



The Attributes of Biophilic Design (Educational Buildings Case Study)

Hiyam Siham Taha

Authors affiliations:

Dept. of Architecture Eng.,
College of Engineering, Al-
University of Nahrain, Baghdad
-Iraq.
hayam.suham@nahrainuniv.edu.iq

Paper History:

Received: 22nd Mar. 2023

Revised: 27th April 2023

Accepted: 14th May 2023

Abstract:

Three decades of empirical research have proven that well-being in humans is stimulated by designs that link people to natural elements and landscapes. Environmental psychology research also revealed that these characteristics can lower stress and anxiety while having a positive impact on human productivity. therefore, there were more recent interest from theorists and architects to discover approaches to re-connect the constructed environment with the natural components. One of the most current theories of re-communication and its use in architecture is called "biophilia.". Therefore, the research problem is the lack of knowledge of biophilic architecture and what are the most prominent features affecting the user. the research aims to shed light on the basics of this design theory as well as testing its design patters in the educational environment to find out which attributes are most effective for users in improving productivity and well-being By adopting the quantitative descriptive approach and based on a questionnaire for the purpose of adopting it in design and to aid in the practical application of the Biophilia idea by designers and architects. The research concluded that there are design features that are more important than others for educational buildings, such as (day light, water, air, plants, landscapes, mobility, integrating the parts to create the whole).

Keywords: Biophilia, Biophilic Design, Human-Nature Relationship, Biophilic Design Patterns, Biophilic Design Attributes.

سمات التصميم البيوفيلي (المباني التعليمية كحالة دراسية)

هيام سهام طه

الخلاصة:

في العقود الثلاثة الماضية أكدت الأدلة التجريبية ان التصميم التي تربط الانسان بالمكونات والمناظر الطبيعية تساعد على تحفيز الاحساس بالرفاهية لدى البشر، اظهرت النتائج في علم النفس البيئي ايضا هذه الميزات لها تاثيرات ايجابية على انتاجية الانسان ويمكن ان يقلل من الاجهاد والقلق لذلك كان هنالك مزيد من الاهتمام مؤخرًا من المنظرين والممارسين لايجاد طرق لاعادة ربط البيئة المبنية بعناصر الطبيعة. وتعد البيوفيليا من احدث هذه النظريات لاعادة التواصل وامكانية تطبيقها في العمارة لذلك ان مشكلة البحث هو النقص المعرفي بالعمارة البيوفيلية وماهي ابرز سماتها المؤثرة على المستخدم. لذلك يهدف البحث الى تسليط الضوء على دعائم هذه النظرية التصميمية وكذلك اختبار سماتها التصميمية في البيئة التعليمية لمعرفة السمات الأكثر فعالية عند المستخدمين في تحسين الانتاجية والرفاهية من خلال اعتماد المنهج الوصفي التحليلي وذلك لغرض اعتمادها في التصميم ولمساعدة المصممين لتطبيق مفهوم البيوفيليا في الممارسة العملية.خلص البحث الى ان هنالك ميزات تصميمية ذات اهمية أكثر من غيرها بالنسبة للمباني التعليمية مثل(ضوء النهار ، الماء ، الهواء ، النباتات ، المناظر الطبيعية ، التنقل ، تكامل الأجزاء لإنشاء الكل)



1. Introduction:

Over the course of human history, mankind has developed methods of adapting to nature however, this process started to slow down after the industrial revolution., when the inhabitants of cities were isolated from the natural environment [1] and the prevailing design approach encouraged the modern urban environment massive alteration and degradation of natural systems as well as growing human disconnection from nature have led to increased energy use, the use of non-renewable resources, biodiversity loss, and chemical pollution., climate change and human alienation [2] in addition to that 90% of our time is within the built environment, Considering that By 2030, 60% of the world's population is expected to live in cities, it is imperative to reevaluate how to preserve the bond between urban residents and nature. [3], but progress in sustainable design in recent years has led to an improvement in the situation somewhat, but sustainable design focuses on reducing environmental damage caused by pollution or excessive use of natural resources however, the missing thing remained, which is the connection with the natural environment in modern buildings, which is necessary for human health and well-being, since man has an innate need to communicate with nature for the safety of health. it concerns the physical and mental, so it is called biophilia, and meeting this need in the modern built environment is biophilic design [4] therefore, the biophilic design was concerned with creating a good habitat for people in the modern built environment that meets their inherent needs to communicate with the natural environment, as the natural environment includes two types, which are living, which includes plants, animals, and all living and natural non-living organisms, which are water, sunlight, soil, oxygen, and temperature [5]. Biophilic architecture is part of a new concept in architecture that works intensively with the principles of human health, the environment and sustainability as an integrated part of the architectural composition that must be ideally proportional to other buildings [6], and a study of the findings in the field of environmental psychology demonstrates that people are drawn to natural landscapes and elements on an aesthetic level. It was also discovered that they have beneficial effects on human performance, as well as reducing stress, chronic fatigue, depression, and loss of productivity. therefore, re-establishing the relationship between nature and humans and integrating natural features into the built environment is the ideal solution [7] through many practical proposals to reach for best results.

2. A Historical View:

The relationship between nature and architecture is very old, and one of the oldest such examples is the hanging gardens in Babylon. architects have always been inspired by nature, taking natural shapes and proportions. since then, they have been striving to achieve aesthetic perfection. for example, in ancient Egypt, columns were designed from palm

trees and lotus plants, using human proportions. to achieve balance in the design, therefore, nature is a source of inspiration for architects who try to communicate with it and learn from it and take different paths [8], that the term biophilia appeared for the first time when Erich Fromm, a social psychologist, first used the term in 1964 to refer to a the love of life or the it psychological obsession of attraction to things vitality and livingness [9,10] and biophilia is a “term that stems from the Greek roots meaning love of life”, then this was followed by the biologist and naturalist Edward Wilson in 1984, where he defined biophilia “as the innate tendency of man to focus on life in the event of this link rupture, various physical and psychological defects occur in human health through many scientific investigations” [5,11].then, the social ecologist “Stephen Kellert” (1993) identified nine values of biology: “utilitarian, naturalistic, scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic , and negativistic”. Then, in 2008, “Kellert” in reference “Biophilia” is the term used to describe the innate human desire to participate in natural systems and processes. The notion subsequently switched from examining the link between humans and the natural world to focusing on life and living organisms, at the start of the 21st century, “biophilia” was developed within architecture and attention was drawn to the interaction of the built environment. with the natural environment [12,13].

3. Biophilia and biophilic design:

Kellert defines “biophilic design” as a “deliberate attempt to satisfy the need to connect to natural systems and processes in the contemporary built environment and to improve the physical and mental health and productivity of people”. Therefore, biophilic design can promote beneficial communication between man and nature and produce a positive environmental impact [12]. It is an intentional endeavor to incorporate knowledge of people's innate kinship with natural systems and processes—known as vital life—into the design of the built environment [1] and that while having different methods, there are two hypotheses that advocate spending time in nature for health and well-being. the first theory (stress recovery) suggests that contact with natural characteristics exposure to them can lessen unpleasant emotions and aid in the recovery from physiological stress. (such as plants and water) can cause a quick psychological reaction. According to a different idea, performing too many cognitive tasks might cause mental stress and brain exhaustion. while we do not need a lot of energy to interact with nature therefore provides an opportunity to restore exhausted attention [12,14]. the basic principles of biophilic design are:

- Frequent and continuous participation with nature.
- A plan that places greater emphasis on human adaptability to the environment than on evolution.
- Promotes a sense of emotional connection to specific locations.



- Encourages healthy interactions between people and nature that foster a sense of obligation to both natural and human communities.
- Encourage coherent and mutual reinforcement and integrated architectural solutions [15].

That Natural shapes and patterns serve as a language and compositional rules in biophilic architecture, which is a cutting-edge approach that paves the way for a natural conversation between a collection of human intrinsic affinities and architectural places. Direct access to sunlight, clean air, living things, and green spaces are some specific tactics for starting this conversation. [16] and that the task for biophilic design is to overcome the flaws of modern architecture and to launch a new framework for the advantageous experience of nature in the urban environment. [3]. While sustainable design focuses on the physical aspects of how people must connect with nature, biophilic design emphasizes the emotional side of that interaction. And from the perspective of biophilia, sustainable architecture is the modern architectural thinking that is in harmony using environmental frameworks based on prudent and ethical use of finite resources and energy, which is achieved through the integration of a work system of technical intelligence and multiple disciplines., Even though the inverse relationship between changing consumption habits, lifestyles, and natural resources is widely acknowledged as posing a serious threat to sustainability on both a local and global scale, it is also known to make it possible to integrate the economic, social, and environmental aspects of sustainability into design processes in a balanced manner. Therefore, instead of emphasizing human comfort, sustainable architectural design is concerned with the future of the planet. while biophilic design focuses on human dependence on nature and creating the positive connection necessary for human health. and its productivity and well-being and extends beyond that to reach aesthetic, intellectual, cognitive and even spiritual satisfaction. these goals are the essence of “biophilic design”, which is the missing link in the current sustainable design [1].

4. The importance and benefits of the biophilic design:

There are many reasons for studying biophilic design, the most important of which is the desire for widespread recognition of nature in the contemporary built environment to create frameworks for comprehending nature in architecture, as well as the reality that many design ideas related to nature are used as tactics (e.g., environmentally friendly washing) or placebo treatments, therefore more research should be done to look into their impacts. [12]. however, there are many empirical studies that support that access to nature Since it promotes the principles of respect for and care for the environment, it ought to be accessible to everyone who lives in cities, not only those who reside in the suburbs. This is true regardless of one's age, gender, or color., and there is

a review article published in 2009 that summarized more than fifty experimental studies focusing on the importance of visual communication with nature for human health and well-being. interacting with plants outdoors and indoors is a good initiative for the environment and has an appropriate cost. [4]

The advantages of "biophilic design" include:

- In the workplace: productivity increases, absenteeism decreases, concentration increases, mood improves, and general health improves when transferred to buildings with lighting and landscaping.

- In hospitals: integrating nature into health care improves medical outcomes and speeds up recovery [11]

And that the healing environment is a physical environment that can accelerate recovery time or adaptation to disease in chronic cases through psychological effects that affect the final state of health by reducing recovery time, reducing feelings of stress, and improving mood [17]

- In education: in educational buildings, merging nature with classrooms leads to enhanced focus, increased test results, reduced student absenteeism, increased learning rates, and improved student behavior.

- Most of the distinguished and successful buildings in the world are in forms inspired by nature and respectful of nature [4], for example, the (Fallingwater house) building by frank lloydright is a biophilic building, despite the absence of this concept previously, which is the reason for the great distinction of this building [13] and there are many behavioral benefits include improved mental health, decreased stress, increased attention and well-being, decreased violence and crime, and reduced stress and anxiety [18]. Therefore, we believe that environmental degradation and a growing disconnection from nature are not inevitable consequences of modern life but rather failures in the way we chose to design our buildings and cities[4]. Biophilic design can help us resolve this conundrum by enhancing our quality of life and is not just a luxury but also a wise financial investment in our health and productivity, as well as our ability to learn more quickly and with less stress. Based on thoroughly researched neurological and physiological data.

5. Design strategies to achieve biophilic design:

In 2008, kerlet developed a proposal to interpret the biophilic design methodology, consisting of two basic dimensions, six elements, and more than seventy features [19][3]. the elements consist of:

1. “Environmental features”: it includes natural characteristics and features such as "sunlight, fresh air, plants, animals, water, soil, landscapes, natural colors, and natural materials such as wood and stone".
2. “Natural shapes and forms”: mimicry and simulation of natural forms found in plants and animals, such as leaves, shells, trees,



3. “Natural patterns and processes”: the procedures and structures that characterize the natural world, particularly those that played a significant role in the evolution of man.
4. “Light and space”: Natural lighting, the sensation of spaciousness, and the combination of light, space, and mass are just a few examples of the spatial elements and lighting that can elicit meaning from being in the natural environment.
5. “Place-based relationships”: By incorporating geological and landscape aspects, using native materials, and connecting to historical and cultural traditions, it is possible to create spatial links between structures and the distinctive geographic, environmental, and cultural characteristics of particular locales.
6. The development of human relations with nature: the natural inclination towards nature and the sense of containment and sanctuary [11]. Then,

the proposal was simplified and a new proposal was developed in (2014) under the title (experiments and characteristics of biophilic design) that includes twenty-four features within three main categories [20]:

1. Direct experience of nature.
2. The indirect experience of nature.
3. Space and place experiences.

Then, these two proposals were revised and updated with a new model (browning and ryan) in 2020 consisting of three main categories with 12 attributes, and these categories are: 1.figure (1)

1. Nature in the space.
2. Natural analogues.
3. Nature of the space.

The three headings he describes are similar, sharing that they are very close to each other in terms of meaning and the sub-headings are very similar but with different words [13,21].

2 Dimensions, 6 Elements, and 72 Attributes of Biophilic Design (Kellert, 2008b)					
I. Organic or Naturalistic				II. Place-based or Vernacular	
1. Environmental features	2. Natural shapes and forms	3. Natural patterns and processes	4. Light and space	5. Place-based relationships	6. Evolved human-nature relationships
<ul style="list-style-type: none"> • Color • Water • Air • Sunlight • Plants • Animals • Natural materials • Views and vistas • Façade greening • Geology and landscape • Habitats and ecosystems • Fire 	<ul style="list-style-type: none"> • Botanical motifs • Tree and columnar supports • Animal (mainly vertebrate) motifs • Shells and spirals • Egg, oval, and tubular forms • Arches, vaults, domes • Shapes resisting straight lines and right angles • Simulation of natural features • Biomorphy • Geomorphology • Biomimicry 	<ul style="list-style-type: none"> • Sensory variability • Information richness • Age, change, and the patina of time • Growth and efflorescence • Central focal point • Patterned wholes • Bounded spaces • Transitional spaces • Linked series and chains • Integration of parts to wholes • Complementary contrasts • Dynamic balance and tension • Fractals • Hierarchically organized ratios and scales 	<ul style="list-style-type: none"> • Natural light • Filtered and diffused light • Light and shadow • Reflected light • Light pools • Warm light • Light as shape and form • Spaciousness • Spatial variability • Space as shape and form • Spatial harmony • Inside-outside spaces 	<ul style="list-style-type: none"> • Geographic connection to place • Historic connection to place • Ecological connection to place • Cultural connection to place • Indigenous materials • Landscape orientation • Landscape features that define building form • Landscape ecology • Integration of culture and ecology • Spirit of place • Avoiding placelessness 	<ul style="list-style-type: none"> • Prospect and refuge • Order and complexity • Curiosity and enticement • Change and metamorphosis • Security and protection • Mastery and control • Affection and attachment • Attraction and beauty • Exploration and discovery • Information and cognition • Fear and awe • Reverence and spirituality
3 Experiences and 25 Attributes of Biophilic Design (Kellert, 2018)					
1. Direct Experience of Nature		2. Indirect Experience of Nature		3. Experience of Space and Place	
<ul style="list-style-type: none"> • Light • Air • Water • Plants • Animals • Landscapes • Weather • Views • Fire 		<ul style="list-style-type: none"> • Images • Materials • Texture • Color • Shapes and forms • Information richness • Change, age and the patina of time • Natural geometries • Simulated natural light and air • Biomimicry 		<ul style="list-style-type: none"> • Prospect and refuge • Organized complexity • Mobility • Transitional spaces • Place • Integrating parts to create wholes 	
3 Categories and 15 Patterns of Biophilic Design (Browning and Ryan, 2020)					
1. Nature in the Space		2. Natural Analogues		3. Nature of the Space	
<ul style="list-style-type: none"> • 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 		<ul style="list-style-type: none"> • Biomorphic Forms & Patterns • Material Connection with Nature • Complexity & Order 		<ul style="list-style-type: none"> • Prospect • Refuge • Mystery • Risk/Peril • Awe 	

Figure (1): There are three main pillars of biophilic design (Source: authors, adapted 2,14).

6. Methodology:

Through the theoretical framework and examination of all classifications, it was decided to choose the design features within the Kellert study because it is more comprehensive and more appropriate. The main contribution of this article is

to measure the feature that has the most impact on users in terms of achieving well-being and improving performance by adopting the quantitative descriptive approach and conducting a questionnaire for architectural experts and professors in the university environment, numbering 33 architects from three



universities (Al-Nahrain, Baghdad, and Babylon). And test the extent to which each of these features affects performance, well-being, and improving mental health in the educational environment. Through this questionnaire, designers can know what are the most influential features and what are the least influential features.

The tested features are:

1- Day light: natural light is important for human health and creating interaction with day and night and seasons through the movement of the sun and can be adopted in spaces through walls and ceilings and the use of reflective surfaces to create different and attractive forms of lighting and create an interaction between shadow and light.

2- Water: water is necessary for life, and its presence relieves tension and enhances satisfaction and performance. It can be included in the design through water bodies, fountains, water basins, waterfalls, and approaching rivers [22].

3- Air: natural ventilation is necessary for human comfort and can be improved by creating differences in temperature and pressure to create air flow and activate natural air movement. It can also be activated through more complex strategies.

4- plants: introducing green cover into buildings and integrating plants through green roofs and walls to improve comfort.

5- Animals: establishing green spaces that are animal-friendly and developing facilities to accommodate animals, such as ponds and tanks for fish, to foster a connection with nature.

6- Landscape: paying attention to the design of gardens outside buildings, such as entry areas and corridors, and the use of rocks and natural materials in them.

7- Weather: exposure to climatic changes through transparent windows and roofs, trying to let in sunlight and direct contact with outside weather.

8- Views: the extent to which the angles of view are open to landscapes, whether for internal or external spaces.

9- Fire: it can be a source of comfort and anxiety, and it can be obtained through stoves and barbecue places [15].

10- Images: it includes displaying pictures of landscapes inside and outside the building, such as plants, animals, and geological features.

11- Materials: preferring the use of natural materials over industrial materials such as (wood, stone, leather,)

12- Colors & texture: the use of textures and colors inspired by nature is a way to communicate

with it, such as the colors of plants, stones, soil.....etc.[23]

13- Shape & forms: building shapes inspired by nature, such as plant shapes or water movement, as well as the use of plant and animal motifs and all shapes taken from nature.

14- Information richness: people tend to respond positively to technical and diverse environments with information as long as the complexity is experienced.

15- Age, change, and the patina of time: nature is in a state of continuous change, and the change of the building with time is tantamount to adapting the building to nature, and it is a response to the change of time and time.

16- Natural geometrics: it is drawing inspiration from forms that may not be directly from nature, but reflect nature's inspirations, such as using the same patterns and proportions.

17- Simulated nature light and air: (simulating natural light and air) technological progress led to the inevitability of using artificial light, but this lighting and ventilation can simulate nature through the dynamics of light as well as differences in the intensity of air flow and its temperature, as in natural ventilation.

18- Biomimicy: it is to take advantage of natural systems such as plant or biological systems and employ them in buildings through structural or design systems.

19- Prospect and refuge: anticipation and refuge can be achieved through outward-facing design strategies with visual communication between interior design and protected settings.

20- Organized complexity: people often like complexity, but excessive complexity may be confusing and chaotic, so the complexity that is experienced is in an organized manner. [24]

21- Mobility: mobility designing movement paths and clearly understood entry and exit points is important to enhance the sense of security in the building.

22- Transitional spaces: transitional spaces are often links between spaces that facilitate the process of transition and include corridors, thresholds, entrances, balconies and patios.

23- Place designs related to culture, spatial association, and a sense of place identity reinforce environmental ties to the place as they stimulate the preservation and sustainability of the natural environment.

24- Integrating the parts to create the whole: integration of parts to create the integrated environment. [15]

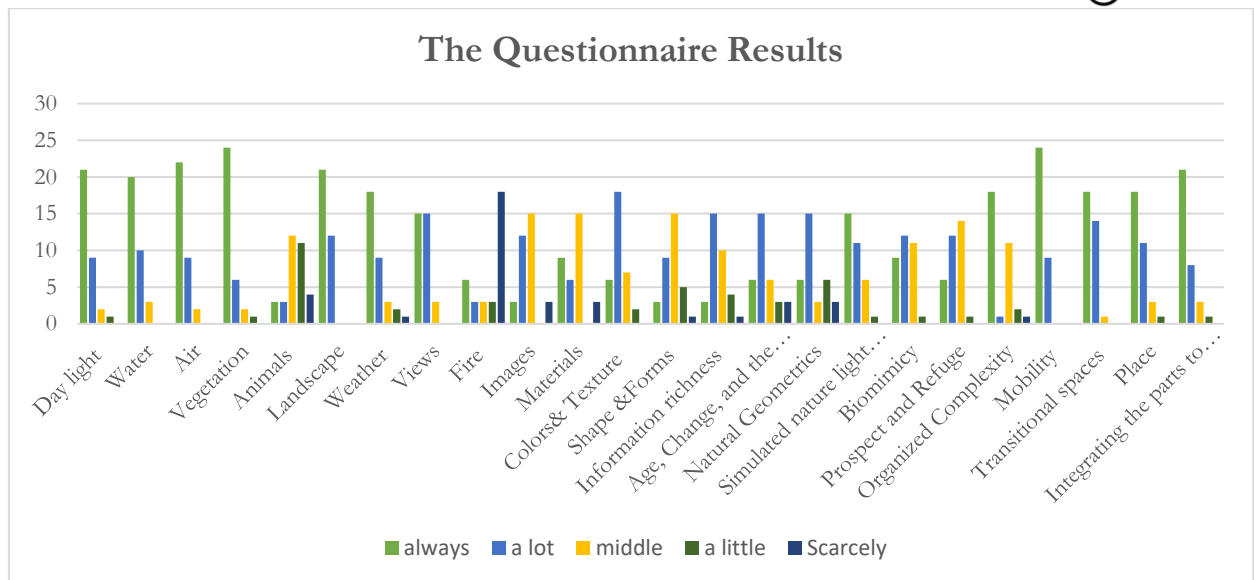


Figure (2): The Questionnaire Results (Source: author)

7. Results:

The results of the questionnaire, which included 33 samples, indicate that there are some design features that are more important to experts and users of the educational environment, which are (day light, water, air, plants, landscapes, mobility, integrating the parts to create the whole).

Therefore, they are features that must be available and adopted as design criteria in the educational environment, and some features are less important to achieve the well-being of users, which are (fire, animals, information richness, prospect and refuge, shape & forms)

Therefore, designers can adopt them in the design, but with a less important degree than the first features, and the rest of the features are graded in medium importance among them, as in figure (2).

8. Conclusions:

Improving the building's connection with nature and the sense of the building's belonging to it is no less important than lowering energy use in order to achieve sustainability. "Biophilic buildings" contain rich sensory stimuli that support a sense of satisfaction and well-being and reduce stress and tension among users, and when examining the architectural works that have been published in architectural literature, we note that most of them integrate natural elements with the building despite the lack of biophilia previously. Therefore, the research assumed that biophilic architecture has a significant impact on the productivity and well-being of the user in the educational environment. Through the research paper, we conclude that there are many design features to achieve biophilic design, but there are more important features for users of the educational environment than the rest of the features, which are (day light, water, air, plants, landscapes, mobility, integrating the parts to create the whole).

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