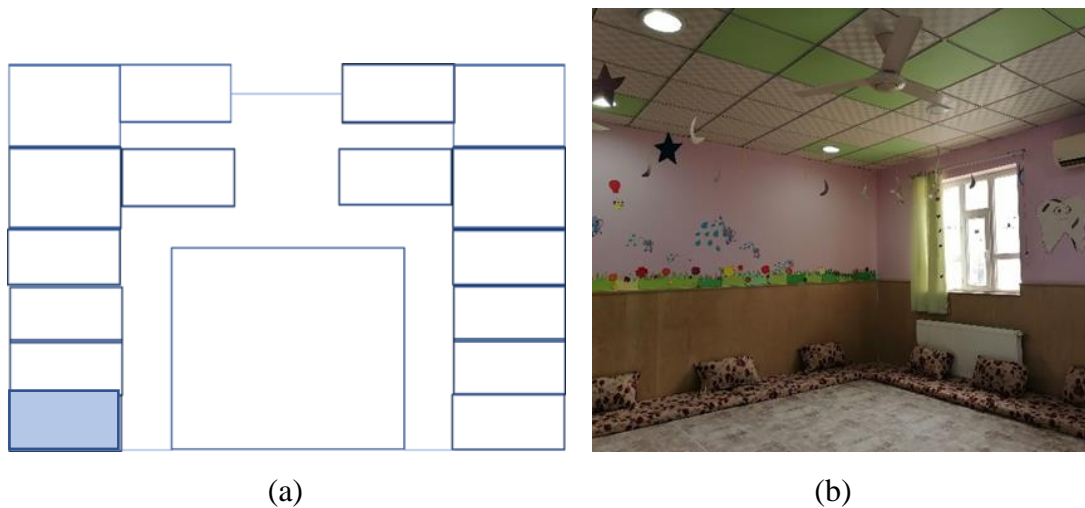


Figure 40.

*Classroom 7 of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



#### 4.4 Corridors

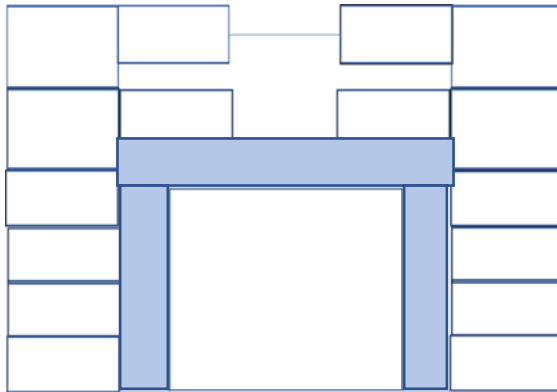
Corridors are transitional areas that connect spaces (Figure 41), with a variety of colors, wall-mounted posters, artwork, and small toys adding environmental features. These added biophilic features, including botanical motifs, animals, shells, and spirals. Sensory variability/information richness, integration of parts to wholes, bounded space,



and linked series and chains are features found in the space. The space was lit by natural light, filtered and scattered light, and light and shadow. Geographic and cultural connections are found, but human-nature relationships are lacking. The corridors scored 12, which is lower than the biophilic design matrix's overall average (Table 6).

Figure 41.

*Corridors of Zaryland Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Table 6.

*Biophilic Interior Design Matrix of Zary Land Preschool Interiors*

Zaryland preschool		Classroom 1	Classroom 2	Classroom 3	Classroom 4	Play room	Cafeteria	Classroom 5	Classroom 6	Classroom 7	Corridors	Total scores
<b>Environmental features</b>												
1	Color	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
2	Water	×	×	×	×	×	✓	×	×	×	×	1
3	Air	✓	✓	✓	✓	×	✓	✓	✓	✓	×	8
4	Sunlight	✓	✓	✓	✓	×	✓	✓	✓	✓	×	8
5	Plants	×	×	×	×	×	×	×	×	×	×	0
6	Animals	×	×	×	×	×	×	×	×	×	×	0
7	Natural material	×	×	×	×	×	×	×	×	×	×	0
8	Views and vistas	✓	✓	✓	✓	×	✓	✓	✓	✓	×	8
9	Fire	×	×	×	×	×	×	×	×	×	×	0
Sub score		4	4	4	4	1	5	4	4	4	1	35
<b>Natural shapes and forms</b>												
10	Botanical motifs	✓	×	✓	×	×	✓	✓	✓	✓	✓	7
11	Tree & columnar supports	×	×	×	×	×	×	×	×	×	×	0
12	Animal	×	×	×	✓	✓	×	✓	×	✓	×	4
13	Shells & spirals (invertebrates)	×	✓	✓	×	×	×	×	✓	×	×	3
14	Egg, oval, and tubular forms	×	×	×	×	×	×	×	×	×	×	0
15	Arches, vaults, domes	×	×	×	×	×	×	×	×	×	×	0
16	Shapes resisting straight lines	×	×	×	×	×	×	×	×	×	×	0
17	Simulation of natural features/ biomorphy	×	×	×	×	×	×	×	×	×	×	0
18	Geomorphology	×	×	×	×	×	×	×	×	×	×	0
19	Biomimicry	×	×	×	×	×	×	×	×	×	×	0
Sub score		1	1	2	1	1	1	2	2	2	1	14
<b>Natural patterns and processes</b>												
20	Sensory variability/ Information richness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
21	Age, change, the patina of time	×	×	×	×	×	×	×	×	×	×	0
22	Central focal point	×	×	×	×	×	×	×	×	×	×	0
23	Patterned wholes	×	×	×	×	×	×	×	×	×	×	0
24	Bounded spaces	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
25	Transitional spaces	×	×	×	×	×	×	×	×	×	✓	1
26	Linked series and chains	×	×	×	×	×	×	×	×	×	✓	1
27	Integrations of parts to wholes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
28	Complementary contrasts	×	×	×	×	×	×	×	×	×	×	0
29	Dynamic balance and tension	×	×	×	×	×	×	×	×	×	×	0
30	Fractals	×	×	×	×	×	×	×	×	×	×	0
31	Hierarchically organized ratios & scales	×	×	×	×	×	×	×	×	×	×	0
Sub score		3	3	3	3	3	3	3	3	3	5	32
<b>Light and space</b>												
32	Natural light	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	9
33	Filtered and diffused light	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	9
34	Light and shadow	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	9

Table 6 (Continued).											
35	Reflected light	×	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	×	×	×	×	×	×	×	×	0
39	Spaciousness	×	×	×	×	×	×	×	×	×	0
40	Spatial variability	×	×	×	×	×	×	×	×	×	0
41	Space as shape and form	×	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	×	×	×	×	×	×	×	×	0
	Sub score	3	3	3	3	0	3	3	3	3	27
Place-based relationships											
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
45	Historic connection to place	×	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	×	×	×	×	×	×	×	×	×	0
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	✓	10
48	Indigenous materials	×	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	×	×	×	×	×	×	×	×	×	0
	Sub score	2	2	2	2	2	2	2	2	2	20
Human-nature relationships											
50	Prospect and refuge	×	×	×	×	✓	×	×	×	×	1
51	Order and complexity	×	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	×	0
	Sub score	0	0	0	0	1	0	0	0	0	1
	Total score	13	13	14	13	8	14	14	14	14	129
											12.9

## 5. *Kapir Preschool*

A typical public preschool located within a residential area and accommodates 330 children. Included five classrooms, a multipurpose hall, a cafeteria, and corridors.

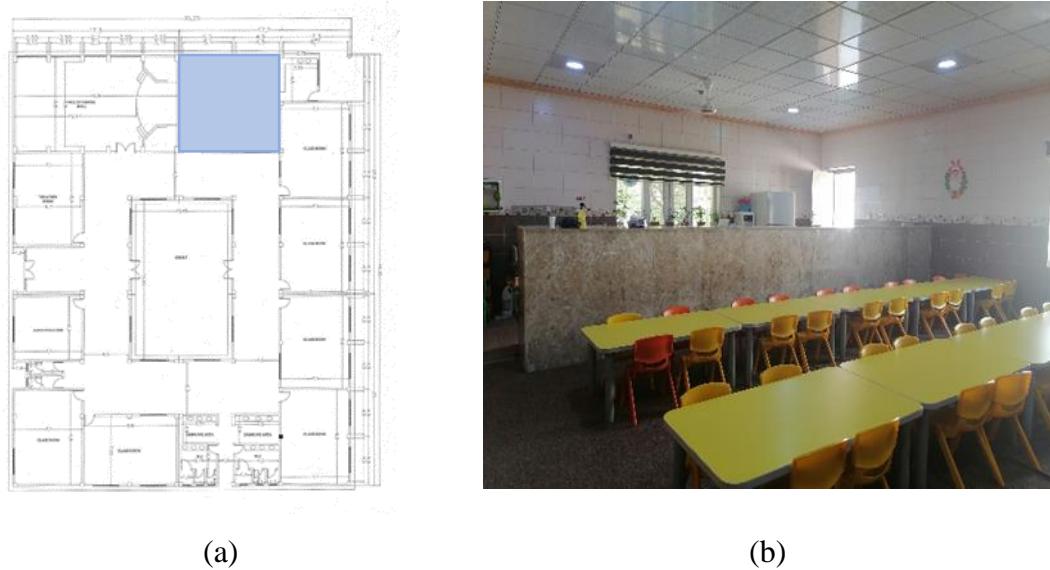
### 5.1 Cafeteria

The space added some indirect biophilic features, such as color, water (a sink), and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). The presence of natural materials added to the space. Botanical motifs were found in the cafeteria. Sensory variability/information richness, integration of parts into wholes, and bounded space features could be found. Through the windows, natural, filtered, and diffused light, as well as light and shadow features, were provided, along with artificial lighting in all places. The windows have curtains in order to control the light, but the height of the windows restricts children from viewing the natural views (Figure 42). The space offers geographic and cultural connections to places and landscape features. The lack of human-nature relationships

in the cafeteria. The space recorded a 17 score, which is higher than the overall average of the biophilic design matrix (Table 7).

Figure 42.

*Cafeteria of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*

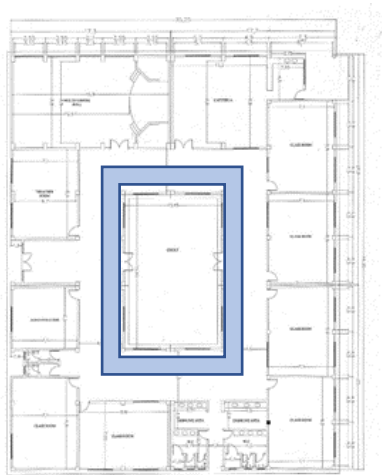


## 5.2 Corridors

Corridors are transitional spaces that provide access between spaces (Figure 43). The space added some indirect biophilic features, such as color and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). Moveable door that allows access to the outdoors (fresh air). Botanical motifs were found in the space. Sensory variability/ information richness are achieved through visual senses as natural colors and smell senses as near outdoor gardens. Integrations of parts into wholes can be seen in the ceiling, connected series, and chains, transitional spaces. The windows provided both natural and artificial lighting in the corridors, as well as dispersed and filtered light and light and shadow effects. The space offers geographic and cultural connections to the places. The lack of human-nature relationships in the cafeteria. The space recorded a 15 score, which is lower than the overall average of the biophilic design matrix (Table 7).

Figure 43.

*Corridors of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

### 5.3 Multipurpose Hall

The multipurpose hall used for social activities for children included a stage, toys, chairs, and a TV screen. The walls were covered with wood, a natural material. The space added some indirect biophilic features, such as color and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). The presence of natural materials (walls were covered with wood) added to the space (Figure 44). The space lacks any natural forms or shapes. The area was characterized by sensory variety and information abundance that were produced through the senses of sight (natural colors), hearing (music), and touch. A stage in the multipurpose hall provided a sense of isolation from the main area and a sense of connection between nature and humans through its prospect and refuge attributes. It also offered a central focal point for the space. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole, and bounded space features were found in the space. The space offered natural light (through windows), light that has been diffused and filtered (blinds), light and shadow, and artificial light. The large space of the hall creates a sense of spaciousness. The space offered geographic and cultural connections to places and landscape features. This space scored 17 of the biophilic attributes, which was higher than the average as shown in Table 7.

Figure 44.

*Multipurpose hall of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



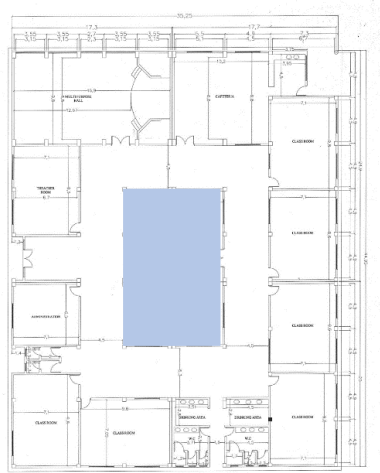
(b)

#### 5.4 Playroom

The central space in the preschool is used as a playroom, offering a variety of biophilic features. The space added some indirect biophilic features, such as color and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). The space lacks any natural forms or shapes and has characteristics of a bounded space: sensory variety, information abundance, and integration of parts into wholes. Figure 45). Through the windows, the space received artificial lighting as well as natural light that was filtered and dispersed and created shadow effects. The high ceiling added spatial variety to the space. The space offered geographic and cultural connections to the place's features. Some toys provide an impression of isolation from the entire play area as well as a chance to watch what is occurring in different spaces of the room. The playroom scored 14 of the biophilic attributes, which was lower than the average as shown in Table 7.

Figure 45.

*Playroom of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



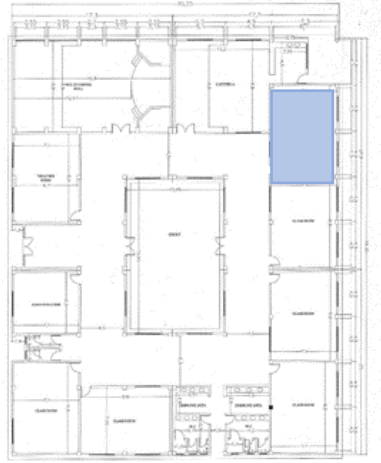
(b)

## 5.5 Classrooms

The classrooms added some indirect biophilic features, such as color and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). Botanical motif features and animal representations were found in the classrooms. Sensory variability/information richness, integration of parts into wholes, and bounded space features could be found in the space (Figures 46, 47, 48, 49, and 50). Natural light (through windows), diffused and filtered light (blinds), and light and shadow accompanied by artificial lighting. The space is connected geographically to the adjacent mountains, which offer place-based relationships. As well, the space offered cultural connections to places and landscape features. The classrooms scored 15 points below average because the limited features included in the human-nature relationships element were not present in these spaces (Table 7).

Figure 46.

*Classroom 1 of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)

Figure 47.

*Classroom 2 of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)

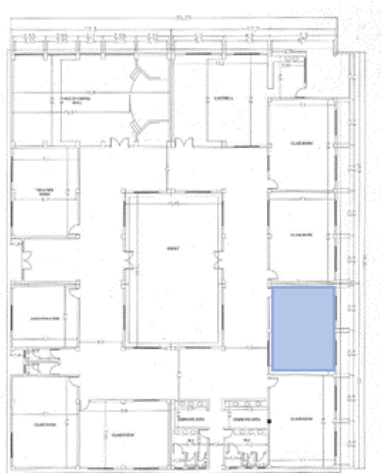


(b)



Figure 48.

*Classroom 3 of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



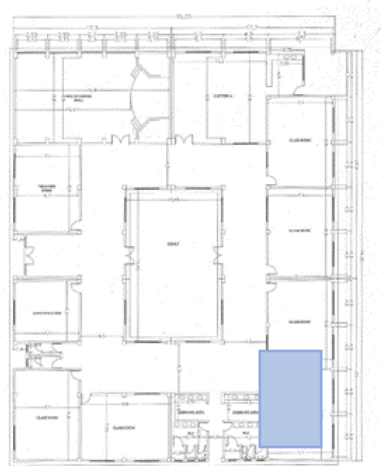
(a)



(b)

Figure 49.

*Classroom 4 of Kapir Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)



Table 7 (Continued).										
16	Shapes resisting straight lines	×	×	×	×	×	×	×	×	0
17	Simulation of natural features/ biomorphy	×	×	×	×	×	×	×	×	0
18	Geomorphology	×	×	×	×	×	×	×	×	0
19	Biomimicry	×	×	×	×	×	×	×	×	0
	Sub score	1	1	0	0	2	2	2	2	12
Natural patterns and processes										
20	Sensory variability/ Information richness	✓	✓	✓	✓	✓	✓	✓	✓	9
21	Age, change, the patina of time	×	×	×	×	×	×	×	×	0
22	Central focal point	×	×	✓	×	×	×	×	×	1
23	Patterned wholes	×	×	×	×	×	×	×	×	0
24	Bounded spaces	✓	✓	✓	✓	✓	✓	✓	✓	9
25	Transitional spaces	×	✓	×	×	×	×	×	×	1
26	Linked series and chains	×	✓	×	×	×	×	×	×	1
27	Integrations of parts to wholes	✓	✓	✓	✓	✓	✓	✓	✓	9
28	Complementary contrasts	×	×	×	×	×	×	×	×	0
29	Dynamic balance and tension	×	×	×	×	×	×	×	×	0
30	Fractals	×	×	×	×	×	×	×	×	0
31	Hierarchically organized ratios & scales	×	×	×	×	×	×	×	×	0
	Sub score	3	5	4	3	3	3	3	3	30
Light and space										
32	Natural light	✓	✓	✓	✓	✓	✓	✓	✓	9
33	Filtered and diffused light	✓	✓	✓	✓	✓	✓	✓	✓	9
34	Light and shadow	✓	✓	✓	✓	✓	✓	✓	✓	9
35	Reflected light	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	×	×	×	×	×	×	×	0
39	Spaciousness	×	×	✓	×	×	×	×	×	1
40	Spatial variability	×	×	×	✓	×	×	×	×	1
41	Space as shape and form	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	×	×	×	×	×	×	×	0
	Sub score	3	3	4	4	3	3	3	3	29
Place-based relationships										
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
45	Historic connection to place	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	×	×	×	×	×	×	×	×	0
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
48	Indigenous materials	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	✓	×	✓	×	✓	✓	✓	✓	7
	Sub score	3	2	3	2	3	3	3	3	25
Human-nature relationships										
50	Prospect and refuge	×	×	✓	✓	×	×	×	×	2
51	Order and complexity	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	0
	Sub score	0	0	1	1	0	0	0	0	2
	Total score	17	15	17	14	15	15	15	15	138

## 6. *Chiman Preschool*

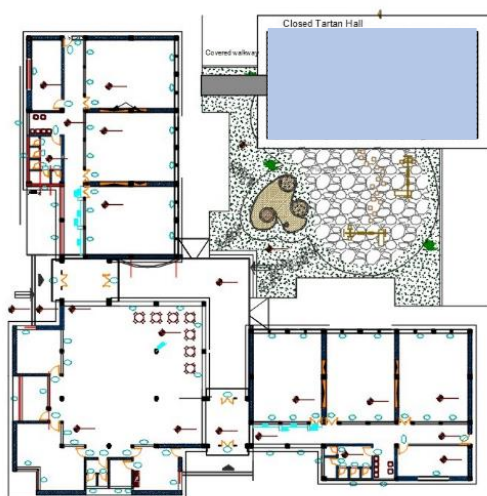
A typical public preschool located near the city center and accommodates 245 children. Included six classrooms, a multipurpose hall, a cafeteria, and corridors.

### 6.1 Multipurpose Hall

The multipurpose hall is a space that is isolated from the other spaces by the garden (Figure 51). Direct environmental features (i.e., air and sunlight) and indirect features (i.e., color, views, and vistas) were found in the space. A lot of toys can be seen in the space, as well as small chairs for sitting with various colors and animal representations. While most of the biophilic features related to natural shapes and forms were absent in this space. Sensory variability/ information richness are achieved through visual senses such as natural colors, auditory senses (music), and the sense of touch. Integrations of parts into wholes can be seen through the ceiling that divided into parts that connected together to form the whole. A spacious feature and bounded space were also present, and the windows in the space let in artificial light along with natural, dispersed, and filtered light and shadow features. Geographic, cultural, and ecological linkages to place, landscape features, and landscape orientation were found in the space. The human-nature relationship element was not present. As seen in Table 8, this space had a slightly below-average score of 16 on the biophilic features.

Figure 51.

*Multipurpose Hall of Chiman Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



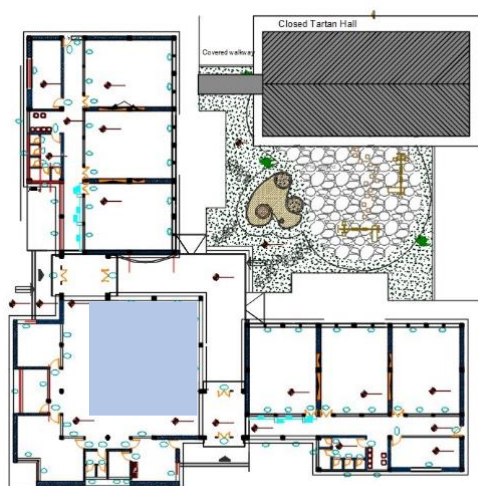
(b)

## 6.2 Cafeteria

Direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, water, views, and vistas) were observed in the cafeteria. The space offered botanical motifs and animal representations through paintings and posters mounted on the walls. The cafeteria had several design features, including egg, oval, and tube shapes, as well as tree and columnar supports. Sensory variability/information richness, integration of parts into wholes, and Links and chains were found. Natural, diffused and filtered, light, as well as shadow attributes, are provided through the windows, accompanied by artificial light. Furthermore, the cafeteria adds light as shape and form and a central focal point feature through the skylight, and attributes of both spatial variability and inside/outside spaces were found in the cafeteria as well (Figure 52). Spacious features were also found in the cafeteria. Geographic and cultural connections to places were found in the space. While lacking human-nature relationships. Table 8 shows that across all preschool settings, the cafeteria had the highest rating of 22.

Figure 52.

*Cafeteria of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



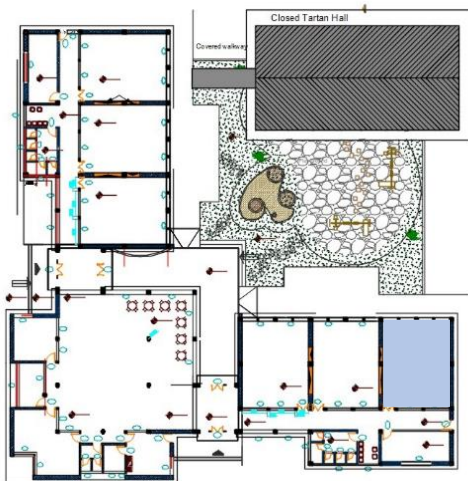
(b)

### 6.3 Classrooms

Direct environmental features (i.e., air and sunlight) and indirect features (i.e., color, views, and vistas) were observed in all spaces Figures 53, 54, 55, 56, 57, and 58. The classrooms offered botanical motifs; a few classrooms included features of animal representations through paintings and posters mounted on the walls, and shells and spirals in the space. Sensory variability, information richness, and integration of parts into wholes were found in these spaces. The classrooms were provided with bounded areas. Natural, diffused and filtered, light, with light and shadow attributes, is provided through the windows in all of the spaces, accompanied by artificial light. Furthermore, spacious features were found in these spaces. Geographic and cultural connections to place, landscape orientation, and landscape features were found in the classrooms. A lack of human-nature relationships was featured. As indicated in Table 8, these areas scored 16 of the biophilic attributes, which was slightly lower than the average.

Figure 53.

*Classroom 1 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



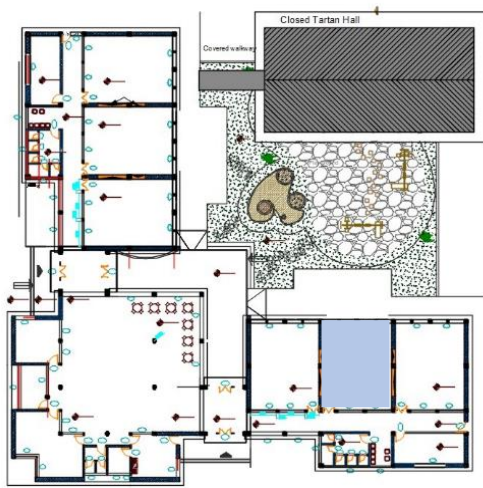
(a)



(b)

Figure 54.

*Classroom 2 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



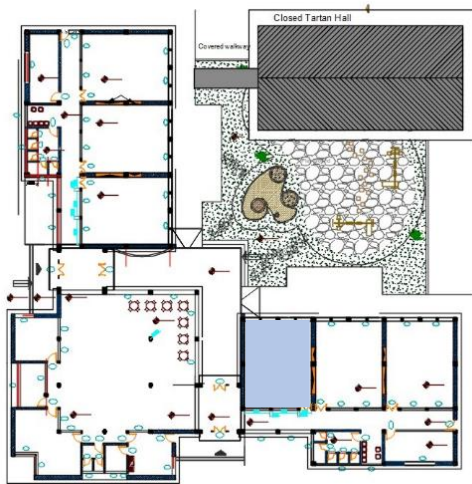
(a)



(b)

Figure 55.

*Classroom 3 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



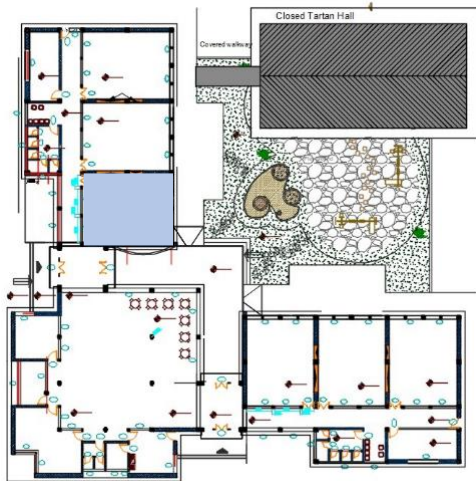
(a)



(b)

Figure 56.

*Classroom 4 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



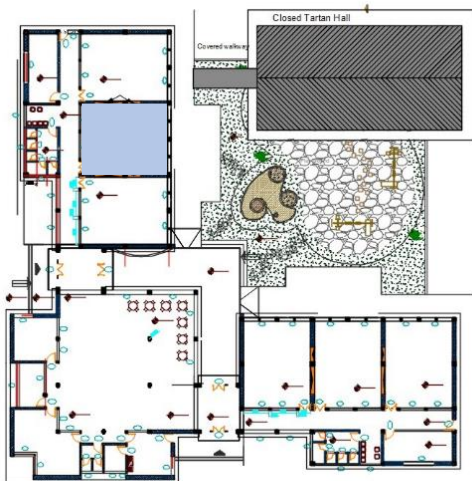
(a)



(b)

Figure 57.

*Classroom 5 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



(a)



(b)



Figure 58.

*Classroom 6 of Chimam Preschool: (a) Plan Drawing from the Directorate of the Preschool; (b) Photo by the Author*



#### 6.4 Corridors

Corridors are transitional spaces that provide access between spaces (Figure 59). Direct environmental features (i.e., air and sunlight) and indirect features (i.e., color, views, and vistas) were observed in the corridors. The use of natural shapes and forms was restricted to paintings with botanical motifs rather than other features. Sensory variability, information richness, integration of parts into wholes, and links and chains were found. Natural, filtered, and diffused light, as well as shadow attributes, are provided through the windows, accompanied by artificial light.

Furthermore, inside-outside attributes were found in the corridors. Geographic and cultural connections to place, landscape orientation, and landscape features were found in the space. A lack of human-nature relationships. As seen in Table 8, this space had a slightly below-average score of 16 on the biophilic features.



Table 8 (Continued).										
16	Shapes resisting straight lines	×	×	×	×	×	×	×	×	0
17	Simulation of natural features/ biomorphy	×	×	×	×	×	×	×	×	0
18	Geomorphology	×	×	×	×	×	×	×	×	0
19	Biomimicry	×	×	×	×	×	×	×	×	0
	Sub score	1	4	2	2	2	2	2	1	18
Natural patterns and processes										
20	Sensory variability/ Information richness	✓	✓	✓	✓	✓	✓	✓	✓	9
21	Age, change, the patina of time	×	×	×	×	×	×	×	×	0
22	Central focal point	×	✓	×	×	×	×	×	×	1
23	Patterned wholes	×	×	×	×	×	×	×	×	0
24	Bounded spaces	✓	×	✓	✓	✓	✓	✓	×	7
25	Transitional spaces	×	×	×	×	×	×	×	✓	1
26	Linked series and chains	×	✓	×	×	×	×	×	✓	2
27	Integrations of parts to wholes	✓	✓	✓	✓	✓	✓	✓	✓	9
28	Complementary contrasts	×	×	×	×	×	×	×	×	0
29	Dynamic balance and tension	×	×	×	×	×	×	×	×	0
30	Fractals	×	×	×	×	×	×	×	×	0
31	Hierarchically organized ratios & scales	×	×	×	×	×	×	×	×	0
	Sub score	3	4	3	3	3	3	3	4	29
Light and space										
32	Natural light	✓	✓	✓	✓	✓	✓	✓	✓	9
33	Filtered and diffused light	✓	✓	✓	✓	✓	✓	✓	✓	9
34	Light and shadow	✓	✓	✓	✓	✓	✓	✓	✓	9
35	Reflected light	×	×	×	×	×	×	×	×	0
36	Light pools	×	×	×	×	×	×	×	×	0
37	Warm light	×	×	×	×	×	×	×	×	0
38	Light as shape and form	×	✓	×	×	×	×	×	×	1
39	Spaciousness	✓	✓	✓	✓	✓	✓	✓	×	8
40	Spatial variability	×	✓	×	×	×	×	×	×	1
41	Space as shape and form	×	×	×	×	×	×	×	×	0
42	Spatial harmony	×	×	×	×	×	×	×	×	0
43	Inside-outside spaces	×	✓	×	×	×	×	×	✓	2
	Sub score	4	7	4	4	4	4	4	4	39
Place-based relationships										
44	Geographic connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
45	Historic connection to place	×	×	×	×	×	×	×	×	0
46	Ecological connection to place	✓	×	×	×	×	×	×	×	1
47	Cultural connection to place	✓	✓	✓	✓	✓	✓	✓	✓	9
48	Indigenous materials	×	×	×	×	×	×	×	×	0
49	Landscape orientation/ landscape features	✓	×	✓	✓	✓	✓	✓	✓	8
	Sub score	4	2	3	3	3	3	3	3	27
Human-nature relationships										
50	Prospect and refuge	×	×	×	×	×	×	×	×	0
51	Order and complexity	×	×	×	×	×	×	×	×	0
52	Curiosity and enticement	×	×	×	×	×	×	×	×	0
53	Change and metamorphosis	×	×	×	×	×	×	×	×	0
	Sub score	0	0	0	0	0	0	0	0	0
	Total score	16	22	16	16	16	16	16	16	150
										16.66



## Findings for Research Question II

The biophilic matrix of each preschool was organized into a separate table. Each table includes a set of preschool spaces distributed along the columns and a set of biophilic features distributed along the rows. Every space has subscores resulting from each existing attribute. These subscores were collected and the averages extracted to compare with one another in order to find the variances from the total average. The matrix results revealed that Avrocity preschool settings received a score of 19.15, higher than the average of the biophilic design of other preschools. The classrooms rated higher than average, while the cafeteria rated lower (Figure 60, 19, and 23). The highest scoring was indicated through environmental features (4.25), followed by natural patterns and processes (3.42), as shown in Table 9.

The next highest score of 17.33 was indicated in Daveen preschool settings through the light and space elements. The Chiman and Shang preschool spaces received scores of 16.66 and 16.55, respectively, which were nearly equal to the average of the biophilic de-sign in the matrices. Kapir preschool spaces received a score of 15.33, below the average score, and Zaryland preschool settings scored 12.9 for biophilic design see Figure 61.

The highest scoring was presented through the environmental features, while the lowest was indicated through the human–nature relationships element. The cafeteria of Chiman preschool scored the highest in biophilia. The space was large and spacious and also provided direct and indirect biophilic features like color, water, air, and views. The space offered botanical motifs, animal representations, and a tubular form of column. The height of the ceiling and the skylight provided a central focal point for the space, as well as natural light (see Figure 52), and Table 8.

The playroom in Zaryland preschool scored the lowest rating for biophilic design attributes in the matrix (Figure 36). Although it was a small space without windows, it offered the absence of fresh air, natural light, and views. There are opportunities to improve the space if some adjustments could be made, such as expanding the area or adding a window. The ceiling enlarges the room and completes the integration of its various components into a larger whole. As well as adding sensory variability and information richness through various colors, toys added visual variety to the space Table 6.

The environmental features, which included features like color that could be present in all spaces, were rated above average. This element is classified as the

organic dimension, which offers direct features (e.g., air, sunlight) and indirect features (e.g., views and vistas) that can be seen in most spaces. The highest ratings of the attributes among all elements were found in color, sensory variability, and information richness (e.g., sound from gaming devices, laptops, and TV), or various colors, which have sensory diversity, integration of parts into wholes (e.g., ceiling patterns), and geographical and cultural connections to place (e.g., near mountains, natural vegetation). The second-highest attributes were natural light and light and shadow (e.g., windows, skylights). Additionally, following in the sequence were some features such as air, sunlight, filtered and diffused light, and views and vistas that were present in most of the spaces. In contrast, the natural shapes and forms and human–nature relationships elements both displayed lower scores than the average, as indicated in Table 9. This may occasionally happen because designing a space with some direct and indirect biophilic features may be easier than incorporating another biophilic attribute, which may seem more challenging.

The features that received the lowest rankings among all elements included curiosity and enticement, order and complexity, change and metamorphosis, historic connection to place, indigenous materials, space as shape and form, reflected light, light pools, warm light, spatial harmony, patterned wholes, age, change, the patina of time, fractals, dynamic balance and tension, hierarchically organized ratios and scales, geomorphology, biomimicry, simulation of natural features, animals, and fire (fire is a common issue, particularly in preschool settings, and should be considered in safe spaces), as indicated in Table 9. None of these features were observed in any observed space. While more research may justify increasing features for safe, proper incorporation in children’s spaces, the presence of biophilia was increased and supported by design elements with multiple attributes in the children’s space. By integrating various attributes and undertaking additional research to determine their impact, this can assist in the development of future products (McGee, 2012). It has been found that biophilia’s engagement style in spaces is generally passive, whereas active engagement necessitates immersive experiences in nature.

### **Findings for Research Question III**

The final scores of the whole matrix revealed the final averages of each preschool, which indicated Avrocity as the highest among the other preschools. While Zaryland preschool revealed the lowest average, as shown in Table 9.

Table 9.

*The Biophilic Interior Design Matrices of the whole Preschools*

Biophilic Interior Design Matrix		Shang Preschool	Daveen Preschool	Avrocity Preschool	Zaryland Preschool	Kapir Preschool	Cihman Preschool	Total Scores	Average
Environmental features									
1	Color	9	9	13	10	9	9	59	
2	Water	2	1	12	1	1	1	18	
3	Air	9	9	13	8	9	9	57	
4	Sunlight	9	9	13	8	9	9	57	
5	Plants	1	0	0	0	1	0	2	
6	Animals	0	0	0	0	0	0	0	
7	Natural material	0	0	0	0	2	0	2	
8	Views and vistas	9	9	12	8	9	9	56	
9	Fire	0	0	0	0	0	0	0	
	Subscores	39	37	63	35	40	37	251	4.25
Natural shapes and forms									
10	Botanical motifs	8	8	13	7	7	8	51	
11	Tree and columnar supports	0	1	0	0	0	1	2	
12	Animal	2	9	11	4	5	6	37	
13	Shells and spirals (invertebrates)	6	0	0	3	0	2	11	
14	Egg, oval, and tubular forms	0	1	0	0	0	1	2	
15	Arches, vaults, domes	0	0	9	0	0	0	9	
16	Shapes resisting straight lines	0	0	9	0	0	0	9	
17	Simulation of natural features/ biomorphy	0	0	0	0	0	0	0	
18	Geomorphology	0	0	0	0	0	0	0	
19	Biomimicry	0	0	0	0	0	0	0	
	Subscores	16	19	42	14	12	18	121	2.05
Natural patterns and processes									
20	Sensory variability/information richness	9	9	13	10	9	9	59	
21	Age, change, the patina of time	0	0	0	0	0	0	0	
22	Central focal point	1	1	1	0	1	1	5	
23	Patterned wholes	0	0	0	0	0	0	0	
24	Bounded spaces	9	7	13	10	9	7	55	
25	Transitional spaces	1	1	0	1	1	1	5	
26	Linked series and chains	1	2	1	1	1	2	8	
27	Integrations of parts to wholes	9	9	13	10	9	9	59	
28	Complementary contrasts	0	0	11	0	0	0	11	
29	Dynamic balance and tension	0	0	0	0	0	0	0	
30	Fractals	0	0	0	0	0	0	0	
31	Hierarchically organized ratios and scales	0	0	0	0	0	0	0	
	Subscores	30	29	52	32	30	29	202	3.42
Light and space									
32	Natural light	9	9	13	9	9	9	58	
33	Filtered and diffused light	9	9	12	9	9	9	57	
34	Light and shadow	9	9	13	9	9	9	58	
35	Reflected light	0	0	0	0	0	0	0	
36	Light pools	0	0	0	0	0	0	0	
37	Warm light	0	0	0	0	0	0	0	
38	Light as shape and form	0	1	1	0	0	1	3	
39	Spaciousness	8	7	1	0	1	8	25	
40	Spatial variability	1	7	1	0	1	1	11	
41	Space as shape and form	0	0	0	0	0	0	0	
42	Spatial harmony	0	0	0	0	0	0	0	
43	Inside/outside spaces	0	1	1	0	0	2	4	
	Subscores	36	43	42	27	29	39	216	3.66

Table 9 (Continued).

Place-based relationships									
44	Geographic connection to place	9	9	13	10	9	9	59	
45	Historic connection to place	0	0	0	0	0	0	0	
46	Ecological connection to place	1	1	13	0	0	1	16	
47	Cultural connection to place	9	9	13	10	9	9	59	
48	Indigenous materials	0	0	0	0	0	0	0	
49	Landscape orientation/landscape features	8	9	0	0	7	8	32	
Subscores		27	28	39	20	25	27	166	2.81
Human–nature relationships									
50	Prospect and refuge	1	0	11	1	2	0	15	
51	Order and complexity	0	0	0	0	0	0	0	
52	Curiosity and enticement	0	0	0	0	0	0	0	
53	Change and metamorphosis	0	0	0	0	0	0	0	
Subscores		1	0	11	1	2	0	15	0.25
Total subscores		149	156	249	129	138	150	971	
Average		16.55	17.33	19.15	12.9	15.33	16.66	16.45	16.45



## CHAPTER V

### Discussion

In general in Shang preschool, as shown in Table 3, all spaces shared the presence of the same direct biophilic features (i.e., fresh air, sunlight) and indirect features (i.e., various colors, natural views for vegetation) through operable windows or doors. Additionally, the cafeteria and corridors added water (a sink) as another indirect biophilic feature. Botanical motifs, representations, or symbolic themes in paintings were found in most of the spaces, except for the multipurpose hall (Figure 2). In addition, animal representation features were found only in the multipurpose hall and corridors. Classrooms (Figure 3) added shell and spiral features to the space through the paintings on the walls. Sensory variability and information richness created through visual sense (natural colors or toys), auditory sense (music), and tactile sense of touch (natural materials) were the common features in all of the spaces. Integration of parts into wholes could be seen through the ceiling, which was divided into parts that connected together to form the whole, and bounded space features were found in all spaces. All of the spaces offered natural light (through windows), filtered and diffused light (blinds), light and shadow, and artificial lighting. The classrooms, cafeteria, and multipurpose hall offered spaciousness and a sense of openness through their large areas. The classroom spaces were divided into two distinct areas: one area used chairs and tables, and the other area used pads stuffed for sitting or activities. The spatial variability feature produced a variety of play zones, with some toys found in the multipurpose hall. Transitional spaces and linked series and chains could be found in the corridors. Through the prospect and shelter features, a stage in the multipurpose hall utilized for play or participation activities gave the idea of isolation from the main area and fostering a link between nature and humans. Furthermore, the stage offered a central focal point for the space. All of the spaces offered geographic and cultural connections to places and landscape features. The corridors and the multipurpose hall both scored higher than the average, whereas the classrooms and cafeteria were all given lower ratings than the biophilic matrix's overall average.

Generally, in Daveen preschool, direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, views, and vistas) were found in all of the analyzed spaces, while water (a sink) was found in the cafeteria as an indirect feature. A lot of toys could be seen in spaces with animal representations. Except for the

multipurpose hall, most of the spaces had paintings and posters with botanical motifs hanging on the walls. The cafeteria (Figure 11) had several features including egg, oval, and tube shapes as well as tree and columnar supports, resulting in an extremely lively space with many different design features. Sensory diversity, information abundance, and integration of parts into wholes were added to all spaces. Most of the spaces provided were bounded spaces, except for the cafeteria and corridors. Linked series and chains were offered for both corridors and cafeteria spaces, while transitional space features were found only in corridors. Outdoor access is one of the possibilities for enriching biophilic incorporation. For example, a courtyard layout can support other spaces by adding some natural themes and representational features through the visual connection. Natural, filtered, and diffused light and shadow attributes are provided through the windows in all spaces together, and they are accompanied by artificial light. Furthermore, the cafeteria added light in shape and form and a central focal point feature to the space through the skylight. Spaciousness features were found in most spaces except for the cafeteria and corridors. With the exception of the multipurpose hall and corridors, most of the spaces exhibited the spatial variability feature through zones of activities. Geographic and cultural connections to place, landscape orientation, and landscape features were found in all spaces. The human–nature relationship element was not present in all spaces. Generally, the majority of Daveen preschool settings (classrooms and corridors) scored a little higher than the average for the biophilic features in the matrix. The cafeteria had the second-highest score among all other preschool spaces, whereas the multipurpose hall scored lower than the average (Table 4).

Altogether, in Avrocity preschool all of these spaces together displayed the highest average variance of biophilic features in the matrix. Color, water, air, sunlight, views, and vistas are examples of indirect environmental features that could be found in all spaces. Nevertheless, only the courtyard space as shown in Figure 31, lacked water and views. A lot of photos or posters hanging on the walls could be seen in most spaces, with animal representations like fish or botanical motifs as natural shapes and forms. A variety of open and closed storage added complementary contrast features, and non-rectilinear desks or furniture in the classrooms added arches, vaults, domes, and shapes resisting straight lines. Sensory variability/information richness, integration of parts to wholes, and bounded space features were found in all spaces. Linked series and chains featured in courtyard spaces. Natural, filtered, and diffused

light, as well as shadow attributes, are provided through the windows, accompanied by artificial light in all spaces. Through the skylight and the variation in height, the courtyard contributed multiple features, including light as shape and form, spaciousness, spatial diversity, a central focal point, and inside and outside areas. Geographic, ecological, and cultural connections to place features were found in all spaces. A prospect and refuge feature provided by an open small space separated from the classroom was one of the features of the human–nature relationship. Although Avrocity preschool’s classrooms are generally smaller than those at Shang, Daveen, Chiman, and Kapir preschools, they are differentiated by a higher level of biophilic inclusion than those at other preschools. All of the spaces indicated were higher than the overall average of the biophilic design matrix (Table 5).

In general, in Zaryland preschool the classrooms were the smallest compared to the classrooms of all other preschools. They include chairs and tables, a whiteboard on the wall, and some open and closed storage, some of which is high and not appropriate for children to use. Storage, particularly floor-level storage that children could access, was another frequent necessity. The incorporation of direct biophilic features (i.e., sunlight, air) and indirect features (i.e., views) was added to the classrooms and cafeteria, whereas the playroom was missing these features except for the indirect feature (color), since it lacked windows. In the cafeteria, corridors, and some classrooms, wall-mounted posters, artwork, and small toys were used. These added biophilic features, including botanical motifs, animals, shells, and spirals, but they were too high and challenging for the kids to reach, view, or touch. Sensory variability or information richness, integration of parts into wholes, and bounded space features were found in all settings. Natural light (through windows), diffused and filtered light (blinds), and light and shadow, accompanied by artificial light features, were provided in all spaces except for the playroom, which had no windows. Geographic and cultural connections to place were found in all spaces. The lack of human–nature relationships in Zaryland preschool spaces revealed a lower level of biophilic inclusion than the overall average, especially in the playroom, which scored the worst rating for biophilia in the matrix (Table 6).

Generally, in Kapir preschool all of the spaces added some indirect biophilic features, such as color, water (a sink), and natural views of vegetation, as well as direct natural features like windows (sunlight) and ventilation (natural air). The presence of plant and natural material features was limited to the cafeteria and multipurpose hall.

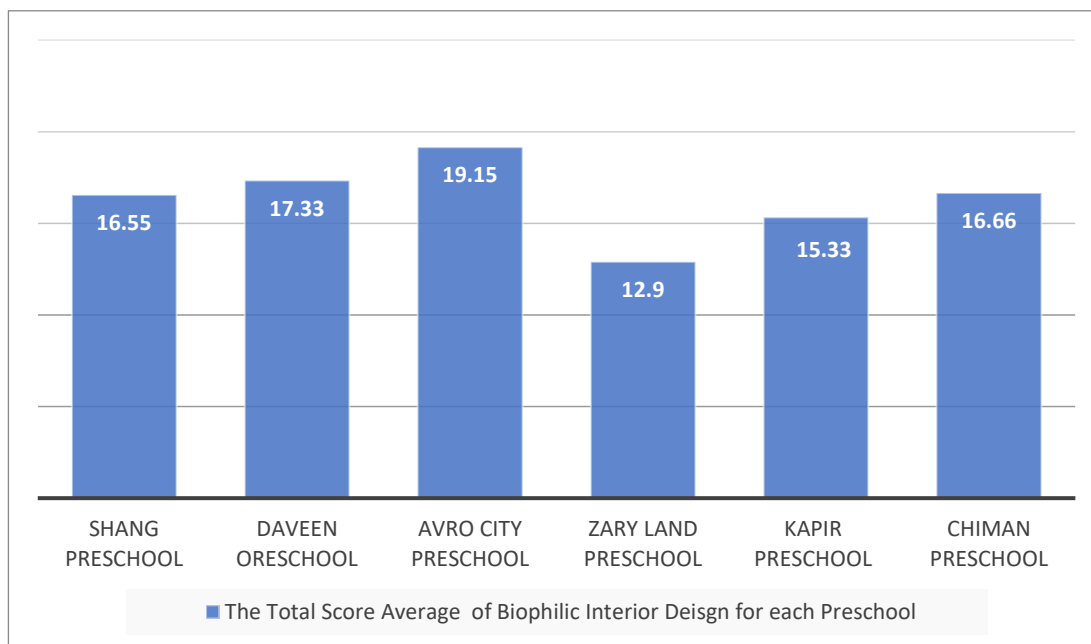
Botanical motif features were found in the classrooms, corridors, and cafeteria, while animal representations were found only in the classrooms. Sensory variability and information richness, integration of parts into wholes, and bounded space features could be found in all spaces, with corridors providing transitional space as well as link series and chains. Through the windows, natural light, dispersed and filtered light, as well as light and shadow features, were provided along with artificial lighting in all areas. The windows have curtains to regulate the light, but the height of the windows restricts children from viewing the natural views. The prospect and shelter features of the stage in the multipurpose hall give the sensation of isolation from the main area as well as a sense of connection between nature and humans. Furthermore, features like focal points and spaciousness in the playroom space add prospect, refuge, and special variability to the space (Figure 45). Most of the spaces offer geographic and cultural connections to places and landscape features. The majority of Kapir preschool's settings were ranked below the average of the biophilic matrix, whereas the multipurpose hall and the cafeteria ranked slightly higher (Table 7).

Finally, in Chiman preschool the direct environmental features (i.e., air, sunlight) and indirect features (i.e., color, views, and vistas) were observed in all spaces, while water (a sink) as an indirect feature was found in the cafeteria. Most of the spaces offered botanical motifs and animal representations through paintings and posters mounted on the walls. A few classrooms included features of shells and spirals in the space. A lot of design elements could be found in the cafeteria, with multiple features like egg, oval, and tubular forms, tree and columnar supports, and a central focal point. Sensory diversity, information abundance, and integration of parts into wholes were found in all spaces. Most of the spaces were provided with bounded spaces, except for the cafeteria and corridors. Links and chains were found in both the corridors and cafeteria spaces, while transitional space features were found only in corridors. Natural, filtered, and diffused light, with light and shadow attributes, is provided through the windows in all of the spaces, accompanied by artificial light. Furthermore, the cafeteria adds light as shape and form and a central focal point feature through the skylight, and attributes of both spatial variability and inside/outside spaces were found in the cafeteria as well (Figure 52). Spacious features were found in most of the spaces except for the corridors. Geographic and cultural connections to place, landscape orientation, and landscape features were found in all spaces. A lack of human–nature relationships featured in all spaces. The majority of Chiman preschool's

spaces were rated lower than the average for the biophilic matrix. However, the cafeteria scored the highest among all other preschool spaces, as shown in Table 8.

Figure 61.

*The Biophilic Interior Design Matrix Score Chart for each Preschool Analyzed in the Study*



Based on the final average scores of the BID-M of all preschools, Figure 61 graphically organizes these findings from low to high average scores, respectively. In order to show the average score variance for biophilic incorporation in each preschool. Avrocity preschool received the highest rating for the inclusion of biophilic features, while Daveen's Preschool scored the second highest. However, Zaryland preschool received the lowest rating compared to other preschools, according to the results of the final evaluation of BID-M, which scored below-average ratings for all of the spaces studied. As a result, it was given the lowest rating of all the preschools reviewed. In addition, both Zaryland preschool and Kapir preschool experienced a decrease in integrating biophilia. Finally, Shang and Chiman preschool scores were nearly identical to the mean matrix scores, as can be seen in Table 9.

The biophilic interior design matrix BID-M provides an innovative interior design perspective, adding to the body of information already known about biophilic design and demonstrating its value in the design process. In addition to providing a

practical tool for implementing and evaluating biophilic characteristics in interiors, it gives designers and practitioners a methodical and comprehensive vocabulary for the biophilic interior design of preschools. The BID-M provides a variety of options that maximize the presence of biophilia in the space and can support multiple biophilic features through a single attribute.

The environmental features element was the highest-scoring in some preschools, such as Avrocity, Zaryland, Kapir, and Shang, through some features such as color, which could be seen in all spaces. This element is classified as the organic dimension, which offers direct features (e.g., air, sunlight) and indirect features (e.g., views and vistas), which can be seen in most spaces. A slight presence of some other features such as water, which can be represented as a pool or fountain, natural materials like wood or stone, and plants like plant pots. While animals like aquariums and fire were not present in any of the analyzed spaces.

On the other hand, natural light, dispersed and filtered light, light and shadow features, which were present in most of the spaces, enabled Daveen and Chiman preschools achieve the highest scores for the light and space element. However, features like spatial diversity, spaciousness, inside and outside spaces, and light as shape and form were less common in the spaces that were evaluated. Along with the absence of warm light, light pools, reflected light, spatial harmony features, and space as shape and form.

According to the matrix results, Avrocity preschool recorded a higher inclusion of biophilic features through environmental features (e.g., color, water, air, sunlight, and views and vistas). Natural shapes and forms such as sensory diversity and information abundance, integrations of parts into wholes, complementary contrasts, and bounded spaces. Botanical themes, spiral and shell patterns, arches, domes, vaults, and shapes resisting straight lines are only a few examples of natural patterns and processes. And light and space features like natural, scattered, and filtered light, as well as light and shadow, in comparison with the other preschools. While Daveen preschool is recorded as having the next highest inclusion of biophilic features through light and space, such as natural, diffused, and filtered light, as well as light and shadow, spaciousness, and spatial diversity. And environmental features (e.g., color, water, air, sunlight, and views and vistas).

Zaryland preschool received the lowest rating in the BID-M evaluation, with spaces analyzed based on biophilic features having lower ratings than the average.

This was particularly evident in human-nature connections such as prospect and refuge, curiosity and enticement, order and complexity, and transformation. Following that are all of the natural shapes and forms, such as shells and spirals, animal, tree, and columnar supports, shapes resisting straight lines, egg, oval, and tubular shapes, arches, domes, vaults, simulation of natural features through biomorphy, biomimicry, and geomorphology. Then place-based relationships such as ecological and historical connections to place, landscape orientation and landscape features, and indigenous materials. Therefore, it was considered the worst-rated among the rest of the preschools that were evaluated.

In addition, Kapir preschool recorded a decrease in the incorporation of biophilic features, almost similar to the Zaryland preschool, which is the absence of the same elements that were recorded in the Zaryland preschool, which included human-nature relationships, place-based relationships, and natural shapes and forms. Lastly, scores for both Shang and Chiman preschools were almost identical to the matrix's overall average.

The matrix reveals biophilic variability in preschool spaces, with Chiman preschool's cafeteria incorporating the most biophilic features. This includes natural, filtered, scattered light, shadow, spaciousness, light as shape and form, spatial diversity, and inside and outside spaces. Davin preschool's cafeteria and Avrocity preschool's classrooms follow closely behind.

Fire, animals, geomorphology, biomimicry, simulation of natural features/biomorphy, age, change, the patina of time, patterned wholes, fractals, dynamic balance and tension, hierarchically arranged proportions and scales, reflected light, light pools, warm light, space as shape and form, spatial harmony, historical relationship to place, local materials, curiosity and attraction, regularity and complexity, and change and transformation features were all missing from the BID-M.

According to this study's recommendation, more biophilic features should be added to the BID-M. The conclusions and many of the important challenges listed in the conclusion chapter support these findings. Incorporating the following features into the suggested preschool matrix was indicated by the study (Figure 62).

1. Environmental features:

- **Natural colors (e.g., blue, green, .....)**

- **The windows' height above the ground should allow the child to see the surroundings without difficulty.**
  - **Use organic materials rather than manufactured ones.**
  - **Using floor finishing products that promote freedom, safety, and allow for easy movement**
2. Natural shapes and forms:
    - **Creating furniture with curved or streamlined shapes rather than angles and straight lines**
  3. Natural patterns and processes
    - **Ease of access for children to the supplies they need while playing or performing some activities.**
    - **Posters and artworks should be positioned on the walls with consideration for the size of young children.**
  4. Light and space:
    - **Outdoor access: connection of indoor spaces to the surrounding landscape**
  5. Place-based relationships:
    - **Historical connection: adding some historical photos or paintings**
  6. Human-nature relationships:
    - **Prospect and refuge: independent play places**
    - **Order and complexity: adding lighting and shadow or light and dark**



Figure 62.

*Biophilic design elements and attributes (Kellert, 2008)*

Environmental Features	<ul style="list-style-type: none"> <li>Color, water, and air</li> <li>Sunlight</li> <li>Plants and animals</li> <li>Natural materials</li> <li>Views and vistas; façade greening</li> <li>Geology and landscape; habitats and ecosystems</li> <li>Fire</li> <li><b>Natural colors</b></li> <li><b>Organic materials</b></li> <li><b>Proper window height</b></li> <li><b>floor finishing products (safety, and ease of movement)</b></li> </ul>
Natural Shapes and Forms	<ul style="list-style-type: none"> <li>Botanical and animal motifs</li> <li>Tree and columnar supports</li> <li>Shells and spirals, egg, oval, and tubular forms</li> <li>Arches, vaults, domes</li> <li>Shapes resisting straight lines and right angles</li> <li>Simulation of natural features</li> <li>Biomorphy, geomorphology, and biomimicry</li> <li><b>furniture with curved or streamlined shapes</b></li> </ul>
Natural Patterns and Processes	<ul style="list-style-type: none"> <li>Sensory variability</li> <li>Information richness</li> <li>Age, change, the patina of time</li> <li>Growth and efflorescence</li> <li>Central focal point</li> <li>Patterned wholes</li> <li>Bounded spaces and transitional spaces</li> <li>Linked series and chains</li> <li>Integrations of parts to wholes</li> <li>Complementary contrasts</li> <li>Dynamic balance and tension</li> <li>Fractals</li> <li>Hierarchically organized ratios and scales</li> <li><b>Accessibility for children to the supplies (consideration for children's size)</b></li> </ul>
Light and Space	<ul style="list-style-type: none"> <li>Natural light and shadow</li> <li>Filtered and diffused light; reflected light</li> <li>Light pools, warm light; light as shape and form</li> <li>Spaciousness, space as shape and form</li> <li>Spatial variability and harmony</li> <li>Inside-outside spaces</li> <li><b>Reachability to the outdoor area</b></li> </ul>
Place-Based Relationships	<ul style="list-style-type: none"> <li>Historic, geographical, cultural, ecological connection to place</li> <li>Indigenous materials</li> <li>Landscape orientation and ecology</li> <li>landscape features that define built form</li> <li>Integration of culture and ecology</li> <li>Spirit of place and avoiding placelessness</li> <li><b>Historical photos, or paintings for children understanding</b></li> </ul>
Human–Nature Relationships	<ul style="list-style-type: none"> <li>Prospect and refuge; security and protection</li> <li>Order and complexity; information and cognition</li> <li>Curiosity and enticement; exploration and discovery</li> <li>Change and metamorphosis</li> <li>Mastery and control</li> <li>Affection and attachment; attraction and beauty</li> <li>Fear and awe</li> <li>Reverence and spirituality</li> <li><b>Independent play places</b></li> <li><b>Adding lighting and shadow or light and dark</b></li> </ul>

## CHAPTER VI

### Conclusion and Recommendations

#### Conclusion and Recommendations According to Findings

The goal of this research is to create BID-M, an evidence-based design tool for preschools, with the aim of increasing the integration of nature into interior spaces. Based on Kellert's six proposed biophilic design features, it will assist interior designers and other professionals in recognizing and analyzing biophilic design features.

Remarkably, one of the most common issues discovered in most of the preschool spaces studied especially in the Daveen and Chimani preschools was a lack of biophilic features that strengthen the bonds between nature and humans, referred to as the human–nature relationships element, although this was minimally observed in Avrocity preschool. It can be supported by some small formations, such as independent play places that have privacy from the overall space and overlook the larger space in which they are located. Prospect and refuge refer to places where children enjoy playing when they feel they are in a special space. Another opportunity comes through the element of temptation and curiosity, perhaps through the creation of some features such as lighting and shadow or light and dark, and the presence of elements that stimulate the child's curiosity to discover order and complexity through furniture, materials, or colors.

The presence of some places with limited areas and the absence of windows resulted in a lack of daylight and natural air; thus, those spaces received the lowest ratings for biophilic design attributes. There are opportunities to make areas more biophilic by expanding them and adding some windows. Furthermore, the incorporation of biophilia through place-based relationships can be supported by outdoor access, which connects indoor spaces to the surrounding landscape. As well, it was observed that there was a lack of historical connection in all the studied spaces.

Overall, some common issues were observed in these interiors. For example, the storage used by children in some spaces was high and difficult to reach. It would be better to design this furniture with consideration of children's scale and the variations of open or closed storage to make its use easier. Also, the posters and photos mounted on the walls are another issue to be considered when children cannot reach them to see or touch them for more interaction with these natural paintings.

Additionally, the window height from the ground floor in some cases restricted children's ability to enjoy the natural views behind the windows, such as butterflies or feeling the breeze. Including natural themes and representations of the natural world in the spaces (e.g., Sun, plants, water, animals, or color) would make them more biophilic. Adding natural materials (e.g., wood, stone, metal or sand) rather than artificial ones would be more biophilic and healthier. Another significant issue that was observed throughout the preschool environments was the unintentional random use of colors. Using a carpet on flooring that is uncomfortable for children to play on or move around on, while it would be better to use materials that allow them to move more freely and don't interfere with their daily activities. Using curved or streamlined lines, for example, in designing furniture instead of straight lines and angles. This study suggests that more biophilic features be incorporated into the BID-M. According to the findings and many of the significant challenges highlighted above. The study advised integrating the features into the proposed preschool matrix described in the discussion chapter.

### **Recommendations for Further Research**

Implications throughout time: Using biophilic design elements in preschool interiors may have long-term implications, which could be investigated in future studies. Researchers can measure the long-term effects on children's wellbeing, cognitive development, and academic achievement through longitudinal studies, offering important insights into the long-term advantages of biophilic environments.

Design interventions: More research is required to determine the efficacy of particular design solutions intended to improve biophilic features in preschool spaces. Researchers can investigate the use of naturally inspired components, including living walls, organic materials, and daylighting techniques, and evaluate their effects on students' engagement, concentration, and overall learning results.

More research is needed to investigate the benefits of biophilic design in preschool settings for well-being and health. Factors such as stress reduction, immune system performance, creativity, and emotional wellbeing could be investigated. Cultural context and diversity are crucial for ensuring inclusion and meeting diverse community needs. Future studies should explore how cultural backgrounds, geographic regions, and socioeconomic issues affect the integration and effectiveness of biophilic features.

Understanding how users—children, instructors, and parents—perceive and behave in relation to biophilic design in preschool spaces is another potential research subject. Insights into user preferences, satisfaction, and the possibility for behavioral changes can be gained via qualitative research, surveys, and interviews about how various stakeholders interpret, value, and use biophilic features.

Researchers can advance their knowledge of biophilic design in preschool interiors by delving into these areas for future research, which will ultimately help to develop evidence-based recommendations and tactics for creating healthier, more interesting, and nature-connected learning environments for young children.

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## Appendices

### Appendix A Biophilia dimensions, elements, and attributes

**1. Environmental features:** these features can be found in both the natural world, and the built environment, based on Kellert (2008). They are based on features of both.

**Color:** makes it easier to find resources and potential threats. Colorful elements in nature attract people, and a wide spectrum can have positive health effects (Marberry & Zagon, 1995). Complementary analogy, full-spectrum harmony, and split complement are the four basic color harmonies that may be utilized to identify color. The hues of each of the seven colors can be combined in various ratios to create a full-spectrum color palette, or each color can be used in exactly the same proportion. Another choice is to use a neutral color scheme with various accent colors and a neutral backdrop. It can also feature larger surfaces of a preferred color and larger surfaces of brilliant colors, as well as reduced proportions of the other six colors in the textiles, floors, and artwork.

**Water:** water is a basic human requirement, and Ulrich (1993) found in his study of the literature that it frequently elicits strong preferences or likes. Clarity, flow, amount, and quality of the water must all be taken into account during design (Kellert, 2008). Water adds texture, motion, white sound, and life support as it interacts with natural materials. It can be reflected, fluctuate in tint, and interact with light to change its appearance. Aquariums are a good illustration (Mador, 2008). According to Ulrich (1981), images of water and, to a certain extent, views of vegetation were more successful in capturing viewers' interest and attention than views of cities.

**Air:** while moving air is preferable over still air, this feature also needs to have good quality, movement, flow, clarity, and stimulation of the senses (including scent and feel). The three methods for reducing indoor pollutants are local source management, source removal, and dilution by mechanical or natural ventilation (Spengler & Chen, 2000). In American healthcare, a mechanical ventilation system is frequently used. Air quality control methods include removing contaminants such as odors from nearby food preparation and off-gassing products, containing local sources

of fumes or aromas, diluting with access to external air, and adjusting temps to accommodate tenant needs.

***Sunlight or daylight:*** compared to artificial light, natural light, such as sunshine or daylight, has been demonstrated to increase moods, health, and efficiency.

***Plants:*** can improve physical fulfillment, well-being, and performance while also supplying food, fodder, and security (Kellert, 2008). According to one study's findings, patients' perceptions of stress were lowered when indoor plants were present in their hospital rooms (Dijkstra, Pieterse, & Pruyn, 2008).

***Animals:*** in addition to providing food, animals also provide additional resources and protection. They can be comforting while also causing terror. There is evidence that pets increase human health and lifetime. and the inclusion of animals in images has been shown to positively influence social attribution (Beck & Katcher, 1996).

***Natural materials:*** In general, natural materials—those sourced from animals, plants, or the earth—are favored to synthetic or artificial ones. This preference may be in part a result of the artificial materials' incapacity to mimic the aging process or the natural movement of energy through the environment. The use of imaginative play is usually facilitated by the abundance of knowledge that can be found in natural materials (Heerwagen & Orians, 2002).

***Views and Vistas:*** people like to see savannas, water, or plants from the outside (Ulrich, 1981, 1993). The scale and proportion of the views are best suited to the surrounding landscaping and architecture. Ulrich (1984) was the first to discover the therapeutic effects of nature views, demonstrating that viewing natural surroundings might result in positive recovery from stress in less than five minutes (Ulrich, 1981).

***Fire:*** although fire is frequently favored indoors, it poses a safety risk, particularly in a hospital setting. When under control, it brings warmth, color, and movement in addition to comfort and civilization. Fire is enticing with its warmth and capacity for destruction (Fisher, Salmela, & Bastianelli Kerze, 2005)

**2. Natural shapes and forms:** these forms and shapes mimic and depict the natural environment.

***Botanical motifs:*** framed leaves, which are a natural example of a botanical theme, and imaginative trompe l'oeil paintings of plants, which are a representation, are two instances of naturally occurring forms, shapes, and patterns of plants. Studies demonstrating the health advantages of simply observing vegetation and gardens or

going to areas with plenty of them, for example, in hospitals settings, provide proof of the attractiveness of greenery and plants (Ulrich, 2002).

***Tree and columnar supports:*** The term "tree" refers to naturally occurring shapes that resemble tree-like structures, most typically expressed as a large number of columnar supports (Kellert, 2008). Actual large-scale timber building would be a natural example.

***Animal*** (vertebrate): the simulation of animal life encompasses each of the various parts that make up an animal. (Animals addresses form emphasis)

***Shells and spirals*** (invertebrates): invertebrate forms that occur naturally include shells and spirals, which are the most common. Nautilus and scallop have been used since Greco-Roman times, and they were particularly well-known throughout the Rococo era. One of the eight buddhist emblems of a happy august was the conch shell. These shell designs are widely used as heraldic insignia (Stafford & Ware, 1974).

***Egg, oval, and tubular forms:*** examples of unusual natural forms that people have been drawn to employ include egg, oval, and tubular forms. The egg-and-dart design known as the ovolo in classical Greek architecture exemplifies this. Natural ovalar forms are frequently employed as adornment (Stafford & Ware, 1974).

***Arches, vaults, domes:*** natural curve forms have a long history of use in architecture and mimic natural forms for artistic or practical reasons (Lewis & Darley, 1986).

***Shapes resisting straight lines:*** natural features are frequently utilized to distinguish between man-made and natural features since there are rarely lines that are straight or at right angles in nature.

***Simulation of natural features:*** the tendency to mimic rather than reproduce real-world natural forms is strengthened by models of nature. This holds true for the creative creation of shapes that are only tangentially inspired by the original natural creativity (highlighted in particular by the various natural shapes and forms elements).

***Biomorphy:*** biomorphy imitate rather than copies natural forms, bearing minimal resemblance to live organisms. For example, the Sydney Opera House appears naturally organic without any particular natural precedent.

***Geomorphy:*** geomorphy is the duplication or imitation of the local geology, layered surfaces, rooted connections to other materials, or neighboring landscape that has an earthy influence.

**Biomimicry:** animals, plants, and other natural systems can all be used in biomimicry, which is the imitation of nature. However, function may take precedence over form in some cases. Nature provides a standard, a guide, and an example. (Benyus, 2002).

**3. Natural patterns and processes:** are attributes of the natural world.

**Sensory variability:** human contentment and wellbeing in a given environment depend on our ability to perceive and react to sensory variation. It is the result of simultaneous stimulation of the visual, aural, olfactory, and tactile senses. For seasonal fluctuations in light, note window arrangements that face east or west. Additional examples are the variety of colors and scents. There should be stimulation of all the senses.

**Information richness:** information can pique interest and inspire creative thinking, problem-solving, exploration, and discovery. Variety, texture, and features that mirror natural patterns are indicators of the abundance of information.

**Age, change, and the patina of time:** these characteristics demonstrate how natural materials and processes age over time.

**Central focal point:** using a reference point makes chaotic situations more orderly.

**Patterned wholes:** when used with patterned wholes, variability can provide disorder structure (see parts to wholes).

**Bounded spaces:** the boundaries of a demarcated area are distinct. To do this, adjust the scale and proportion. An area that is clearly defined can give one a feeling of safety.

**Transitional spaces:** Access points between spaces can be situated in the areas that separate rooms or in other areas that have a completely different design from the spaces they link. The region should entice one to continue while also providing the possibility of more spaces.

**Linked series and chains of spaces:** as seen in enticement, linked spaces lead you from one area or place to another.

**Integrations of parts to wholes:** you are drawn in by connected spaces that serve as a bridge between various rooms or spaces.

**Complementary contrasts:** blending opposing aspects, such as light and dark, cool and warm colors, open and closed, hot and cold temperatures, smooth versus

coarse textures, and others, can add meaning and comprehensibility as well as interest and excitement. In nature, opposites are frequently found together.

***Dynamic balance and tension:*** you may create creative tension that makes the static look more organic while yet displaying strength and durability by balancing contrasting forms.

***Fractals:*** Benoit Mandelbrot used mathematics to explain the fractal as a non-Euclidian shape, stating that they "tend to be scaling, suggesting that the degree of their irregularity and/or fragmentation is equal at all scales" (Mandelbrot, 1982). Fractals have an aesthetic impact on human psychology and physiology because of their naturally occurring shape and structured complexity. These shapes elicit physiological and psychological responses in people (Kellert, 2008).

***Hierarchically organized ratios and scales:*** geometry and arithmetic can be hierarchically coupled and produce incredibly complex patterns without seeming overpowering. Examples of Fibonacci's sequence include the arrangement of some plant stems, the number of petals on some flowers, the shell of a nautilus with golden spirals, the ratio of a human hand to an arm, as well as the proportions of dolphins and other creatures with the golden section.

**4. Light and space:** this category examines the properties of light as well as its interaction with space.

***Natural light:*** sunshine is a natural source of light that contains the whole color spectrum and undergoes seasonal and annual fluctuations.

***Light and shadow:*** light and dark are frequently combined in the natural world and can heighten human interest, mystique, and stimulation. The sun's movement as well as shifting patterns of brightness and shadow can be seen in daylight coming from at least two different directions.

***Reflected light:*** reflected light makes a space glitter. Accent lights, as well as light-colored ceilings, walls, and reflecting materials, are utilized in lighting designs to improve reflection. In addition to glare reduction, the functional advantages of adequate levels of reflected light also include greater light penetration (ex. a light shelf). Secondary light sources can also be created through reflections.

***Light pools:*** someone can be guided through a space by clusters of connected light. Light pools, like a lit fireplace or accent lighting, can give a dark space a sense of security.

**Warm light:** spaces that are warmly lighted are frequently encircled by darkish areas and areas of filtered daylight. They can have an island-like vibe, which heightens the sense of safety and nesting.

**Light as shape and form:** When light is manipulated, it may take on an appealing shape. Attractive light sculptures can help with exploration, discovery, and movement.

**Spaciousness:** the spatial variation is increased by placing open spaces close to sheltered parts or larger areas near smaller ones.

**Spatial variability:** differentiation in scale, mass, or light can stimulate the mind and the emotions. Prospectively, spaciousness should be paired by more intimate, secluded areas to add variation. Examples include variations in ceiling heights based on room size. In addition, there is spatial harmony.

**Space as shape and form:** interest and exploration are sparked by manipulating space through shape.

**Spatial harmony:** spaces with a balance of light, mass, and/or size within a given area can inspire feelings of peace and security and promote freedom of movement.

**Inside-outside spaces:** interior-outside spaces: Typical methods to link the interior to the outside include colonnades, porches, foyers, and indoor gardens for a more indirect connection to nature.

**5. Place-based relationships:** the environment and culture in a geographical context.

**Geographic connection to place:** establishing a link between the space and the local geography creates a sense of familiarity (measured using ecological and geomorphic connections to place).

**Historic connection to place:** reflecting the past can help us feel more culturally aware and record the passage of time.

**Ecological connection to place:** it enhances the sense of place to represent prominent ecological and biogeographical features that are local.

**Cultural connection to place:** unique vernacular architectural forms contribute to the relationship between culture and human need.

**Indigenous materials:** or native materials, used in locally made goods connect you to the local culture while also being more ecologically beneficial. The LEED grading system uses a 500-mile radius to assess if a material is local (Council, 2009). A visual inventory may call for previous or subsequent research.



***Landscape orientation:*** is how a landscape's elements are oriented in relation to a structure.

***Landscape features that define building form:*** they define and connect the structure to the landscape by way of the landscape features that determine building shape.

**6. Human-nature relationships:** they involve essential attributes of the human-nature connection.

***Prospect and refuge:*** protection should be supplied by the combined effects of prospect and refuge, which also produce porous barriers to allow the prospect to observe the surrounding environment (Kahn & Kellert, 2002). Children's love of climbing into tight spaces (refuges) and surveying by ascending to the top of things is evidence of the employment of these components in play areas (prospect). Small, semi-enclosed spaces can be utilized to facilitate associative or cooperative play with a small group of people, as well as spectator or lonely play. Children should be able to look around the entrance before entering. Additionally, having access to heights that may be reached securely might facilitate surveying; examples include climbing walls, slides, and raised forts. Forts often have partially enclosed areas where people might take refuge.

***Order and complexity:*** a balance between order and complexity is achieved by the deliberate repetition of visually complex design components. In the same way that complexly structured sound is referred to as music but chaotically complex sound is referred to as noise, complexity must be coupled with order since too much complexity or intricateness leads to disorder and order alone is monotonous. The visible intricacy and order of the materials also help us recognize structures.

***Curiosity and enticement:*** innovation and discoveries are sparked by curiosity and allurement. Temptation piques our attention. Together, they can use layers of information to pique attention, which can help them exercise their imagination and creativity. The change from darkness to brightness within a structure is seductive. Interest can also be piqued by variety.

***Change and metamorphosis:*** this integrated feature, which is present in growth, maturity, and metamorphosis, is manifest in the transition from one form or state to another.

## Appendix B

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## CV.

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### **Ibtisam MOHAMMED ALSULAIVANY**

**Assistant Lecturer, Duhok University**




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### CONTACT INFORMATION



Email: [ibtsam\\_11@yahoo.com](mailto:ibtsam_11@yahoo.com)



Address: Iraq- Duhok-Malta



Phone: +9647504808207

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### LANGUAGES

Kurdish (Native)

English

Arabic

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### ACADEMIC QUALIFICATIONS

B. Sc. in Architectural Engineering/ Mousl University/ Iraq 1994

Higher diploma in Planning/ Duhok University/ Kurdistan Region/Iraq 2009-2010

M.Sc. in Interior Architecture/ Eastern Mediterranean University/Cyprus 2011-2013

Studies Doctor of Philosophy (Ph.D.) in Interior Architecture at Near East University/Cyprus 2017-Present

---

### PROFESSIONAL EXPERIENCES

1994-2003

Work experience in designing and constructing residential, commercial, and public buildings in offices and companies.

2000-2003	Owner of the Altakween Bureau for Engineering Design and Construction in Mousl city.
2005-2007	Worked in the Directorate of Municipalities of Duhok Governorate as an Architect Engineer.

### **ACADEMIC EXPERIENCES**

2007- 2017	I have worked in the Architectural Department, College of Engineering, University of Duhok-Kurdistan Region, Iraq, as a member of the teaching staff full-time. I am a member of the teaching team for Architectural Design, Working Drawings, Engineering Drawing, Urban Infill, Interior Design, and Landscape. Responsible for the graphic design teaching team. Key role participation in teaching a theoretical course on: History of Architecture, Local Architecture, and Building Materials
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### **EMPLOYMENT**

2014 – 2017	Assistant lecturer/ Department of Architecture/ University of Dohuk.
2013	Member of the examination committee in Architectural Department.
2016	Member of the quality assurance committee.

### **MEMBERSHIPS**

1994	Membership of Iraq Engineering Union
2005	Membership of Kurdistan Engineering Union

### **COMPUTER SKILLS**

Microsoft Office tools (Word, Excel, and Power point)

AutoCAD tools and techniques (highly used in architecture practice) 3D Studio MAX

Adobe Photoshop

Statistical Package for Social Sciences, SPSS

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**TRAINING PROGRAMS**

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2014	Teaching method/ Culture center/ Duhok University
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