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TOWARDS THE APPLICATION OF BIOPHILIC PARAMETERS IN LOCAL BUILDINGS: A CASE STUDY OF BILKENT SCHOOL, ERBIL CITY- IRAQ

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ABSTRACT

As the world progresses towards a greener and healthier environment, with the design of cities and buildings responding to human requirements and having less impact on the natural world, biophilic design is used as a tool by architects to connect people inside buildings with the nature outside them through relevant design patterns and parameters. These patterns have a wide range of applications in both internal and external environments, bringing physiological, cognitive and psychological benefits. This study aims to examine the availability of these patterns in Bilkent School in Erbil city, which was selected as a case study. A quantitative approach based on a survey questionnaire was used to achieve the objectives. The results show that 13 out of 14 biophilic design patterns were available in the building. Eight patterns achieved availability of more than 75%, while five other patterns ranged between 50 and 75%. Three main categories of biophilic patterns, namely "Nature in Space", "Natural Analogues" and "Nature of Space", achieved 75%, 68.33% and 61.25%, respectively. Therefore, the school can be considered as a biophilic design building. Based on the findings, modifications or arrangements can be made in other local schools by applying these patterns. Moreover, this particular building can be used as a model to evaluate biophilic design criteria in other types of building. Finally, the study serves as a useful survey which may assist in designing future pilot studies in Erbil city.

Keywords: Biophilic design; Bilkent school; Building design; Erbil city; Nature; Patterns

1. INTRODUCTION

Biophilia is the notion that humans possess an innate tendency to seek connections with nature and other forms of life. It stems from the Greek word meaning "love of life" (Berman et al., 2008). Biophilic design applies these principles to the built environment, incorporating nature in a deep and fundamental way. It is a thoughtful approach that incorporates elements of nature, both in the skin of a building and its interior environment (Francis, 2017). The term "biophilic" was used by Erich Fromm in his book "The Anatomy of Human Destructiveness" (Fromm, 1964) and was first described and defined in 1984 by Wilson (Griffin, 2004). Wilson's hypothesis was popularized in his book "The Biophilic Hypothesis". He proposed that humans have an innate propensity towards nature because they are created from it and like to be close to nature and natural features (Kellert & Wilson, 1995). Wilson and other biophilia theorists assert that human beings not only derive specific aesthetic benefits from interacting with nature, but that the human species has an instinctive, genetically determined need to be closely affiliated with natural settings and lifeforms (Wilson, 1993; Besthorn & Saleeby, 2003). Biophilia theory is still in its early developmental phase. Nevertheless, researchers from diverse disciplines, such as architecture,

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landscape design, psychology, biology, genetics, child development, geography and evolutionary science, are beginning to critically examine and detail both the limits and possibilities of this emerging interdisciplinary impulse (Frumkin, 2001). Biophilia is the deep-seated need of humans to connect with nature. It helps them explain why crackling fires and crashing waves captivate them, why a view of nature can enhance their creativity, why shadows and heights instill fascination and fear, and why gardening and strolling through a park have restorative healing effects (Ryan et. al., 2014). In context, biophilia considers the evolution of biophilic design in architecture and planning and presents a framework for relating it to human biological sciences and nature (Browning et al., 2014). Scholars such as Alexander et al. (1977), Kaplan et al. (1998) and Jacobson et al. (2001) have categorized biophilic design according to a variety of different patterns. These patterns have a wide range of applications in both interior and exterior environments, providing physiological, cognitive and psychological benefits, all of which are interrelated. In biophilic building design, spaces are designed in a way that encourages and supports the connection between human and natural systems. With this design method, people can experience the natural elements and natural environment. It is important to encourage humans to not only stay connected to nature, but also to be part of the natural system and to interact with it. When experiencing this connection, humans will feel that there is a bigger system which contains them and of which they are a part (Bhatt, 2015). Occupants of built environments do not simply want to work, play, eat or sleep in a functional building. They want to be inspired, invigorated, comforted and reassured by their surroundings. They want spaces that will make them more productive and healthy, and in which they love to be. Grant Hildebrand, a professor of architectural history at the University of Washington, was the first to make the leap of applying the concept of biophilia to the overall built environment (Kellert & Speth, 2009; Kellert, 2018). A small number of scientific studies have shown major benefits of a connection to the natural environment, including increased productivity and improved well-being (Wilson, 1984; Clements-Croome, 2001; Griffin, 2004; Gladwell et al., 2013; Ryan et al., 2014; Gillis & Gatersleben, 2015).

For decades, research scientists and theorists have worked on defining the aspects and appearances of nature in order to respond to our satisfaction with the built environment. The central questions are how we can move from research to application, in a manner that effectively improves productivity, health and well-being, and how efficiency should be measured. Cramer and Browning (2008) established three categories intended to help define biophilic buildings – Nature in the Space, Natural Analogues and Nature of the Space – and a preliminary list of "Biophilic Conditions". Based on these three categories, Ryan et al. (2014) presented 14 patterns of biophilic design reflecting the nature-health relationships most prominent in the built environment. These design patterns have been developed from empirical evidence and interdisciplinary analysis in more than 500 peer-reviewed articles and books. The patterns have a wide range of applications in both interior and exterior environments, and are intended to be flexible and adaptive, allowing for project-specific implementation. From a designer's perspective, biophilic design patterns have the potential to reposition the environmental quality conversation to give individuals' needs equal consideration alongside the conventional parameters for building performance, which have historically excluded health and well-being. Consequently, these 14 patterns of biophilic design illuminate the relationship between human biology, nature and the built environment. Using these patterns, designers are able to implement and verify biophilic design in buildings, urban spaces, and landscapes. In addition, they have a strong psychological effect in the workplace, increasing well-being and productivity (Roelofsen, 2002; Joye, 2007; Zhang et al., 2014; Gray & Birrell, 2014; Benfield et al., 2015; Gray, 2017).

Locally, buildings in Erbil city in general, and school buildings in particular, need to move towards a more biophilic design approach for greater connectivity between interior spaces and

the internal environment and nature to achieve improved productivity and wellbeing for users/students. It is necessary to develop an integrated strategy, to make buildings biophilic in design and construction. Biophilic parameters and patterns are considered one of the most fundamental design features of environmentally friendly buildings. This paper presents a study of the biophilic patterns in a school design, based on the perception of the users. The focus is on schools for several reasons. Anything that helps engage students in learning helps them to achieve better grades and to be happier is worth exploring. In addition, helping them feel more connected to nature is good for the environmental conscience of the next generation; schools currently have a serious capacity shortage, making expansion and innovation crucial; and children's wellbeing and productivity are important issues nowadays and through effective application of biophilic design parameters these can be achieved and better understood. Therefore, this paper addresses the importance of applying the parameters and patterns of biophilic design in local designs. Consequently, the main aim of the paper is to examine and analyze whether biophilic design patterns exist in one of the educational buildings in Erbil city. It attempts to determine whether users of Bilkent School feel connected or unconnected to nature, especially with regard to the various aspects related to nature in the building, and whether these aspects have created an enjoyable, healthy and productive internal environment. To achieve these research aims, the research adopts school buildings as a case study to verify whether they meet the known patterns and parameters of biophilic design, to reach highlighting the shortage in the new generation of architects concerning this architectural trend, underlining its importance and viability. In turn, this opens up prospects for the architects, designers and planners in Erbil city to adopt this vital trend in their designs and to modify existing buildings in general, and local school buildings in particular.

1.1. Research Problem and Importance

Despite the new trend of architectural design known as biophilia, which has become a source of great interest to many architects and designers around the world, aiming to create a relationship between man, nature and building; this is what has been observed through a review of previous literature (Figueiro et al., 2002; Heschong et al., 2013; Ryan et al., 2014; Gray & Birrell, 2014; Movahed, 2015; Gurung, 2014; Browning & Cooper, 2015; Benfield et al., 2015; Düzenli et al., 2017, amongst many others), as scholars seek to link the internal environment of building with nature, as the world is in dire need of moving towards more environmentally friendly buildings. However, in Erbil city there is a significant absence of connections between the local buildings and nature in general, and in schools in particular. On the other hand, architects might not be aware of biophilic design and its parameters, due to a lack of scientific knowledge of the subject, as it is relatively new terminology in architecture. Consequently, this research is a serious attempt to bridge this knowledge gap, in an effort to link the existing built environment with nature. To achieve this endeavor, the research adopts school buildings as a case study to verify whether these meet the known patterns and parameters of biophilic design, with the aim of revealing the lack of awareness of the new generation of architects concerning this architectural trend, and highlighting its importance and feasibility.

2. METHODOLOGY

2.1. Case Study - Building Description

After visiting several schools in the city of Erbil to observe if there were aspects of the natural environment inside and outside the buildings, Bilkent School was chosen as a good case study for the research because it largely fulfilled these aspects. The building is oriented to the south. The total site area of the school is 75,000 m^2, the school premises area is 33,000 m^2, and the green area and playground area total 8,000 m^2. The school building consists of three parts: one part in the center, with the two other parts located on the right and the left-hand sides of the central part;

there is also an apartment building for teachers. These parts are connected with each other by corridors, creating green open courtyards between the buildings. The school has two floors, encompassing 70 classrooms, a world-class concert hall, a cafeteria, shops for school clothes, and service rooms.

2.2. Study Variables

Biophilic design as a theory was formulated by Browning et al. (2014) in "14 Patterns of Biophilic Design". Based on this theory, scholars around the world have established many theoretical and conceptual frameworks to improve health and well-being in the built environment. This study is limited to the subjective perspective of the users of the building; further empirical studies may be needed to make objective measurement of the biophilic parameters. A theoretical framework of biophilic building design was adopted from Ryan et al. (2014). A building can be considered to be biophilic if it contains the 14 known patterns of biophilic design (Kellert, 2008; Ryan et al., 2014; Browning et al., 2014). In accordance with the literature review, there are three categories of patterns, namely "Nature in the Space", "Natural Analogues" and "Nature of the Space", each of which includes a number of patterns, as shown in Table 1.

Table 1 Categories and patterns of biophilic design
(Cramer & Browning, 2008; Browning et al., 2014; Ryan et al., 2014)

Category	Biophilic Patterns (Variables)
1. Nature in the Space	Visual Connection with Nature
	Non-Visual Connection with Nature
	Non-Rhythmic Sensory Stimuli
	Thermal & Airflow Variability
	Presence of Water
	Dynamic & Diffuse Light
	Connection with Natural Systems
2. Natural Analogues	Biomorphic Forms & Patterns
	Material Connection with Nature
	Complexity & Order
3. Nature of the Space	Prospect
	Refuge
	Mystery
	Risk/Peril

This study adopts these three categories of biophilic design and the 14 patterns and parameters as the research variables. These categories and variables can be defined as follows:

Nature in the Space: This addresses the physical, direct and fragile entity of nature within a place or space. It encompasses animals and water, plant life, sounds, breezes, smell and other natural elements. Examples include flowerbeds, butterfly gardens, fountains, potted plants, bird feeders, aquariums, courtyard gardens, water features, vegetated roofs and green walls. These elements can be used to create a strong and meaningful connection with nature in a space or place. This category encompasses seven biophilic design patterns:

1. **Visual connection with nature:** A view of elements of nature, living systems, and natural processes.
2. **Non-visual connection with nature**: Auditory, haptic, olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
3. **Non-rhythmic sensory stimuli:** Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
4. **Access to thermal & airflow variability:** Subtle changes in air temperature, relative humidity, airflow across the skin and surface temperatures that mimic natural environments.

5. **Presence of water:** A condition that enhances the experience of a place through seeing, hearing or touching water.
6. **Dynamic & diffuse light:** Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
7. **Connection with natural systems:** Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

Natural Analogues: Natural analogues deal with organic, non-living and indirect evocations of nature. Objects, materials, colors, shapes, sequences and patterns found in nature are manifest as artwork, ornamentation, furniture, décor and textiles in the built environment. Mimicry of shells and leaves, furniture with organic shapes, and natural materials (Sofyan et al., 2016) that have been processed or extensively altered (e.g., wood planks, granite tabletops), all provide an indirect connection with nature; while they are real, they are only analogous to the items in their 'natural' state. The strongest natural analogue experiences are achieved by providing rich information in an organized and sometimes evolving manner (Ryan et al., 2014; Kellert & Calabrese, 2015; Sofyan et al., 2016). Natural analogues cover three patterns of biophilic design:

8. **Biomorphic forms & patterns:** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.
9. **Material connection with nature:** Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.
10. **Complexity & order:** Rich sensory information that adheres to a spatial hierarchy similar to that encountered in nature.

***Nature of the Space*:** This category addresses spatial configurations in nature. It comprises our innate and learned desire to be able to see beyond our immediate surroundings; our fascination with the slightly dangerous or unknown; obscured views and revelatory moments; and sometimes even phobia-inducing properties when they include a trusted element of safety. The strongest nature of the space experiences are achieved through the creation of deliberate and engaging spatial configurations commingled with patterns of nature in the space and natural analogues (Ryan et al., 2014; Downton et al., 2017). Nature of the space includes four biophilic design patterns:

11. **Prospect:** An unimpeded view over a distance, for surveillance and planning.
12. **Refuge:** A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
13. **Mystery:** The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.
14. **Risk/Peril:** An identifiable threat coupled with a reliable safeguard.

2.3. Measuring Method

The decision on whether to adopt a qualitative or quantitative approach lies in the research assumptions (Kanaan, 2009). This study is based on a quantitative approach, using a survey questionnaire to achieve the objectives. Selecting a survey questionnaire offers a description of the tendencies in a population or of the relationships between its variables (Creswell, 2005; Berawi et al., 2013). In addition to this advantage, a survey questionnaire is also inexpensive and less time consuming, as it enables the researcher to acquire both a quantitative scale and qualitative data from a large research sample. For this reason, a survey design associated with quantitative analysis was used to examine the variables in the adopted model (biophilic patterns) and to achieve the research objectives. Moreover, a Likert scale was employed for each set of questions. The Likert scale is designed to examine how strongly subjects agree or disagree with statements on a five-point scale, as follows: 1-Strongly disagree, 2-Disagree, 3-No idea, 4-Agree,

and 5-Strongly agree (Kanire, 2013). The following formula was used to establish the percentages of each pattern of biophilic design for which the five Likert scales were employed:

$$p = \frac{n}{t} * 100 \quad (1)$$

where *p* is the percentage of availability of a pattern; *n* is the number of scores received for each point on the Likert scale; and *t* is the total number of the selected sample.

For this study, interviews were conducted with teachers at Bilkent School, who were also asked to fill out the questionnaire. 25 questionnaires were distributed and 20 responses received, so a total of 20 valid responses were adopted for the study, representing 80% of the distributed ones. The total number of teaching staff was 25, 20 of whom completed the questionnaire. This number was considered adequate for the analysis, based on the assertion by Moser and Kalton (1971) that the results of a survey could be considered biased and of minimal value if the response rate is lower than 30–40%. After collecting the answers from the respondents, they were counted and the number of answers for each point on the Likert scale (Strongly agree, Agree, No idea, Disagree, Strongly disagree) was added to its blank square. The results are tabulated and listed in Table 2.

Table 2 Survey outcome: percentage and total agreement for each biophilic pattern

Category	Biophilic Pattern	Strongly agree		Agree		No idea		Disagree		Strongly disagree		Total
		n^1	p^2	n^1	p^2	n^1	p^1	n^1	p^2	n^1	p^2	$p_t{}^3$
Nature in the Space	Visual connection with nature	16	80	4	20	0	0	0	0	0	0	100
	Non-visual connection with nature	10	50	5	25	3	15	2	10	0	0	75
	Non-rhythmic sensory stimuli	7	35	9	45	1	5	3	15	0	0	80
	Thermal & airflow variability	5	25	14	70	1	5	0	0	0	0	95
	Presence of water	0	0	0	0	0	0	5	25	15	75	0
	Dynamic & diffuse light	11	55	4	20	5	25	0	0	0	0	75
	Connection with natural systems	15	75	5	25	0	0	0	0	0	0	100
Natural Analogues	Biomorphic forms & patterns	5	25	9	45	5	25	0	0	0	0	70
	Material connection with nature	8	40	4	20	1	5	4	20	3	15	60
	Complexity & order	9	45	6	30	5	25	0	0	0	0	75
Nature of the Space	Prospect	6	30	0	0	10	50	4	20	0	0	30
	Refuge	5	25	13	65	1	5	1	5	0	0	90
	Mystery	5	25	4	20	7	35	4	20	0	0	45
	Risk/Peril	14	70	0	0	6	30	0	0	0	0	70

n^1 is the number of answers for the item; p^2 is a percentage of agreement with the item; pt^3 is a total percentage of availability of the pattern.

3. RESULTS AND DISCUSSION

Based on Table 2, the results relating to the percentage of the presence of each biophilic design pattern in Bilkent School are clarified in Figure 1. Each result is discussed individually below. The data obtained from the questionnaire are supported by photos taken by the authors to verify the availability of the patterns in the building.

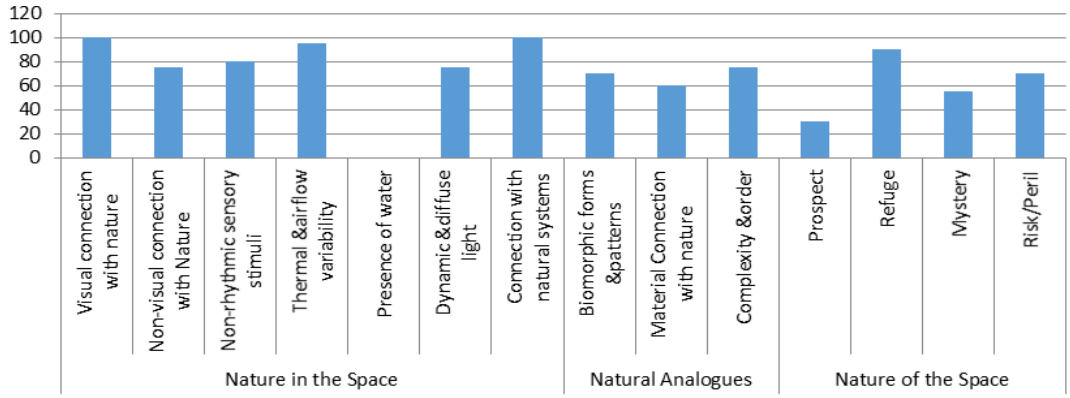

Figure 1 Percentage of the presence of the 14 patterns of biophilic design in Bilkent School

3.1. Visual Connection with Nature

For this pattern, 16 respondents felt that it was strongly connected with nature, while the other four only agreed with the visual connection with nature. No one disagreed with the statement. Hence, the availability of this parameter is 100%. As shown in Figure 2, the windows are open to the green space outside.

3.2. Non-Visual Connection with Nature

50% of the answers showed strong agreement with connecting with nature by smell, touch and hearing, despite the visual connection; whereas 25% felt that they were somehow connected non-visually with nature. However, 25% showed disagreement with the statement. Therefore, the presence of this pattern is only 75%. There are lattice panels located in front of the windows, as shown in Figure 3, which make the wind whirl through the vents and produce sounds audible to the occupants.

Figure 2 View from inside the building

Figure 3 Latticework panels in front of windows

3.3. Non-Rhythmic Sensory Stimuli

When the wind blows against the leaves of trees causing them to move, this is termed a "non-rhythmic sensory stimulus". Seven respondents answered that they strongly agreed with the presence of "non-rhythmic sensory stimuli", while nine only showed agreement with the statement. One person had no idea about this pattern, which may be due to misunderstanding of the meaning of it. Three respondents highlighted their disagreement with the availability of the pattern in the school. The overall score for this pattern is therefore 80%. The result is greater than 50%, meaning there are "non-rhythmic sensory stimuli" in the school (Figure 4).

3.4. Thermal and Airflow Variability

This includes heating and cooling issues to achieve thermal comfort, whereas air flow refers to buildings' natural ventilation. Five out of the 20 respondents said they felt very comfortable and that the building was well ventilated. 14 of the others agreed about the availability of an effective thermal comfort system and natural ventilation inside the building. One person had no idea, but no one disagreed. These results show that the pattern is very close to that of "visual connection

with nature", reaching 95%. In the school, there are several doors and windows which are open during daylight hours for natural air flow and ventilation from outside (Figure 5).

Figure 4 Movement of tree leaves in the wind.

Figure 5 Door open for natural ventilation

3.5. Presence of Water

This refers to the sound of flowing water or being able to see water features such as fountains, pools, ponds, cascades and waterfalls. This was the only pattern which was totally absent from the school, which may be due its nature, requiring safety for the children and students.

3.6. Dynamic and Diffuse Light

The results show the appearance of another pattern in the school, namely natural daylight. The skylights and large windows make the interior of the school pleasant because of the natural sunlight (Figures 6 and 7). When the sun moves during daylight hours, its incident angle changes, which produces different shadows and diffuse light in the interior of the school. Therefore, the presence of this pattern had a percentage of 75% based on the answers given by the respondents. 55% of the answers indicated strong agreement with the presence of the parameter, while 25% of the respondents had no idea. The remaining 20% showed agreement with the presence of the pattern.

3.7. Connection with Natural Systems

This pattern relates to seasonal and temporal changes. There are different recreation places in the school, some of which are used during hot seasons (Figure 8), while other internal space is used during the cold months of the year (Figure 9). From Table 2 it is clear that all respondents agreed with the existence of this condition, with 15 strongly agreeing. Accordingly, it can be said that this pattern is clearly present in the school, with a maximum percentage of 100%.

Figure 6 Daylight in the lobby of the school

Figure 7 Daylight and shadows in a classroom

Figure 8 Summer playgrounds

Figure 9 Internal court used for winter activities

3.8. Biomorphic Forms and Patterns

In the school, a spiral staircase is used for vertical circulation, based on organic natural forms. The walls feature natural paintings and biomorphic drawings (Figure 10). Five respondents strongly agreed, with nine only agreeing, on the presence of natural forms and patterns in the school. Five of the respondents said they had no idea, but no-one disagreed with the statement. Therefore, this pattern shows a 70% level of existence.

Figure 10 Use of a spiral staircase and natural colors, patterns and biomorphic drawings on the internal walls

3.9. Material Connection with Nature

Natural granite was used for the interior finishing of the building (Figure 11). The furniture is made of wood, and the doors of the classrooms and administration rooms are also wooded (Figure 12). According to responses provided, this pattern has a presence level of 60% in the school. From Table 2 it can be seen that 35% of the respondents disagreed with this statement.

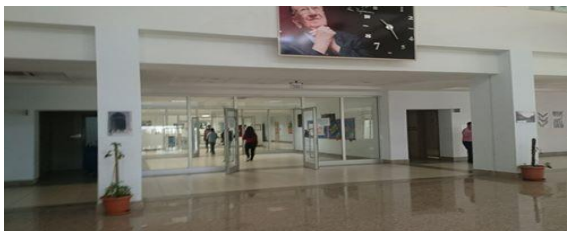

Figure 11 Use of granite for the flooring

Figure 12 Use of wooden doors and furniture

3.10. Complexity and Order

The columns, as shown in Figure 13, allow movement in different directions between them. Moreover, they have an order in their arrangement as a structural element of the building (Figure 14). This pattern achieved a presence level of 75%, with nine respondents showing strong agreement, six simply agreeing, and the remaining five indicating that they had no idea. However, no answers indicated disagreement with the statement.

Figure 13 Columns providing complex movement

Figure 14 Order in the column arrangement

3.11. Prospect

The transitional zone located at the entrance, as clearly shown in Figure 15, links the inside and outside, with the interior of the school visible far from this location. The openings between the columns on both sides also provide distant vision of the site of the building. In the answers provided, the agreement percentage was 30%, while disagreement was 20% and 10 respondents indicated that they had no idea. The prospect presence according to the responses was therefore 30%.

3.12. Refuge

Students go to the backyard to play, as shown in Figure 16. The results show that five of the respondents strongly agreed, where 13 simply agreed on the availability of a place of refuge. One person indicated that he had no idea, and another expressed disagreement. Thus, this pattern had a high score of 90%.

Figure 15 Prospect of Bilkent School

Figure 16 Refuge in Bilkent School

3.13. Mystery

The floor plan contains numerous corridors and passages leading in different directions, making people pass through and discover the spaces above it, to see the scenes they are looking for and find where they will end up (Figure 17). The school building is open from four sides. The results show that five of the respondents strongly agreed, while four agreed about the availability of mystery in the school. Seven indicated that they had no idea and the four others expressed their disagreement. Accordingly, this pattern had a level of 45%.

3.14. Risk/Peril

As noted, there are a large number of stairs in the school. They are wide, which give a sense of sliding (Figure 18). However, in some places they are provided with rails, which students can use while going up or down for more safety. The corridors are also open on courtyards. Agreement on the presence of this pattern was 70%. 14 of the respondents strongly agreed on the presence of the risk pattern, no-one disagreed, and six said they had no idea.

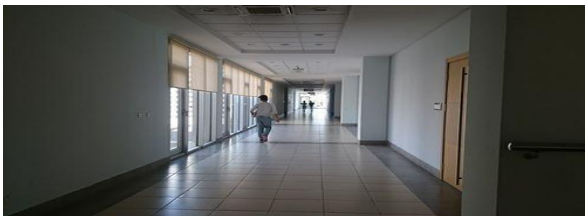

Figure 17 Mystery of the corridors in Bilkent School

Figure 18 Stair and corridor risk

4. CONCLUSION

Due to the positive findings of the questionnaire, the purpose of the study has been achieved. Based on the 14 known patterns of biophilic design examined in Bilkent School, it is concluded that it can be considered as such a building, as 13 of the patterns were present. The high percentage of the patterns indicates that the majority of respondents felt connected with nature.

In accordance with the literature review, there are three categories of pattern, namely "Nature in the Space", "Natural Analogues" and "Nature of the Space" (Kellert, 2008; Browning et al., 2014; Ryan et al., 2014). The percentages achieved by each category were 75%, 68.33% and 61.25%, respectively. As for the level of patterns related to these categories, two, visual connection with nature and connection with natural systems, were completely present, with scores of 100%. Two other high percentages were 95% and 90% for thermal & airflow variability and refuge respectively. The pattern of presence of water was not evident in the school, which may be due to its function, requiring safety for children and students. Non-rhythmic sensory stimuli rated 80%, but the percentages for the patterns of non-visual connection with nature, dynamic & diffuse light, complexity, and order were only 75%. Biomorphic forms & patterns and risk scored 70%, while the remaining three patterns, material connection with nature, mystery, and prospect, achieved 60%, 55%, and 30%, respectively. The study shows that the respondents did not show an equal connection with nature in all 14 patterns. Future studies could explore issues relating to the low percentage of these patterns, highlighting their underlying causes. According to the findings of this study, Bilkent School is a good base for future designs in Erbil city because of the presence of most of the biophilic design patterns, as indicated by their high percentages. Based on the findings, modifications could be made to other locally designed schools by applying patterns of biophilic design, thus helping to improve the productivity of students and enhance connectivity with nature. Furthermore, it can be concluded that this building can be used as a model to evaluate the biophilic design criteria in other types of building. Finally, the study serves as a useful survey that may assist in the design of future pilot studies in Erbil.

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