

Biophilic Design Principles in Library Interiors: A Proposal for a Conceptual Design Guide

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Abstract

As urbanization, digitalization, and prolonged indoor occupancy increasingly weaken human contact with nature, biophilic design has emerged as a significant approach for improving the environmental quality of learning spaces. Although a growing body of research has examined the cognitive, psychological, and experiential benefits of biophilic environments, studies focusing specifically on library interiors remain limited. Addressing this gap, this study investigates how biophilic design principles become spatially visible in contemporary library interiors and how these principles can be systematized into a conceptual design guide. The research adopts a qualitative multiple case study method and examines four contemporary libraries selected from different geographical and cultural contexts: Library in the Earth (Japan), Calgary Central Library (Canada), Seashore Library (China), and Austin Central Library (USA). The cases were analysed through thematic visual and spatial interpretation based on established biophilic design frameworks. The findings reveal that natural light, visual connection with nature, materiality, prospect–refuge balance, and spatial transition strategies are the most consistent biophilic components across the cases, although their expression varies according to context. Based on these findings, the study proposes a conceptual design guide for library interiors. The article contributes to the biophilic design literature by offering a library-specific, design-oriented framework for future practice.

Keywords: *Biophilic Design, Library Interiors, Learning Environments, User Experience, Environmental Comfort, Spatial Quality, Conceptual Design Guide.*

Introduction

Rapid urbanization, digitalization, and the increasing amount of time spent indoors have made it necessary to reconsider the relationship between humans and the natural environment within architecture and interior architecture. As contemporary life is increasingly conducted in indoor settings characterized by artificial materials, limited daylight, and declining environmental quality, users' physical comfort, psychological well-being, and environmental satisfaction may be adversely affected. In this respect, user-oriented green building research has clearly demonstrated the relationship between environmental comfort and user satisfaction (Yasar et al., 2025). Accordingly, the built environment can no longer be regarded merely as a physical shell that accommodates functional requirements; rather, it should be understood as an environmental system capable of influencing cognitive, emotional, and behavioral processes. Classic findings on restorative environments and views of nature, together with the contemporary literature on biophilic design, support this perspective (Ulrich, 1984; Wilson, 1984; Tekin et al., 2025).

Within this context, biophilic design has emerged as a holistic approach that reintroduces humans' innate affinity for nature into the built environment. The intellectual roots of the concept can be traced to Fromm's definition of "biophilia" as a positive orientation toward life and living systems, while its theoretical formulation was further developed through Wilson's biophilia hypothesis, which conceptualized human beings as possessing an inherent tendency to affiliate with the natural world (Fromm, 1964; Wilson, 1984). Subsequently, Kellert and Calabrese (2015) and Browning et al. (2014) translated this perspective into an applicable architectural and design framework by identifying key biophilic strategies such as natural light, vegetation, water features, natural materials, biomorphic forms,

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and visual or multi-sensory connections with nature (Browning et al., 2014; Kellert & Calabrese, 2015). In support of this framework, research on contemporary university buildings has shown that biophilic design principles can produce tangible spatial outcomes through daylight, landscape relationships, visual contact with nature, and experiential qualities of space (Yasar & Öktem Erkartal, 2026).

The significance of biophilic design lies not only in its visual representation of nature but also in its potential effects on user health, environmental comfort, and cognitive performance. In environmental psychology, attention restoration, stress reduction, and restorative environmental experience have long been recognized as key outcomes of contact with nature (Kaplan & Kaplan, 1989; Ulrich, 1984). More recent studies focusing on educational buildings and learning environments have further demonstrated that biophilic features can enhance user well-being and spatial satisfaction. Peters and D’Penna’s (2020) critical review of university learning environments emphasizes the importance of nature-based and restorative design strategies for students’ quality of life and learning outcomes. Mahrous et al. (2024) found that natural light, natural ventilation, green elements, large openings, and natural finishing materials had significantly positive effects on university students’ satisfaction levels. Similarly, Latini et al. (2024), in an immersive office-like experimental setting involving university students, showed that audio-visual connections with nature could positively influence working memory, inhibition, and task-switching performance. Makaremi et al. (2024), in turn, argued that student well-being in higher education settings should be understood not only through individual comfort parameters but also through broader environmental and collective dimensions. In addition, within design education, biophilic design has been suggested to support creative thinking processes and shape design studio production (Yasar, 2023).

This discussion is particularly relevant to library interiors. Contemporary libraries are no longer merely repositories of information; rather, they function as multilayered learning environments that accommodate individual concentration, research, silent reading, collaborative work, and social interaction within the same setting. As a result, environmental variables such as daylight, views, indoor air quality, material selection, acoustic balance, and a sense of psychological refuge directly affect the quality of user experience in these spaces. Nevertheless, although the literature on the effects of biophilic design in offices, healthcare buildings, and educational settings continues to expand, studies examining how these principles can be systematically articulated in university libraries and similar learning-oriented interiors remain relatively limited (Peters & D’Penna, 2020; Sakip et al., 2024; Tekin et al., 2025). Sakip et al. (2024), who directly addressed university library environments, likewise emphasized that this area has received considerably less attention than office and healthcare typologies.

Against this background, the present article investigates how biophilic design principles become spatially manifest in contemporary library interiors. It is grounded in the assumption that biophilic design in libraries should not be understood merely as an aesthetic enhancement, but rather as a comprehensive issue of spatial quality that influences attention, psychological comfort, user satisfaction, environmental comfort, and the learning experience. In this respect, the study seeks to reveal the potential of biophilic design within library interiors and to establish a conceptual basis that can be translated into design practice. Accordingly, the following research questions are addressed:

RQ1. Through which spatial components and design decisions do biophilic design principles become visible in contemporary library interiors?

RQ2. To what extent can biophilic design principles in library interiors be systematized so as to support the development of a conceptual design guide?

The main contribution of this study lies in moving beyond a purely theoretical discussion of the relationship between biophilic design and library interiors and, instead, framing this relationship within a conceptually transferable design framework. More specifically, the study proposes a guide based on biophilic design principles for library interiors. In doing so, it argues that biophilic design in libraries extends beyond an aesthetic approach and should be understood as a holistic matter of spatial quality directly related to user well-being, attentional continuity, environmental comfort, and the learning experience. In this way, the article contributes to the biophilic design literature through the lens of library typology while also developing a conceptual guide for the design of library interiors.

Method

Research Design

This study adopts a comparative multiple-case study design within a qualitative research framework. The research was structured in two stages. In the first stage, the conceptual and theoretical foundations of biophilic design were established through a literature review. This stage examined the definition and scope of biophilic design, the historical transformation of library architecture, human–nature interaction in the built environment, the cognitive and psychological effects of biophilic spaces, and the principal theoretical approaches that have informed the field. In particular, Kellert’s approach to biophilic design, Browning, Ryan and Clancy’s framework of biophilic design patterns, E. O. Wilson’s biophilia hypothesis, Fromm’s concept of biophilia, and Kaplan and Kaplan’s Attention Restoration Theory provided the theoretical basis for the study.

In the second stage, case study analysis was undertaken, and the selected library buildings were comparatively examined in relation to biophilic design principles. The purpose of this stage was to identify the spatial, material, and environmental strategies through which biophilic design becomes visible in contemporary library buildings and, based on these findings, to develop a conceptual design guide for library interiors.

Case Selection

Purposive sampling was used in the study. The sample consisted of four contemporary library buildings that are internationally recognized, display clearly identifiable biophilic design features, represent different geographical and climatic conditions, and offer sufficient digital documentation for analysis. Accordingly, the cases selected were Library in the Earth in Japan, Calgary Central Library in Canada, Seashore Library in China, and Austin Central Library in the United States. The cases were selected according to four main criteria:

- The visibility and readability of biophilic features within the project,
- The recognition of the building as a notable and high-quality architectural example,
- The availability of visual and written documentation, including plans, sections, photographs, and project descriptions,
- The representation of different climatic, cultural, and user contexts.

These cases were selected as theoretically informative and analytically illustrative examples rather than as statistically representative samples of library design.

Data Collection Process

The data used in this research were obtained from publicly available digital sources. The data collection process was based on three main sources.

First, visual-spatial documentation of the selected libraries was compiled. In this regard, plans, sections, elevations, interior and exterior photographs, renderings, diagrams, video records, and, where available, virtual tour materials were examined through architectural platforms, official websites of design offices, and accessible digital archives. These materials constituted the primary source of data for evaluating spatial organization, the use of light, material character, interior–exterior relationships, and the visibility of biophilic design components.

Second, project descriptions and architectural narratives were analyzed. Design statements, project texts, and official promotional content published by architects or project teams were reviewed in order to understand the conceptual approach underlying each building and to identify how biophilic design principles were framed and justified within the project narratives.

Third, a coding framework based on the biophilic design literature was established to guide the analytical process. This framework was primarily informed by the 14 biophilic design patterns defined by Browning, Ryan and Clancy (2014) and was further supported by Kellert’s biophilic design principles. In this way, the presence, intensity, and design implications of biophilic features in the case studies could be evaluated systematically.

Evidence Base and Coding Matrix

To increase the transparency of the analytical procedure, each case was documented through a structured evidence base consisting of five evidence types:

- Official project pages published by the design office,
- Architectural media documentation,
- Project descriptions and narrative texts,
- Visual-spatial materials such as plans, sections, and interior and exterior photographs,
- Sustainability- or performance-related information, where publicly available.

The coding matrix was developed deductively from Browning, Ryan and Clancy's (2014) 14 biophilic design patterns and was used to identify how each pattern became visible at both building and interior scales. For each case, the matrix included the following fields: pattern name, observed spatial evidence, building-scale strategy, interior-scale strategy, intensity level, and analytical notes. This procedure enabled the study to move beyond descriptive case reading and to adopt a more systematic framework for cross-case comparison.

Data Analysis

The collected data were analyzed through a multi-layered qualitative procedure combining thematic content analysis, visual analysis, and cross-case synthesis. The analysis was carried out in three consecutive steps.

In the first step, each case was coded according to the 14 biophilic design patterns proposed by Browning, Ryan and Clancy (2014). The coding unit was defined as a spatially identifiable design feature, environmental condition, or architectural strategy that could be directly observed in project documentation and meaningfully associated with a biophilic pattern. These units included, for example, skylights, framed landscape views, recessed reading niches, material palettes, atrium voids, terraced reading areas, roof gardens, and operable façades.

In the second step, the coded evidence was interpreted at two analytical scales: building-scale strategies and interior-scale strategies. Building-scale strategies referred to site integration, massing decisions, sectional organization, façade permeability, environmental systems, and landscape relationships. Interior-scale strategies referred to reading spaces, material and lighting conditions, seating niches, circulation sequences, visual depth, and user-oriented spatial atmospheres.

In the third step, a cross-case comparison matrix was constructed to evaluate the relative intensity of recurring biophilic strategies. Rather than treating patterns as simply present or absent, each coded pattern was classified according to its degree of spatial determinacy. Four levels were used:

●●● Main spatial determinant: the pattern plays a primary role in shaping the project's spatial identity and user experience.

●● Strong supporting element: the pattern is clearly present and contributes substantially, but does not define the project on its own.

● Limited/indirect representation: the pattern is present in a partial, secondary, or indirect way.

– Not observed: the pattern could not be identified on the basis of the available evidence.

To reduce interpretive inconsistency, the coding and classification process was carried out by the first author and then cross-checked by the second author through a comparative review of the coded matrices and case summaries. Discrepancies were resolved through discussion until a shared interpretation was reached. This cross-check procedure did not constitute statistical intercoder reliability testing; rather, it functioned as an analytical consistency procedure appropriate to an interpretive qualitative design.

At the end of the analysis, recurring spatial tendencies, shared biophilic strategies, and context-dependent differences were synthesized. Based on this synthesis, a conceptual design guide for library interiors was developed.

Limitations of the Study

This study is a qualitative comparative analysis based on publicly accessible digital architectural documents and project descriptions. No site visits, in-situ observations, user surveys, interviews, or experimental measurements were conducted within the scope of the research. Accordingly, the findings are based on interpretive results derived from the accessible visual and written data of the selected cases. Rather than providing a direct empirical evaluation of user experience, the study offers a conceptual and analytical framework for discussing the spatial manifestations of biophilic design principles in library buildings. In addition, the selected cases are internationally recognized and well-documented examples; therefore, the findings should be interpreted as analytically illustrative rather than statistically generalizable.

Findings

This section presents a comparative evaluation of the four selected library cases in relation to biophilic design principles. The analysis draws on both the biophilic design patterns defined by Browning, Ryan and Clancy (2014) and the thematic coding framework developed for this study. The findings are presented at three levels:

- The intensity of biophilic design strategies,
- The spatial and material tendencies that emerged in each case, and
- The typological patterns derived from cross-case comparison.

Overall, the findings indicate that biophilic design is represented to a meaningful extent in all four cases, although its manifestation varies according to context, scale, topographical relation, and architectural configuration. In particular, natural light, visual connection with nature, the use of natural materials, and the prospect–refuge relationship emerged as the most frequent and most strongly articulated biophilic strategies across the cases. By contrast, water appeared as a clearly dominant design component only in specific examples.

Intensity of Biophilic Design Strategies

The comparative analysis shows that biophilic design in all four cases is not constructed through a single pattern or isolated feature, but through the combined operation of multiple strategies. At the same time, the dominant strategies vary from project to project. In smaller-scale examples that establish a more direct relationship with their natural context, biophilic design is primarily strengthened through direct experiences of nature. In larger projects situated within dense urban settings, however, natural analogues, material strategies, and spatial organization become more decisive.

The findings identify natural light as the strongest recurring strategy across all four cases. In each example, daylight operates not merely as a technical lighting input but as a primary design component shaping spatial character. Visual connection with nature is also strongly represented, especially in projects that establish a relationship with landscape, sky, topography, or an open surrounding environment. The use of natural materials becomes particularly prominent in the Calgary and Austin cases, where materiality plays a major role in defining interior atmosphere. The prospect–refuge relationship and spatial transitions likewise appear as recurring and significant patterns, albeit with varying degrees of intensity across the cases (Table 1).

Table 1. Comparative Intensity of Prominent Biophilic Strategies Across the Case Studies

Biophilic strategy	Library in the Earth (Japan)	Calgary Central Library (Canada)	Seashore Library (China)	Austin Central Library (USA)
Natural light	●●●	●●●	●●●	●●●
Visual connection with nature	●●●	●●	●●●	●●●
Use of natural materials	●●	●●●	●	●●●
Water element	–	–	●●●	●

Biophilic strategy	Library in the Earth (Japan)	Calgary Central Library (Canada)	Seashore Library (China)	Austin Central Library (USA)
Prospect–refuge relationship	●●●	●●	●●●	●●
Mystery / gradual discovery	●●	●	●●	●●
Connection with natural systems	●●●	●	●●●	●●●
Spatial transitions / interior–exterior continuity	●●●	●●	●●	●●●

Note. ●●● = main spatial determinant; ●● = strong supporting element; ● = limited/indirect representation; – = not observed.

As shown in Table 1, natural light forms the shared core of biophilic design across all four cases. By contrast, the water element is dominant only in the Seashore Library in China, while in Austin it appears in a more indirect manner. Direct experiences of nature are more pronounced in the Japanese and Chinese examples, whereas in Calgary and Austin the biophilic effect is generated more strongly through materiality, form, and interior spatial organization.

Case-Specific Findings

Library in the Earth (Japan)

Library in the Earth stands out as a distinctive example in which biophilic design is articulated through integration with topography, a subterranean spatial configuration, and the controlled use of daylight. The building’s embedded relationship with the ground allows nature to be engaged not only visually but also physically and spatially. The central skylight and the upward-oriented void create a limited yet powerful visual connection with the sky, while shifting light-and-shadow effects generate a dynamic interior atmosphere throughout the day (Hiroshi Nakamura & NAP, 2022; ArchDaily, 2023).

The most prominent biophilic aspect of this project is the way the prospect–refuge relationship is translated directly into spatial organization. On the one hand, the embedded volume and niche-like spaces generate a sense of protection; on the other, the central opening and the directional use of light provide users with a restricted but effective visual outlook. In addition, the roof’s integration with the landscape and its exposure to seasonal change reinforce the connection with natural systems. The water element, however, is absent in this project (Hiroshi Nakamura & NAP, 2022).

Calgary Central Library (Canada)

Calgary Central Library constitutes a strong example of biophilic design operating through indirect natural analogues and the use of natural materials within an urban context. The crystalline façade geometry and hexagonal patterns evoke snow crystals and ice formations found in nature, while the large timber arch and cedar surfaces in the interior create a warm and inviting atmosphere for users (Snøhetta, n.d.; DIALOG, n.d.).

In this project, the category of Natural Analogues is particularly dominant. Biomorphic formal language, material connection with nature, and layered spatial organization function as the main carriers of the biophilic effect. The central atrium and multilevel visual continuity reinforce a strong sense of prospect, while quieter reading niches distributed across different levels support a sense of refuge. Nevertheless, compared to the Japanese and Chinese examples, the project offers a more limited direct experience of nature, and no explicit water element is observed (Snøhetta, n.d.; DIALOG, n.d.).

Seashore Library (China)

Seashore Library is one of the cases in which biophilic design is experienced in the most direct and powerful way. Its coastal location allows water, horizon, wind, sound, and light to occupy a central role in the spatial experience. In this respect, the project produces a dense representation of the Nature in the Space category. Openings oriented toward the sea, the amphitheatre-like sectional arrangement,

and operable surfaces provide users with a multi-sensory encounter with nature (Vector Architects, n.d.).

In this project, the water element functions as a main spatial determinant. Visual connection with nature and non-visual sensory connection operate simultaneously; sea views, the sound of waves, and wind become integral components of the spatial experience. At the same time, the prospect effect generated by wide openings is balanced by a sense of refuge formed in the meditation area and in more protected interior zones. The monolithic, rock-like character of the concrete mass and the natural tonal qualities of the interior further support the project’s indirect natural analogues (Vector Architects, n.d.).

Austin Central Library (USA)

Austin Central Library presents a balanced example in which biophilic design is combined with sustainability strategies. The central atrium, expansive glass surfaces, roof garden, and relationship with the surrounding landscape all reinforce visual connection with nature. At the same time, locally sourced limestone, timber finishes, and angular surfaces that bring daylight deeper into the building contribute to establishing a relationship with nature through both materiality and spatial organization (Lake|Flato Architects, n.d.; Shepley Bulfinch, n.d.).

In the Austin case, Nature in the Space and Natural Analogues are represented in a relatively balanced way. Natural light, interior–exterior continuity, and connection with natural systems are particularly strong. The roof garden, rainwater collection system, and green roof applications demonstrate that biophilic design is addressed not only perceptually but also ecologically. Quiet reading zones and niche-like spaces strengthen refuge, while the central atrium and visual continuity reinforce prospect. Unlike the Chinese case, water is represented here in a more indirect way, primarily through sustainability systems (Lake|Flato Architects, n.d.; Shepley Bulfinch, n.d.). This condition is summarized in Table 2.

Table 2. Summary of the Most Prominent Biophilic Features by Case

Case	Dominant biophilic category	Strongest strategies	Relatively weak / limited aspects
Library in the Earth	Nature in the Space + Nature of the Space	Integration with topography, dynamic daylight, prospect–refuge, connection with natural systems	No water element; natural material use is limited but effective
Calgary Central Library	Natural Analogues	Timber materiality, biomorphic/geometric language, atrium, dynamic light	Direct nature experience is relatively limited; no water element
Seashore Library	Nature in the Space	Water, sea views, wind and sound, prospect–refuge, multi-sensory experience	Material connection with nature is relatively weak; concrete dominates
Austin Central Library	Nature in the Space + Natural Analogues	Natural light, natural materials, roof garden, interior–exterior continuity, sustainability systems	Water is indirect; the sense of mystery is limited

Cross-case Comparisons and Typological Patterns

Cross-case comparison demonstrates that biophilic design clusters around a number of shared principles across all cases, although these principles are materialized differently depending on context. The most prominent common strategies are the treatment of natural light as a primary design component, the strengthening of visual connection with nature, the prospect–refuge relationship, and the careful orchestration of spatial transitions. At the same time, these strategies are not implemented through identical means in each project.

The findings suggest three major typological tendencies. The first, represented most clearly by the Japanese case, may be described as the embedded-in-nature library type. In this approach, the building becomes not simply an object facing nature, but part of nature itself. Integration with topography, embedded volume, and controlled use of light constitute its defining characteristics.

The second typology, exemplified by the Chinese case, may be described as the landscape-oriented coastal library type. Here, water, horizon, and atmospheric environment become the primary

carriers of spatial experience. Direct visual and sensory engagement with nature is most strongly articulated in this group.

The third typology, visible in the Calgary and Austin examples, may be described as the urban iconic library type. In this approach, direct physical contact with nature is more limited; however, biophilic effects are generated through natural materials, biomorphic forms, atrium spaces, daylight organization, and sustainability strategies.

Table 3. Cross-Case Typological Synthesis

Typology	Representative case(s)	Distinctive characteristics	Dominant biophilic mode
Embedded-in-nature library	Library in the Earth	Integration with topography, embedded space, controlled light, strong refuge	Direct experience of nature + spatial experience
Landscape-oriented coastal library	Seashore Library	Direct relationship with water, horizon-oriented spatiality, multi-sensory experience, strong prospect	Direct experience of nature
Urban iconic library	Calgary Central Library, Austin Central Library	Atrium, natural materials, biomorphic language, sustainability, interior–exterior continuity	Natural analogues + spatial organization

This typological distinction indicates that biophilic design does not operate as a single formal language, but rather as a flexible design strategy reconfigured according to context. In examples with a more direct relationship to rural or natural settings, Nature in the Space becomes more strongly represented. In dense urban contexts, by contrast, Natural Analogues and strategies of spatial organization become more prominent. Even so, natural light, visual connection with nature, and the prospect–refuge relationship emerge as common core strategies across all typologies.

Overall Evaluation of the Findings

The findings demonstrate that biophilic design in contemporary library buildings is not merely an aesthetic approach, but a multilayered design logic that shapes spatial quality and user experience. Strategies such as natural light, visual connection, materiality, spatial refuge, and interior–exterior continuity play a decisive role in enabling libraries to function as environments that support both cognitive concentration and psychological comfort.

In addition, the cross-case comparison indicates that biophilic design should be understood not as a uniform model, but as a context-sensitive system capable of adapting to different spatial conditions. This also clarifies why the conceptual guide developed in the following section is structured not around singular formal prescriptions, but around flexible yet coherent design principles.

Discussion

The findings suggest that, in contemporary library interiors, biophilic design operates less as an isolated or decorative strategy of “adding nature” and more as a multilayered system that organizes spatial quality. The recurring prominence of natural light, visual connection with nature, natural and nature-associated materials, the prospect–refuge balance, and spatial transitions across all cases indicates that biophilic design functions within library typologies according to a structural rather than incidental logic. This result aligns with recent review studies that describe biophilic design research as still fragmented across building types, user groups, and geographical contexts, while also confirming the absence of a more concrete, typology-sensitive framework specifically tailored to library interiors. In this respect, the guide proposed in this article is not simply a summary of examples; rather, it represents an attempt to transform dispersed biophilic knowledge into a design logic specific to the library typology (Tekin et al., 2025; Peters & D’Penna, 2020; Sakip et al., 2024).

The prominence of natural light across all four cases strongly corresponds with the literature on higher education and learning environments. Mahrous et al. (2024) demonstrated that natural light, large openings, natural ventilation, and natural finishing materials significantly support university students’ satisfaction. Similarly, Emara et al. (2024) reported that daylight conditions in higher education buildings can substantially affect students’ satisfaction, mood, and behavior. AlSehaimi and Ayoub

(2025) likewise identified natural light, plants, and views of nature among the biophilic criteria most strongly preferred by students in university buildings. In the four library cases examined here, daylight functions not only as a means of illumination but also as a device for spatial orientation, atmosphere-making, support of the reading experience, and the production of environmental quality suitable for prolonged use. In this sense, the findings confirm the broader literature at the scale of library typology. Natural light therefore emerges in the proposed conceptual guide not merely as a component of environmental comfort, but as a primary generator of spatial experience (Mahrous et al., 2024; Emara et al., 2024; AlSehaimi & Ayoub, 2025; Yasar & Öktem Erkartal, 2026).

A second major finding concerns the decisive role of visual connection with nature and, in some cases, multi-sensory nature experience. In Seashore Library, water, horizon, wind, sound, and light operate together; in Library in the Earth, topography, sky, and controlled daylight structure the experience. These cases show that biophilic design works not only through visual imagery, but through sensory and atmospheric continuity. This observation is consistent with the experimental findings of Latini et al. (2024), who showed that audio-visual connection with nature could positively affect working memory, inhibition, and task-switching performance among university students. Sakip et al. (2024) similarly emphasize the cognitive and learning-related potential of biophilic design in university library contexts, while Peters and D’Penna (2020) argue that contact with nature in restorative learning environments should be understood not merely as an aesthetic quality but as a resource for attentional renewal. Accordingly, the findings suggest that visual connection with nature alone may not be sufficient in library interiors; secondary sensory layers, including sound, airflow, material texture, and spatial openness, also strengthen biophilic quality (Latini et al., 2024; Sakip et al., 2024; Peters & D’Penna, 2020).

At the same time, the findings indicate that direct experiences of nature are not established with equal intensity in all libraries. In more urban and programmatically dense examples such as Calgary and Austin, the biophilic effect is produced to a greater extent through natural analogues, material strategies, and spatial organization. This point is significant because biophilic design is often equated with the direct presence of plants, water, or landscape; however, the present findings suggest that indirect references to nature may also play a decisive role in urban libraries. Yildirim et al. (2024), in their systematic review of restorative effects in workplace settings, show that biophilic benefits can be generated through both direct contact with nature and interiorly integrated natural analogues and sensory qualities. Tekin et al. (2025) likewise note that biophilic design is materialized differently across contexts and therefore requires context-sensitive, rather than uniform, frameworks. In the context of this study, this means that while direct access to nature may be ideal for achieving biophilic quality in library interiors, strong biophilic effects can also be produced in dense urban contexts through natural materials, biomorphic geometry, daylight organization, and spatial hierarchy. The inclusion of both direct and indirect strategies in the proposed guide is therefore consistent with the findings and defensible at a theoretical level (Yildirim et al., 2024; Tekin et al., 2025).

The recurring emergence of the prospect–refuge balance across all four cases can also be strongly related to the literature. Although the present study does not provide a post-occupancy evaluation that directly measures user experience, it nevertheless indicates that the combination of open outlooks and protected zones is critical in library interiors that require sustained individual concentration. Quiet reading niches, carefully framed viewpoints around atria, window-side seating, semi-enclosed study pockets, and topographically integrated protected areas offer users both environmental awareness and a sense of psychological shelter. This is consistent with studies showing that users in higher education environments evaluate environmental quality not only in terms of physical comfort but also in terms of spatial conditions that allow them to feel safe, calm, and focused. Makaremi et al. (2024) emphasize that student well-being is related to multidimensional environmental factors within learning settings, while Gür (2024) demonstrates that campus quality of life is shaped through the interaction of educational spaces, environmental quality, and overall campus satisfaction. Prospect–refuge should therefore be read not merely as a theoretical biophilic pattern, but as a spatial performance criterion that addresses library users’ needs for prolonged stay, individual work, and cognitive restoration (Makaremi et al., 2024; Gür, 2024).

Another important outcome of the study is the strong relationship that can be established between biophilic quality and environmental comfort. In library interiors, natural light, indoor air quality, acoustic balance, material texture, and the distinction between quiet and shared zones may initially appear as independent variables. However, the present analysis shows that they operate as an interrelated system. This is consistent with the findings of Yasar et al. (2025), who argue that user satisfaction

should be evaluated together with environmental comfort, functionality, and green building features. AlSehaimi and Ayoub (2025) similarly note that students in university buildings assign high priority to natural light, vegetation, and views of nature, while also emphasizing that implementation must be considered in relation to local climatic and operational conditions. From this perspective, the proposed guide's treatment of environmental comfort as an integral dimension of biophilic design is justified not only pragmatically but also conceptually. In other words, biophilic design in library interiors can produce a meaningful user experience only when it is integrated with environmental comfort; otherwise, it risks remaining a symbolic and superficial reference to nature (Yasar et al., 2025; AlSehaimi & Ayoub, 2025).

At this point, the typology-specific contribution of the study becomes clearer. Recent literature on library interiors has emphasized that libraries are no longer limited to storing collections, but have evolved into flexible, social, digital, and multifunctional learning environments. As Lehmann (2024) argues, the contemporary library is increasingly reinterpreted as a site of social condensation, public interaction, and even regenerative design. Yet while this transformation is often discussed in terms of program, technology, and public role, the biophilic qualities of the interior environment are not articulated with the same systematic clarity. The guide proposed in this article addresses precisely this gap. It rethinks the library as a contemporary learning and public interaction environment while linking that role to concrete design components such as visual connection with nature, light, materiality, environmental comfort, spatial transitions, and psychological refuge. The contribution of the article therefore lies not merely in stating that biophilic design matters in libraries, but in redefining that importance within a framework that can be translated into design decisions (Lehmann, 2024; Sakip et al., 2024).

The relationship between the findings and the literature on educational buildings is also significant. Yasar and Öktem Erkartal's (2026) study of contemporary university buildings shows that biophilic principles are spatially manifested through daylight, visual connection with nature, landscape relations, and material choices. Similarly, studies such as Mahrous et al. (2024) and Emara et al. (2024) demonstrate that students' satisfaction and environmental experience in learning spaces are closely related to light, openness, natural finishes, and visual comfort. Even so, libraries are often absorbed into the broader and more generalized category of "learning spaces" in this literature. The present findings suggest, however, that library interiors differ in requiring the simultaneous accommodation of silence, collaborative work, prolonged occupancy, individual concentration, and social interaction. Biophilic design principles therefore need to be interpreted here through a more delicate and programmatically complex balance. Put differently, while the validity of biophilic principles in educational buildings provides an important starting point for this study, the library typology requires these principles to be reinterpreted in a more nuanced and programmatically differentiated manner (Yasar & Öktem Erkartal, 2026; Mahrous et al., 2024; Emara et al., 2024).

Another point that requires discussion concerns how the guide proposed in this study is positioned between direct evidence and cross-case synthesis. Some of the principles included in the guide—such as treating daylight as a primary design generator, establishing visual connection with nature, and maintaining the prospect–refuge balance were derived directly from recurring case patterns. By contrast, other principles such as creating graded transitions between quiet and collaborative zones, considering maintenance and operational continuity alongside biophilic quality, or foregrounding contextual identity within the design guide emerged not from a single case alone but from cross-case interpretation and literature synthesis. This distinction should not be regarded as a weakness; on the contrary, it is essential to the academic validity of the guide because it makes explicit the difference between directly observed evidence and analytically synthesized inference. In light of the fragmented research landscape identified by Tekin et al. (2025) and the cross-context restorative findings synthesized by Yildirim et al. (2024), it is reasonable that a guide developed for library typology should be both case-derived and synthetic (Tekin et al., 2025; Yildirim et al., 2024).

Finally, the findings suggest that biophilic design may be associated not only with well-being and environmental comfort, but also with cognitive productivity and creative thinking. Although the article does not directly examine creativity through a design education study, Yasar's (2023) findings on the contribution of biophilic design to creative processes in the design studio, together with DeLauer et al.'s (2022) demonstration of the supportive effects of natural environments and biophilic design on student well-being in a university campus context, imply that library interiors may hold potential not only for reading and studying, but also for mental recovery, inspiration, and cognitive renewal. The proposed guide is therefore directed not merely toward producing "greener" or more visually pleasing libraries, but toward creating more focused, balanced, and supportive learning environments. In this respect, the

article offers a typology-specific and practice-oriented contribution to the literature on library interiors by showing how biophilic design can be translated into design-decision frameworks (Yasar, 2023; DeLauer et al., 2022).

On the basis of these discussions, a conceptual biophilic design guide for library interiors was developed by bringing together principles derived directly from the case analyses and insights synthesized through cross-case interpretation. The guide is presented at two levels: Table 4A summarizes the core principles derived from the research, while Table 4B outlines their spatial translations and expected design outcomes.

Table 4A. Core Principles of the Conceptual Biophilic Design Guide for Library Interiors

Core principle	Evidence level	Basis in the case analysis	Design rationale
Establish continuous visual contact with nature	Direct case-derived	Observed in all four cases; strongest in <i>Library in the Earth</i> and <i>Seashore Library</i>	Supports visual restoration, spatial depth, and environmental calm
Treat daylight as a primary design generator	Direct case-derived	The strongest recurring strategy across all four cases	Enhances visual comfort, spatial atmosphere, and prolonged use quality
Support multi-sensory nature experience	Direct case-derived + synthesized	Strongest in <i>Seashore Library</i> ; indirectly supported in other cases through light, airflow, and materiality	Extends the biophilic experience beyond visual contact
Reinforce natural analogues where direct contact is limited	Direct case-derived	Particularly visible in Calgary and Austin	Compensates for limited direct access to nature in dense urban settings
Balance prospect and refuge	Direct case-derived	Recurrent in all cases, especially in Japan and China	Supports psychological comfort, perceived control, and concentration
Create graded transitions between quiet and collaborative zones	Cross-case synthesis	Repeatedly implied by spatial sequencing and interior organization across the cases	Reduces programmatic conflict and improves usability
Integrate environmental comfort into the biophilic framework	Cross-case synthesis	Supported by findings on light, air, materiality, and spatial calm	Links biophilic quality with long-term user satisfaction
Build a place-specific spatial identity	Cross-case synthesis	Cases differ according to topography, coastline, or urban context	Strengthens belonging, contextual integration, and design authenticity
Treat biophilic design as an integrated system rather than isolated features	Cross-case synthesis	Strongest projects combine light, materiality, transitions, and spatial hierarchy	Produces more coherent and durable spatial quality

Table 4B. Design Actions and Expected Outcomes for Biophilic Library Interiors

Design action	Priority application area	Expected outcome	Related biophilic patterns
Use framed landscape views, skylights, courtyards, and inward-facing green voids	Reading halls, individual study areas, entrance foyers, rest zones	Mental relaxation, visual calm, and a stronger connection to surroundings	Visual Connection with Nature; Prospect
Distribute daylight through atria, clerestories, filtered side-light, and glare-control devices	Reading areas, stacks, circulation, and shared study spaces	Visual comfort, attentional support, and atmospheric quality	Dynamic & Diffuse Light; Non-Rhythmic Sensory Stimuli

Design action	Priority application area	Expected outcome	Related biophilic patterns
Introduce controlled airflow, tactile materials, operable openings, and limited sensory nature cues	Transitional zones, semi-open spaces, short-stay areas	Richer sensory engagement without overstimulation	Non-Visual Connection with Nature; Thermal & Airflow Variability
Use wood, stone, natural tones, biomorphic geometry, and patterned surfaces	Urban libraries with limited direct access to nature	Warmth, familiarity, and indirect association with nature	Biomorphic Forms & Patterns; Material Connection with Nature; Complexity & Order
Combine open-view areas with niches, recessed seating, alcoves, and protected study pockets	Quiet reading zones, individual study booths, atrium perimeters	Psychological comfort, sense of control, and improved concentration	Prospect; Refuge
Introduce buffer spaces between silent and collaborative zones	Floor zoning and transitions between entrance, reading, and group-study areas	Reduced conflict, improved behavioral legibility, and smoother spatial transitions	Mystery; Refuge; Complexity & Order
Improve air quality through ventilation strategies and ecological comfort measures	Long-stay reading rooms, enclosed study zones, and group work rooms	Better comfort, longer dwell time, and improved satisfaction	Thermal & Airflow Variability; Connection with Natural Systems
Address acoustics together with biophilic quality	Silent reading rooms, group areas, and atrium surroundings	Better concentration, quieter background conditions, and environmental balance	Refuge; Non-Visual Connection with Nature
Differentiate the environmental character of quiet and shared spaces	Silent versus collaborative learning zones	Better alignment with diverse learning modes	Prospect; Refuge; Mystery
Use local materials, contextual openings, and site-responsive spatial orientation	Whole building and the interior-envelope relationship	Stronger place identity, belonging, and contextual coherence	Connection with Natural Systems; Material Connection with Nature
Strengthen wayfinding through light, visual anchors, and legible circulation hierarchy	Entrance halls, atria, vertical circulation, and shared zones	Reduced stress, easier orientation, and stronger user control	Mystery; Prospect; Complexity & Order
Support flexibility through modular furnishings and adaptable layouts	Shared work areas, semi-quiet zones, and event spaces	Adaptation to changing learning patterns	Complexity & Order; Prospect
Consider maintenance, durability, and long-term ecological operation	Whole building and interior system	Sustained performance and long-term biophilic value	Connection with Natural Systems; Material Connection with Nature

The most critical quality of this guide lies in its treatment of biophilic design not as a decorative repertoire, but as an organizing logic for library interiors. According to the findings, the strongest outcomes do not emerge from isolated elements, but from the combined operation of decisions related to daylight, materiality, views, environmental comfort, the balance between quiet and shared areas, and the prospect–refuge relationship. For this reason, the guide responds less to the question of which biophilic element should be used than to the question of which spatial relationships, when established together, are capable of strengthening biophilic quality.

Conclusion

This study examined how biophilic design principles become visible in contemporary library interiors and explored how these principles can be systematized within a framework that is transferable to design practice. The point of departure was the transformation of libraries from repositories of information into multilayered learning environments that must simultaneously accommodate individual concentration, collaborative learning, research, interaction, and psychological comfort. Within this context, the study sought to demonstrate that biophilic design in libraries should not be understood merely as an aesthetic enrichment, but rather as a holistic design approach associated with spatial quality, environmental comfort, attentional continuity, and user experience. The qualitative analysis based on multiple case studies, together with the conceptual guide subsequently developed, confirms that this objective has been maintained consistently throughout the study.

The first major conclusion concerns the ways in which biophilic design principles become spatially visible in contemporary library interiors. The findings show that this visibility is most clearly established through the controlled use of natural light, visual connection with nature, natural and nature-associated materials, the prospect–refuge balance, interior–exterior continuity, the organization of spatial transitions, connections with natural systems, and, in some cases, multi-sensory experiences of nature. Although the four cases differ in contextual and typological terms, the consistent prominence of daylight across all examples indicates that light and spatial atmosphere constitute the most fundamental shared ground of biophilic design in library interiors. At the same time, direct experiences of nature are more pronounced in the Japanese and Chinese examples, whereas in the Calgary and Austin cases the biophilic effect is generated more strongly through natural analogues, natural materials, and spatial organization.

A second major conclusion concerns the extent to which biophilic design principles can be systematized into a conceptual design guide for library interiors. The most important outcome of the study is that such systematization is indeed possible and that a conceptual guide can be meaningfully derived from comparative case analysis. The findings suggest that biophilic design gains significance not through isolated or decorative interventions, but through interrelated clusters of decisions. For this reason, the proposed guide is not reduced to fragmented recommendations such as simply adding vegetation or using natural materials. Instead, it has been developed as a holistic framework that brings together visual and sensory connection with nature, environmental comfort, the balance between quiet and shared areas, spatial privacy, contextual responsiveness, and long-term operational viability. Accordingly, the guide should not be read as a prescriptive template, but as an analytically derived decision framework. Some principles emerged directly from recurrent case evidence, whereas others were synthesized through cross-case interpretation and literature-informed inference.

Another important conclusion is that biophilic design in library interiors demonstrates a considerable degree of typological flexibility. The typologies identified in this study—namely the embedded-in-nature library, the landscape-oriented coastal library, and the urban iconic library—show that biophilic design can be constructed through different architectural means across different geographical and spatial contexts. This confirms that the proposed guide should not offer a fixed repertoire of forms, but rather a decision-making framework that is adaptable to different conditions while preserving core principles. In this respect, the guide presented here does not describe a single “ideal library form”; instead, it systematically identifies the design principles through which biophilic quality can be strengthened in library interiors.

In conclusion, the study demonstrates that biophilic design principles generate legible and comparable spatial manifestations in contemporary library interiors and that these manifestations can serve as the basis for the development of a conceptual design guide. The guide presented in the discussion section shows how such findings can be translated into design decisions in a systematic way. In this sense, the article contributes not only to the biophilic design literature, but also to the design of library interiors by offering a typology-sensitive and practice-oriented framework for future applications.

Acknowledgment

The authors acknowledge the use of generative artificial intelligence tools for support in improving the clarity and linguistic accuracy of the English text. All conceptual content, interpretations, and analytical decisions remain solely the responsibility of the authors.

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