ISSN: 2329-6119 (Print)
ISSN: 2329-6100 (Online)

International Journal of Life Science Study (IJLSS)

DOI: http://doi.org/10.7508/ijlss.01.2024.04.07

ARTICLE

ENHANCING INFORMAL LEARNING ENVIRONMENTS THROUGH BIOPHILIC DESIGN: AN INNOVATIVE APPROACH

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ARTICLE DETAILS

Article History:

Received 9 January 2024
Accepted 17 February 2024
Available online 7 March 2024

ABSTRACT

The informal learning environments play a crucial role in complementing traditional educational settings, catering to the evolving needs of college students for autonomy, creativity, and flexibility. Based on the concept of biophilic design, this paper discusses the application of biophilic theory in informal learning space and improves the quality of learning space by introducing natural elements based on the problems of college students learning pressure and anxiety, combined with the physiological, and psychological and learning behavior characteristics of college students. Drawing on biophilic design theory, this paper analyzes the health benefits of biophilic design, summarizes the elements of biophilic design in informal learning spaces, and tries to put forward design methods and strategies for informal learning spaces in the future. This study aims to understand the relevance of biophilic theory and the design of informal learning spaces, analyze the impact of biophilic spaces on learners' experiences and outcomes, and provide targeted suggestions for educational practice, to motivate schools, educational institutions, or designers to adopt innovative design concepts to improve learning spaces.

KEYWORDS

Biophilic, Informal learning spaces, Health benefits

1. Introduction

With the swift advancement of the social economy and information technology, education has transitioned into the 4.0 era, aiming to enrich learners' mental experiences and foster their cognitive development. Education 4.0 heralds a transformative shift in higher education paradigms and innovation, positioning informal learning spaces as pivotal venues for educational activities. This shift acknowledges that traditional, time-and-space-bound teaching and learning activities are increasingly unable to fulfill the diverse learning needs of today's learners. A domestic study shows that 73.2% of college students have varying degrees of psychological stress, among which academic pressure and uncertainty pressure have the greatest impact on mental health. Research from the Smart Classroom program in the UK shows that naturalness has the greatest impact on students' learning progress(Feng, et al., 2023). Based on this, it has become an important research topic to explore the relationship between biology and informal learning spaces and to provide innovative design concepts for educational practitioners and designers. Previously, most scholars mainly discussed the healing and restorative functions of horticultural landscapes, the application of biophilic design in medical and elderly care buildings, and the combination of virtual reality technology and biophilic design(Hu, et al., 2023), for example, Jiang et al. (2021) discussed how to improve biophilia to restore the remaining space of the planned city from the perspective of resilience design; Wang et al. (2023) explored the influencing factors of biophilic quality and the relationship between the quality of living streets and perceptual restoration, to enhance the natural characteristics of streets and improve the adaptability of human body and mind in the artificial built environment. Han et al. (2021) explored the application of biophilia theory in senior care buildings and how to improve the built environment of senior living buildings by introducing natural elements. Drawing from a comprehensive review of literature and theoretical foundations, this paper examines the influence of biophilic design on learners' efficiency and emotional well-being. It identifies critical aspects of biophilic design applicable to the enhancement of informal learning spaces. Through an in-depth exploration of the relationship between biophilia and informal learning environments, this study aims to offer insights into the application of biophilic principles within educational spaces for inspiration and guidance.

Overall, fostering a connection with nature and incorporating natural elements through biophilic design emerges as a vital strategy for enriching the learning experience and elevating the quality of learning environments. This approach holds significant promise for the sustainable evolution of informal learning spaces, highlighting its importance in the ongoing development of educational settings.

2. Biophilia and Health Promotion

2.1 The concept of biophilic design

Biophilic design is rooted in the concept of biophilia, which refers to the inherent human inclination towards life and living systems, manifesting as a preference for natural elements. The term "biophilia" was originally coined by the German-American psychoanalyst and philosopher Erich Fromm, and it was further elaborated and popularized by the American biologist and researcher Edward O. Wilson in his seminal 1984 work, "Biophilia." Biophilic design refers to a design method that conforms to the human biophilic nature by integrating natural forms and elements into the design and introducing natural elements into the design strategy of environmental design under the guidance of theories such as 'wait-and-see and shelter', 'complexity and order', and 'connection with natural systems' (Clancy, et al., 2015). Biophilic design is a bridge between humans and the natural environment, contributing to environmental sustainability and generating health benefits through connectivity with natural elements.

2.2 The role of biophilic design

Biophilic design is not simply to meet the needs of users, but is reflected in achieving design goals at different levels. Biophilia is a biological attribute formed by the long-term evolution of human beings in nature and is one of the basic needs of human beings (Liu, et al., 1984). In terms of physiological factors, staying in touch with nature helps the brain produce endorphins, calming the endocrine system and nervous systems, which in turn relieves physiological pain. American scholar Roger Ulrich published a longitudinal study in the journal Science on the relationship between the landscape outside the window and the patient's recovery time and experimentally proved that viewing the natural landscape can alleviate pain and has health benefits in the patient's recovery process (Ulrichr, 1984). In terms of psychological factors, biophilic design can alleviate mental fatigue, reduce stress, anxiety, and depression, and provide motivation for cognitive activity. In terms of environmental factors, biophilic design aims to shape an artificial environment that meets the needs of human biophilia while achieving the well-being of a green China.

3. Feasibility of biophilic participation in the design of informal learning spaces

3.1Concept of Informal Learning Space

Informal learning spaces represent an evolution and augmentation of traditional formal learning environments, embodying the diversification of educational spaces. These spaces are characterized by their non-conventional functionality, primarily aimed at fostering students' self-directed learning behaviors. Emphasizing autonomy, they cater to the demands of personalized learning experiences. Spaces such as corridors and courtyards exemplify this approach through their adaptability, ambiguity, and openness.In the current era, marked by rapid advancements in social science, technology, and shifts in cultural paradigms, learning methodologies have transcended beyond conventional education and hierarchical instruction models. Unbound by time and space, and facilitated by a multitude of learning channels, the acquisition of varied knowledge content has become a predominant mode of learning for students. This shift is crucial for enhancing the quality of education. Viewed through the lens of college student development, the innovative design of informal learning spaces addresses the educational needs of this demographic, bolstering learning efficacy, fostering positive educational experiences, and offering fresh perspectives for educational reform and the development of learning environments.

3.2Coupling relationship between university students and informal learning spaces

Informal learning spaces serve as a dynamic augmentation and diversification of traditional educational environments, significantly enhancing learning efficiency. Unlike the one-dimensional flow of communication typical in conventional learning settings, informal learning spaces encourage a multi-directional exchange of ideas, which stimulates critical thinking and facilitates the broad sharing of knowledge. These spaces are instrumental in nurturing learners' capacity for innovation and practical problem-solving. By fostering interaction and collaboration, learners are empowered to discover and implement effective strategies for addressing real-world challenges. This open and varied educational context is pivotal in cultivating innovative thought and practical abilities, marking a substantial shift from traditional educational models to more interactive and experiential learning frameworks.

Different from the learning behavior of primary and secondary school students, college students in higher education have different professional courses and learning tasks, which require higher autonomy and innovation ability, sufficient free time, and relatively higher learning freedom. For college students, the teacher-centered factory teaching model is no longer the main mode of learning. The discretionary learning time stimulates their desire for independent and in-depth learning, and the innovative learning requirements and team communication and cooperation requirements stimulate flexible learning behaviors, which coincides with Montessori's concept of liberal education. The characteristics of college students' learning behaviors need informal learning spaces as carriers, and the update of college students' learning habits promotes the innovation of learning space design.

4. Biophilic design model for informal learning space environments

Based on the analysis of relevant literature, this paper discusses three types of application models extracted from the *14 Models of Biophilic Design*, including nature in space, analogous nature, and space and place experience. (Table 1)

4.1 Nature-based direct experience

Informal learning spaces are open and different learning behaviors occur in the learning field, so the atmosphere of the space can be created by introducing direct natural elements.

The sense of belonging can affect the learning adaptability and learning behavior of college students, so it should be coordinated according to local conditions (Zhang, et al., 2023). One of the most straightforward ways to create a sense of place is to cater to the outdoor seasons, making full use of seasonal changes in vegetation to create biophilic learning spaces with a sizable view of the four seasons. Secondly, it is necessary to place water features to create fountains, water sounds, and other nodes suitable for viewing, listening, and touching. The water element can directly connect the visual, auditory, and tactile senses, inspiring a positive emotional connection between people and the place. Studies have shown that living near water can improve people's well-being and reduce the risk of death (Adele, et al., 2018).

4.2 Nature-based indirect experiences

Elements reminiscent of nature can subtly foster the connection between humans and the natural world. Leveraging digital technology, it's possible to recreate natural vistas, such as views from a window, and auditory experiences that mimic the sounds of nature. Concurrently, the strategic use of natural materials, like wood, can stimulate olfactory senses, allowing for a comprehensive integration of the five senses to craft immersive natural settings. Clinical comparative studies underscore the significance of spatial organization and the meticulous incorporation of natural elements in promoting health benefits. Consequently, an essential strategy for designers involves utilizing the floor and ceiling to delineate spatial hierarchies based on functional requirements, thereby crafting a biophilic environment that supports wellbeing.

4.3 Space-based and place-based experiences

The shelter and lookout functions of the 'savannah landscape' can make people relax, so it is of great significance to make full use of large herbaceous plants to divide the functional space and supplement the natural details in the design of informal learning spaces, which is of great significance for improving the visual quality. Due to the diversity of learning content and learning forms of college students, it is necessary to flexibly lay out informal learning spaces and consider the learning needs of college students such as teamwork and communication.

5. Strategies for designing biophilic informal

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In the context of advancing high-quality education, informal learning spaces have emerged as critical environments for college students' educational activities. A pivotal question addressed in this research is the integration of biophilic design within these informal learning spaces to enhance health benefits and augment learners' efficiency and effectiveness. Leveraging the three design models articulated by scholars in the field of biophilic design, this study proposes tailored design strategies that cater to the unique requirements of biophilic, flexible, and diverse informal learning spaces. These strategies are aimed at optimizing the symbiosis between biophilic principles and the dynamic, multifaceted nature of informal learning environments.

5.1 Diversity and Flexibility

Based on the learning needs of college students, informal learning includes extracurricular knowledge exploration and extension, digital learning experience, teamwork, discussion and sharing, etc. Therefore, informal learning spaces should be multi-functional, including individual learning, team communication and cooperation, social discussions, leisure, and other spatial forms. The diverse learning activities that occur in the learning field require that the spatial form is not limited to the regular layout form, and that multiple functions are cross-juxtaposed and intensive, so as to improve the efficiency of space use and enhance the learning effect and learning experience of learners. The biophilic design process should maintain the unity of indoor and outdoor scenes, use herbaceous plants and waterscape nodes of various heights and forms to divide the space and create a spatial atmosphere with diverse space forms. Bringing natural light into the room can help ease learners' anxiety and tension. At the same time, the single combination form of space is broken, and a variety of interface treatment methods and furniture enclosure forms are used in the design to meet the practicality and sense of form. If climate conditions permit, ventilation and lighting can be improved by installing patios, skylights, etc., to demonstrate the diversity of natural elements and dynamic changes.

5.2 Humanization and Openness

Informal learning space is to transform passive space constraints into active space creation, and the connection and interaction of human-natural elements and space should be realized in the design. According to Maslow's hierarchy of needs, deficit needs are the basis for improving learner satisfaction and ensuring space utilization, and it is necessary to meet the needs of accessible infrastructure, learning resources, and services. Growth needs are a core part of biophilic informal learning spaces. For the effective realization of biophilic design in informal learning spaces, studies have shown that real natural objects have a more significant positive effect than quasi-natural objects, and the systematic and integrated application of natural elements has more health benefits than single natural elements (Kellert, 2018). First of all, it is necessary to meet the basic functional needs of learners, including the use of wood furniture, cotton and linen decorations, adjustable wavelength lighting, and a sound environment controlled at 50-70 decibels (Mehta, et al., 2012). Secondly, it is necessary to meet the individual needs of learners, including spatial privacy, sense of field boundaries, creativity, etc. Including the use of detachable furniture to meet the needs of learners and realize the interaction between people and furniture; The use of ground lifting, plant enclosure, and other forms to build spatial boundaries, etc. Finally, it is necessary to improve learners' spatial experience, self-worth, and sense of belonging. A study by the University of Michigan in the United States showed that a lack of belonging can trigger anxiety and increase a person's risk of depression. Therefore, in the creation of a spatial atmosphere, it is necessary to configure landscape nodes according to regional location and seasonal cycle changes, for example, in the northern winter, plants are mostly

Table 1: Biophilic Informal Learning Space Design Model

Biophilic design patterns	Natural elements	Methods for the application of natural elements
Directness of nature	plant animal Sunlight body of water air Natural systems	A variety of plants are incorporated to cater to the indoor and outdoor seasons. Animals with healing functions are raised inside and outside the space. Introduce natural light by making full use of natural light, such as floor-to-ceiling windows. Set up landscape nodes such as fountains and flowing water. Indoor and outdoor air circulation, placed with fragrant natural vegetation. Integrate flexibility into the environment and integrate the design of the space.
Class natural	Natural image model Natural materials Natural shapes Natural colors Simulate light Simulates air Natural process of change	It is presented in the form of photographs, digital technology, paintings, etc. Natural wood, stone, cotton and other materials. Fractal geometry, curvilinear forms and other expressions and furnishings. Use natural hues such as plants, sky, animal fur, etc. Simulate changes in color temperature, brightness, and illuminance of natural light. Use humidifiers, fragrances, and more to adjust the air flow and olfactory experience Optimized imitation of natural cycle changes.
Space and place experiences	Security A sense of place Lookout and shelter	Large herbaceous plants are used to create a sense of spatial shelter, and the design techniques of raising and lowering the ground are used to divide the spatial hierarchy. Establish a connection with local history, culture, humanities and customs, and create a sense of place.

withered, and whitebark pine, holly, and plum can be introduced; It is also necessary to fully establish ties with local cultural customs and historical contexts. It can improve self-efficacy and learning resilience.

5.3 Affectivity and interactivity

Informal learning spaces can leverage digital technology to cultivate immersive learning environments and enrich learning experiences through contextual interactivity. Jan Gehl advocates prioritizing "human life," emphasizing the human-centric approach in design. In biophilic informal learning spaces, adhering to the principles of "five senses" therapy, natural visual landscapes, auditory experiences, and aromas can be simulated using advanced information technologies like holographic projection, virtual reality (VR), and augmented reality (AR). Additionally, negative ion technology can be employed to elevate oxygen levels and promote emotional well-being, contributing to a more tranquil and conducive learning atmosphere.

6. Conclusion

As the primary venues for college students to engage in independent learning, collaborative teamwork, and social interaction, informal learning spaces play a pivotal role in facilitating the high-quality learning and overall development of students. In the context of diverse educational approaches, academic pressures, and uncertainties faced by college students, the construction of biophilic informal learning spaces emerges as a viable solution that addresses their multifaceted needs. This paper delves into the intersection of college students' learning behaviors, the essence of biophilia, and the characteristics of informal learning spaces, exploring the interconnectedness between students and their learning environments. It examines the application of biophilic design principles in shaping informal learning spaces, envisioning the integration of digital technology to create digitally enhanced environments that prioritize health and well-being, thereby enhancing the overall learning experience and efficacy for students.

The study necessitates a detailed exploration of various styles of informal learning scenes, coupled with empirical investigations to validate the impact of biophilic design on learning outcomes and psychological factors. Looking forward, as higher education continues its trajectory towards high-quality development, future research on informal learning spaces should align with the evolving landscape of digital technology. Creative utilization of biophilic design methodologies will be crucial in crafting spatial environments that foster optimal learning experiences and outcomes for students.

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