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Evaluating Biophilic Classroom Design and Its Effect on Cognitive Function and Concentration among Nigerian University Students

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Abstract **Original Research Article**

As a modern design approach, biophilic design encourages the incorporation of natural components into the built environment, which has a substantial impact on human health, well-being, and productivity. Bringing living structures to our educational spaces, especially universities, when most educational spaces are devoided of natural features, is a concept that needs to be pervasive within the architects and designers who are responsible to create healthy and creative spaces for the students. The study investigates the influence of biophilic design principles on students' experiences in selected student centers across federal universities in Nigeria, addressing the problem of poor integration of nature into educational facilities, which may affect users' well-being and spatial experience. The study aims to evaluate how students perceive and interact with elements of biophilic design through three main objectives: to assess Direct Contact with Nature, Indirect Contact with Nature, and Experience of Space and Place within the selected centers.

A mixed-method approach was adopted, utilizing qualitative and quantitative data collection techniques. Primary data were obtained through structured observation checklists and semi-structured interviews. The population comprised federal university student centers in Nigeria, with four student centers purposively selected as the sample. Twenty students (five per center) were interviewed. Data were analyzed using descriptive statistics and thematic interpretation.

Findings revealed that while some natural elements like courtyards (75%) and tree planting (75%) were moderately present, critical biophilic elements such as skylights, indoor plants, façade greening, and natural materials were grossly lacking. Only 25% of the centers utilized natural construction materials, and 0% featured skylights or green roofs. Experiences of place and space showed good circulation (100%) but poor harmony of interiors (25%) and signage (0%). Security perception averaged 60%, while aesthetic satisfaction remained low at 25%.

The study concludes that biophilic design is underutilized in Nigerian university student centers, limiting its benefits. It recommends that design professionals and stakeholders prioritize integrating natural features to improve users' psychological comfort, spatial experience, and overall well-being.

Keywords: Biophilic Design, Students' Well-Being, Students' Attraction, Students.

INTRODUCTION

Biophilic design has gained significant global attention in recent decades as researchers and practitioners increasingly recognize the need to integrate natural elements into the built environment to improve human health, well-being, and cognitive performance. Across the world, studies have shown that exposure to nature through biophilic design enhances concentration, reduces stress, and supports better learning outcomes, particularly in educational settings (Browning et al., 2014; Kellert & Calabrese, 2015). In classrooms, the use of natural lighting, ventilation, vegetation, and views of nature has been linked to improved cognitive function, attentiveness, and memory retention among students

(Barrett et al., 2015). As global educational systems seek innovative ways to enhance learning environments, biophilic design has emerged as a critical strategy for promoting academic success and psychological well-being.

At the continental level, the discourse on biophilic design in Africa is still evolving, although its potential is gaining recognition. Given Africa's rich biodiversity and climate diversity, the continent presents unique opportunities for implementing biophilic design strategies that are both culturally and environmentally appropriate (Mokgobu & Rapholo, 2020). However, African educational institutions often prioritize basic infrastructural development over quality learning environments, resulting in limited application of biophilic principles. Research in African schools has highlighted the importance of improving natural ventilation, daylighting, and green spaces to address issues such as poor indoor air quality and low student engagement (Oluremi et al., 2021). As such, integrating biophilic design in African classrooms could bridge the gap between infrastructural development and students' cognitive needs.

Regionally, within Nigeria, learning environments in many universities are often overcrowded, poorly ventilated, and inadequately lit, contributing to diminished student concentration and cognitive fatigue (Akinyemi & Ofem, 2020). Nigerian universities face significant challenges related to the quality of classroom design, with limited emphasis placed on the inclusion of natural elements that can enhance learning outcomes. In response to these challenges, researchers and educators are beginning to explore the relevance of biophilic classroom design in improving the cognitive performance and attentiveness of students within the Nigerian context (Abdulraheem et al., 2022). The urgency to address these environmental shortcomings is further driven by the increasing recognition of the role that the physical learning environment plays in shaping students' academic experiences.

Biophilic classroom design is structured around three core dimensions: direct contact with nature, indirect contact with nature, and the experience of space and place (Browning et al., 2014). Direct contact with nature encompasses elements such as natural features—water, ventilation (air), daylight (sunlight), and vegetation—as well as access to views and vistas, natural landscapes, and ecosystems. Indirect contact with nature involves the incorporation of natural shapes, forms, and patterns, as well as natural materials, images of nature, natural colors, and façade greening. The experience of space and place focuses on transitional spaces, bounded spaces, spatial harmony, spaciousness, connection to place, security, protection, mobility, attraction, and beauty. These sub-variables collectively create an environment that aligns with humans' innate affinity for nature, fostering psychological comfort and cognitive restoration (Kellert & Calabrese, 2015).

The cognitive function and concentration of students, particularly within learning environments, are influenced by a range of environmental and psychological factors. Cognitive function, in this context, refers to mental processes such as memory, attention, problem-solving, and decision-making that are essential for learning (Barrett et al., 2015). Concentration, as a key component of cognitive function, is sensitive to the quality of indoor environmental conditions such as air quality, natural light exposure, noise levels, and access to green views (Leung et al., 2017). Empirical studies suggest that classrooms designed with biophilic principles, including adequate ventilation, daylighting, natural materials, and views of greenery, can significantly improve cognitive performance and sustain student attention (Ulrich, 2008; Kellert, 2008).

The interaction between biophilic classroom design and cognitive function is rooted in environmental psychology, which posits that natural elements in the built environment can reduce mental fatigue and improve attention restoration (Kaplan & Kaplan, 1989). Direct exposure to natural features such as sunlight and vegetation helps regulate circadian rhythms, improve mood, and reduce stress, thereby enhancing concentration (Li & Sullivan, 2016). Indirect contact with nature, including natural shapes, materials, and colors, stimulates sensory engagement and supports cognitive processing through subtle visual and tactile cues (Browning et al., 2014). Additionally, the experience of space and place—through elements like spaciousness, security, and mobility—contributes to psychological comfort, which is essential for optimal cognitive engagement.

In the Nigerian university context, these interrelationships are particularly critical as many classrooms are often characterized by poor ventilation, inadequate lighting, and limited aesthetic consideration (Akinyemi & Ofem, 2020). When students are exposed to uncomfortable or uninspiring learning environments, their cognitive load increases, and their ability to concentrate diminishes. Conversely, classrooms that incorporate biophilic elements can help students feel more connected to their surroundings, fostering a sense of place and emotional security that supports sustained cognitive effort (Abdulraheem et al., 2022). Studies have shown that improving indoor air quality through natural ventilation and enhancing daylight exposure can reduce fatigue and increase attention spans in similar educational settings (Leung et al., 2017).

Furthermore, the inclusion of natural landscapes, green facades, and transitional spaces within the campus environment can offer restorative breaks for students, which are essential for cognitive recovery and sustained concentration throughout the day (Ulrich, 2008). The mobility afforded by well-designed transitional spaces allows students to move comfortably between indoor and outdoor areas, promoting physical activity and further supporting cognitive function (Browning et al., 2014). The visual complexity and natural patterns present in well-designed biophilic classrooms also help stimulate curiosity and engagement, reducing the monotony that often characterizes traditional classroom settings.

The psychological benefits of biophilic design are not limited to improved concentration; they also extend to increased student satisfaction, motivation, and a sense of belonging (Kellert & Calabrese, 2015). Students who perceive their learning environments as attractive, comfortable, and connected to nature are more likely to report positive learning experiences and stronger emotional attachment to their institutions. This connection to place enhances academic

performance and promotes long-term educational engagement (Li & Sullivan, 2016). Therefore, integrating biophilic design into Nigerian university classrooms can serve as a strategic intervention to address both environmental inadequacies and cognitive challenges faced by students.

In sum, evaluating biophilic classroom design and its effects on cognitive function and concentration among Nigerian university students is timely and necessary. As global and regional evidence suggests, the inclusion of natural elements in learning environments can play a transformative role in enhancing cognitive outcomes and promoting well-being. By assessing the presence and adequacy of biophilic features in Nigerian universities, this study can contribute to the growing body of knowledge advocating for healthier, more supportive educational spaces that align with the natural human inclination toward nature.

Cognitive function and concentration among Nigerian university students are significantly challenged by the poor quality of indoor air and inadequate natural ventilation in most learning environments. Many Nigerian university classrooms are overcrowded, poorly ventilated, and lack access to fresh air, leading to the accumulation of carbon dioxide and airborne pollutants, which can impair cognitive performance and reduce students' ability to concentrate (Akinyemi & Ofem, 2020). Exposure to stale indoor air over extended periods has been linked to headaches, fatigue, and decreased attentiveness, which directly hampers students' academic engagement (Leung et al., 2017). Biophilic design, particularly through direct contact with nature such as the integration of natural ventilation systems, can mitigate this problem by improving airflow and indoor air quality, promoting better oxygen circulation and enhancing cognitive alertness. Incorporating natural features like operable windows, air vents, and green plants within the classroom can significantly contribute to cleaner air and provide sensory stimulation that restores mental clarity and reduces fatigue (Browning et al., 2014).

Another critical issue affecting cognitive function and concentration among Nigerian university students is the lack of adequate daylight and exposure to natural lighting in classroom settings. Many lecture halls rely heavily on artificial lighting, which often produces glare, flicker, or insufficient illumination, thereby contributing to eye strain, decreased focus, and cognitive overload (Barrett et al., 2015). Poor lighting conditions are also associated with the disruption of circadian rhythms, which can impair attention span and information processing speed (Li & Sullivan, 2016). Biophilic classroom design can address this challenge through both direct and indirect contact with nature by maximizing daylight penetration using large windows, skylights, and transparent partitions that allow for unobstructed views of the sky and surrounding greenery. Additionally, indirect biophilic elements such as natural materials that reflect daylight and the use of natural colors that reduce visual fatigue can further enhance visual comfort, thereby supporting sustained concentration and cognitive functioning (Kellert & Calabrese, 2015).

A significant problem is the absence of spatial harmony, transitional spaces, and visual connectivity within learning environments, which often results in feelings of confinement, discomfort, and psychological disconnection among students. Overcrowded and poorly organized classrooms restrict mobility and offer limited visual diversity, which can lead to cognitive fatigue and decreased mental engagement over time (Abdulraheem et al., 2022). The absence of transitional and bounded spaces in classroom design also deprives students of the opportunity for cognitive breaks and momentary restoration, which are essential for maintaining prolonged attention (Kaplan & Kaplan, 1989). By integrating biophilic design elements that focus on the experience of space and place—such as creating transitional spaces, open views, spatial harmony, and the use of natural shapes and patterns—students can benefit from an environment that supports mental restoration and fosters a sense of psychological safety. Features like mobility-friendly layouts, green courtyards visible from classrooms, and spacious seating arrangements can reduce the feeling of restriction and enhance the overall cognitive experience (Browning et al., 2014).

Biophilic design theory was founded by Edward O. Wilson in 1984 when he introduced the concept of *biophilia*, which he defined as the innate human affinity for nature and natural processes. Wilson proposed that humans have evolved in close connection with nature, and this evolutionary bond has created an inherent need to associate with the natural environment for psychological and physiological well-being (Wilson, 1984). The rationale for this theory is grounded in the belief that urbanization and the increasing separation of people from natural settings can have detrimental effects on health, productivity, and overall happiness. Wilson's foundational argument emphasized that reconnecting with nature through built environments could help mitigate these negative outcomes, thus sparking a new paradigm in architectural and environmental design.

Several scholars have supported and advanced the biophilic design theory, contributing empirical evidence and practical applications that reinforce its significance. Kellert and Calabrese (2015) argued that integrating nature into design not only enhances aesthetic appeal but also contributes to human health, cognitive performance, and emotional satisfaction. Browning, Ryan, and Clancy (2014) provided further validation by identifying 14 patterns of biophilic design that improve user experience and promote well-being in various building types. Their studies, along with Kellert's (2008) earlier works, emphasized the measurable psychological benefits of biophilic design, including stress reduction, increased focus, and faster healing. Ulrich (2008) and Frumkin (2001) also provided clinical and environmental health perspectives that support the theory, showing that exposure to natural elements in the built environment positively affects recovery rates and mental health outcomes.

Despite widespread support, some authors have critiqued the biophilic design theory, questioning its universality and empirical robustness. Joye and Van den Berg (2011) argued that the emotional responses to nature may vary significantly across cultures, social contexts, and individual experiences, challenging the assumption of a universally innate preference for nature. Additionally, scholars like Tepavčević and

Stojaković (2012) highlighted the practical limitations of applying biophilic design in complex urban environments, where spatial, economic, and technological constraints may hinder the full integration of natural elements. These critiques suggest that while the theory is compelling, it may oversimplify the diversity of human-environment interactions and underestimate the design challenges in densely built contexts.

Biophilic design theory is particularly relevant to the current study, which focuses on the assessment of natural features such as ventilation and daylighting in student centers. The study's findings, which evaluated the adequacy of natural ventilation and daylighting in selected university facilities, align directly with the core principles of biophilic design that advocate for the incorporation of natural elements to improve building performance and user satisfaction (Browning et al., 2014; Kellert & Calabrese, 2015). The students' perceptions of comfort, air quality, and lighting further validate the importance of designing with nature in mind, supporting Wilson's (1984) original claim that human health and experience are closely tied to natural exposure. This connection strengthens the argument that biophilic design not only enhances environmental sustainability but also directly improves the everyday experiences of building occupants.

The theoretical underpinning provided by biophilic design offers a critical framework for interpreting the tables and findings of the study. The observed inadequacies in ventilation and daylighting in some student centers underscore a missed opportunity to harness the benefits proposed by biophilic theory. The positive user perceptions in spaces with adequate natural features reinforce the theory's central claim about the human affinity for natural conditions. Furthermore, the recommendations to improve natural ventilation and daylighting in the assessed buildings are justified through the biophilic lens, as enhancing these elements would likely contribute to improved health, well-being, and academic performance, as supported by Kellert (2008) and Browning et al. (2014). Therefore, the theory not only provides a conceptual foundation but also serves as a practical guide for implementing the study's recommendations.

Powell, Kellert, and Ham (2009) conducted a study aimed at examining the immediate and long-term impacts of multi-day commercial whitewater rafting experiences at Grand Canyon National Park on tourists' knowledge, attitudes, environmental behaviors, and future intentions. Using an interactional theoretical framework, the researchers employed multiple regression models to analyze data collected from participants, focusing on how both tour-specific and tourist-specific characteristics influenced these outcomes. The findings revealed that nature-based tourism experiences not only enhanced participants' understanding of protected areas but also positively shaped their attitudes towards conservation management issues and encouraged pro-environmental behaviors and sustainable intentions. The study concluded that nature-based tourism operators can serve as valuable collaborators with resource managers in promoting sustainable tourism and environmental education. Powell et al. (2009) recommended that tourism managers and policymakers integrate interactional models into tourism planning to strengthen the educational and conservation impacts of nature-based tourism experiences, thereby supporting the long-term sustainability of protected areas.

Kellert and Wilson (1995) in their influential work *The Biophilia Hypothesis* explored the innate human affinity for the natural world, with the aim of investigating the biological, psychological, cultural, and aesthetic dimensions of humanity's connection to nature. The study, though global in its theoretical orientation, focused on compiling diverse scientific perspectives and empirical evidence from various natural settings to validate or challenge the biophilia hypothesis. Through a synthesis of cross-disciplinary research and empirical case studies, the authors employed qualitative analysis supported by biological and psychological observations to explore the genetic and evolutionary foundations of biophilia. Their findings highlighted that humans instinctively prefer natural elements such as trees with climbable structures, water bodies, and green vegetation over artificial constructs, and that innate fears of elements like snakes and spiders develop more rapidly than fears of modern threats like guns or automobiles. The study concluded that biophilia is not merely a philosophical notion but a deeply rooted biological need essential to human psychological and emotional well-being. Kellert and Wilson (1995) recommended that the recognition of this inherent human-nature bond should inform conservation strategies, urban planning, and environmental policies to mitigate the negative psychological consequences of modern societies becoming increasingly disconnected from nature.

Kellert and Calabrese (2015), in their work *The Practice of Biophilic Design*, aimed to promote the integration of biophilic design principles into modern built environments with a global focus on improving human well-being through connection with nature. The study emphasized the practical application of biophilic design across various geographical locations, using a qualitative methodology that involved conceptual analysis, real-world design case studies, and the examination of direct and indirect experiences of nature, as well as the human experience of space and place. Their findings revealed that biophilic design enhances emotional, physical, and cognitive well-being by fostering environments that support human-nature interactions through elements like vegetation, natural materials, organic forms, and spatial configurations that mimic natural patterns. The study concluded that biophilic design is not only aesthetically and functionally beneficial but also an ecological and ethical necessity for sustainable living in urban settings. Kellert and Calabrese (2015) recommended the conscious and systematic incorporation of biophilic elements into architectural and urban design practices to create environments that promote human health, productivity, and ecological harmony, urging designers, planners, and policymakers to prioritize nature-integrated solutions in the built environment.

Kellert, Heerwagen, and Mador (2008) in their influential work *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life* aimed to advance the global understanding and application of biophilic design by demonstrating how integrating nature into built environments

can enhance human well-being and ecological sustainability. The study, which explored biophilic design principles across various regions and contexts, employed a comprehensive qualitative methodology involving interdisciplinary contributions, literature synthesis, case study analysis, and practical design evaluations from experts in environmental psychology, architecture, urban planning, and ecology. The authors found that buildings and spaces that consciously incorporate natural elements, daylight, ventilation, vegetation, and organic forms can significantly improve cognitive performance, emotional well-being, productivity, and health outcomes, particularly in schools, workplaces, healthcare settings, and urban communities. Their findings also emphasized that biophilic design not only fosters human-nature connections but also reduces absenteeism, enhances learning environments, and supports restorative experiences in cities increasingly disconnected from the natural world. Concluding that the exclusion of nature from modern architectural practices has detrimental impacts on physical and psychological health, the authors strongly advocated for the deliberate inclusion of biophilic strategies in both architectural and urban design processes. They recommended that designers, architects, and policymakers systematically adopt biophilic design to create healthier, more productive, and ecologically responsible spaces, encouraging the transformation of conventional building practices to support sustainable development and human flourishing (Kellert et al., 2008).

Browning, Ryan, and Clancy (2014) in their study *14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment* aimed to articulate how integrating biophilic design principles into architectural spaces globally can enhance human health, well-being, and cognitive performance. Conducted by Terrapin Bright Green, an environmental consultancy based in New York, the study utilized a qualitative methodological approach grounded in an extensive review of interdisciplinary scientific research, case studies, and design practices to identify and systematize fourteen key biophilic design patterns. The authors found that these patterns, which include elements such as visual connections to nature, natural materials, dynamic lighting, and spatial complexity, can significantly reduce stress, enhance creativity, improve mood, and expedite healing processes in urban environments. Their findings underscored the critical role of biophilic design in mitigating the adverse health impacts associated with increasing urbanization and disconnection from nature. Browning et al. (2014) concluded that intentional incorporation of these biophilic patterns into building and urban design is essential for promoting healthier, more restorative environments. They recommended that architects, planners, and policymakers systematically apply these biophilic design strategies to create sustainable, human-centered spaces that foster a deeper connection to nature, thereby improving both individual well-being and societal health.

Browning and Ryan (2020) in their book *Nature Inside: A Biophilic Design Guide* aimed to provide a practical framework for applying biophilic design principles specifically within interior design across various global contexts. The study, conducted through extensive documentation and analysis of international case studies across residential, retail, workplace, hospitality, educational, healthcare, and manufacturing spaces, employed a qualitative methodology that combined scientific research with real-world design applications. Their findings emphasized that integrating biophilic elements such as natural materials, daylight, vegetation, and nature-inspired forms into interior spaces significantly enhances human well-being, productivity, creativity, and emotional satisfaction. The authors concluded that biophilic design, when systematically implemented, can transform interior environments into more health-supportive and psychologically restorative spaces. They recommended that interior designers and built environment professionals actively adopt biophilic strategies in their day-to-day practices, using the principles as design tools to improve user experiences across building typologies. Browning and Ryan (2020) advocated for a wider application of these principles not only within buildings but also at the urban scale, highlighting the potential of biophilic design to foster healthier, more connected communities.

RESEACH METHODOLOGY

This section presents the research strategy and the specific methods employed to evaluate and establish the influence of biophilic design principles on student experiences in selected student centers. It covers the research design, data types and sources, data collection methods, instruments used for data gathering, and the processes of both qualitative and quantitative data analysis. The research focused on student centers within selected federal universities in Nigeria to assess how biophilic design principles, as earlier discussed in the literature review, impact students' experiences. To achieve this, primary data relating to Direct Contact with Nature and Indirect Contact with Nature were collected mainly through systematic field observations using a structured checklist. Data regarding the Experience of Space and Place were primarily obtained through semi-structured interviews, with some aspects also assessed via observation when applicable. The variables investigated were selected based on measurable qualitative parameters derived from the principles studied in the (Browning, W. D., & Ryan, C. O. (2020).

RESULTS AND ANALYSIS

Direct Contact with Nature

The analysis of Direct Contact with Nature is based on data collected through observational checklists. As shown in Table 4.2, only 25% of the student centers had an adequate number of openings, and 50% had openings of adequate size, while none featured skylights. These results suggest that exposure to natural sunlight and ventilation was significantly limited within the interior spaces of the student centers, which also constrained the students' visual connection to the surrounding natural environment. Additionally, as revealed in Table 4.3, only 50% of the student centers incorporated water bodies, and none featured indoor plants within interior spaces. These findings indicate that natural features within the internal spaces were minimally represented across the sampled student centers.

Table 4.2 Assessment of Natural Feature (Ventilation and Day lighting) in the Sample student's centers

S/no	List of student's centers	Number of openings	Sizes of openings	Skylight
1	University of Ibadan student union center, Ibadan Oyo state.	√	√	Ø
2	Obafemi awolowo university student center, Ile-Ife Osun state.	x	x	Ø
3	University of Maiduguri student center, Maiduguri Borno state	x	x	Ø
4	University of Ilorin, Ilorin Kwara state.	x	√	Ø
Total (%)		25	50	0

Adequate – √ Inadequate – x Unavailable – Ø

(Source: Authors Fieldwork, 2023)

The results from Table 4.2 above show that only 25% 0f the students Centers have adequate number of openings, while 50% have adequate sizes of openings. While none of the students Centers featured skylight. These results revealed little exposure to sunlight/Daylight and natural ventilation is a common feature within interi0r spaces of the sample students Centers. Also, due to inadequate amount and sizes of windows and other openings there is limited view of the natural environments and features at the surroundings.

Table 4.3: Assessment of Natural Features (Indoor Plants and Water Bodies) in the Sample Student Centers

S/No	List of Student Centers	Indoor Plants	Water Bodies
1	University of Ibadan Student Union Center, Ibadan, Oyo State	Ø	√
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	Ø	Ø
3	University of Maiduguri Student Center, Maiduguri, Borno State	Ø	√
4	University of Ilorin Student Center, Ilorin, Kwara State	Ø	Ø
Total (%)		**0**	**50**

Legend: Adequate – √ Inadequate – x Unavailable – Ø

Source: Author's Fieldwork, 2023

Results from Table 4.3 above reveal that 50% of the student Centers featured Water Bodies while none possessed Indoor Plants within their interior spaces.

From Tables 4.2 and 4.3, results from field observation reveal that Natural Features within interior spaces where minimally featured amongst the Sample student Centers studied.

Table 4.4: Assessment of Views and Vistas in the Sample Student Centers

S/No	List of Student Centers	Courtyards	Vegetation in Courtyards	Atriums	Sit-Outs/Balconies
1	University of Ibadan Student Union Center, Ibadan, Oyo State	√	x	Ø	x
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	√	√	Ø	x
3	University of Maiduguri Student Center, Maiduguri, Borno State	√	√	Ø	√
4	University of Ilorin Student Center, Ilorin, Kwara State	Ø	Ø	Ø	x
Total (%)		**75**	**50**	**0**	**25**

Legend: Adequate – √ Inadequate – x Unavailable – Ø

Source: Author's Fieldwork, 2023

Further observations from Tables 4.2 and 4.3 reinforce the minimal inclusion of natural elements in the interior designs of the student centers. Table 4.4 shows that 75% of the student centers had courtyards, but only 50% of those courtyards contained vegetation. None of the student centers featured atriums, and only 25% had sit-outs or balconies. Combined with the findings on inadequate window sizes and numbers, these results point to restricted visual access to natural vistas and outdoor greenery.

Table 4.5: Assessment of Natural Landscapes and Ecosystems in the Sample Student Centers

S/No	List of Student Centers	Number of Trees	Shrubs	Tree Cover
1	University of Ibadan Student Union Center, Ibadan, Oyo State	√	√	x
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	√	x	√
3	University of Maiduguri Student Center, Maiduguri, Borno State	√	√	√
4	University of Ilorin Student Center, Ilorin, Kwara State	x	√	Ø
Total (%)		**75**	**75**	**50**

Legend: Adequate – √ Inadequate – x Unavailable – Ø
Source: Author's Fieldwork, 2023

Table 4.5 shows that 75% of the student centers had an adequate number of trees on-site, and 75% also had sufficient shrubs, with 50% providing adequate tree cover to support sun shading, noise buffering, air purification, and microclimate control. These findings suggest that the integration of natural landscapes and ecosystems in the design and planning of the student centers was moderate. However, Table 4.6 reveals that none of the student centers incorporated green roofs or climbing vegetation on building facades, although all featured flower pots or flower beds as minimal façade greening elements. This points to a limited consideration of façade greening in the architectural design of the student centers.

Table 4.6: Assessment of Façade Greening in the Sample Student Centers

S/No	List of Student Centers	Green Roof	Use of Climbers on Walls	Flower Pots/Flower Beds
1	University of Ibadan Student Union Center, Ibadan, Oyo State	Ø	Ø	√
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	Ø	Ø	√
3	University of Maiduguri Student Center, Maiduguri, Borno State	Ø	Ø	√
4	University of Ilorin Student Center, Ilorin, Kwara State	Ø	Ø	√
Total (%)		**0**	**0**	**100**

Legend: Adequate – √ Inadequate – x Unavailable – Ø
Source: Author's Fieldwork, 2023

Ultimately, the cumulative results from Tables 4.2 to 4.6 clearly demonstrate that the users of the studied student centers experienced restricted Direct Contact with Nature both inside and outside the facilities. Additionally, limited indirect exposure to natural materials and insufficient biophilic spatial arrangements further indicate that biophilic design principles were not fully embraced in these educational environments.

Indirect Contact with Nature

The following tables below show the results of data obtained from the investigation of biophilic design parameters that revealed Indirect Contact with Nature and they are explained and discussed below.

Table 4.7: Assessment of Natural Materials and Natural Colours in the Sample Student Centers

S/No	List of Student Centers	Use of Natural Construction Materials	Use of Natural Finishes	Use of Natural Colours for Finishes
1	University of Ibadan Student Union Center, Ibadan, Oyo State	√	√	√
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	x	x	x

S/No	List of Student Centers	Use of Natural Construction Materials	Use of Natural Finishes	Use of Natural Colours for Finishes
3	University of Maiduguri Student Center, Maiduguri, Borno State	x	x	x
4	University of Ilorin Student Center, Ilorin, Kwara State	x	x	√
Total (%)		**25**	**25**	**50**

Legend: Adequate – √ Inadequate – x Unavailable – Ø
Source: Author's Fieldwork, 2023

Table 4.7 indicates that only 25% of the student centers utilized natural construction materials, and similarly, only 25% featured natural interior and exterior finishes. Meanwhile, 50% of the student centers employed natural colors within their interior spaces. These findings reflect a low level of indirect engagement with nature within the studied facilities.

Table 4.8: Assessment of Natural Shapes, Forms, Patterns, and Images in the Sample Student Centers

S/No	List of Student Centers	Use of Natural Building Forms	Use of Natural Shapes and Patterns	Use of Images of Nature in Interior Spaces
1	University of Ibadan Student Union Center, Ibadan, Oyo State	√	Ø	√
2	Obafemi Awolowo University Student Center, Ile-Ife, Osun State	x	Ø	x
3	University of Maiduguri Student Center, Maiduguri, Borno State	Ø	Ø	x
4	University of Ilorin Student Center, Ilorin, Kwara State	√	Ø	Ø
Total (%)		**50**	**0**	**25**

Legend: Adequate – √ Inadequate – x Unavailable – Ø
Source: Author's Fieldwork, 2023

EXPERIENCE OF SPACE AND PLACE

The assessment of the Experience of Space and Place was based on both field observations and semi-structured interviews. As shown in Tables 4.7 and 4.8, indirect contact with nature—an essential element of biophilic design—was poorly integrated into the student centers.

Data on translational and bounded spaces, mobility and wayfinding, as well as spatial harmony and spaciousness were collected through direct observation using a checklist, as detailed in Tables 4.9, 4.10, and 4.11. Variables such as security and protection, attraction and beauty, and connection to the indigenous habitat were explored through interviews with five students from each sampled student center. The results of the interviews were summarized in Tables 4.11, 4.12, 4.14, and 4.15.

Table 4.9 Assessment of key elements that reveal experience of place and spaces (translational and bounded spaces) in the Sample student's centers

staircases		Lobbies/halls			walkways			Public spaces	
s/no	List of student's centers	Width ≥1.5m	Natural features	Width ≥2.0m	Natural features	Width ≥1.2m	Natural features	spacious	Connection to nature
1	University of Ibadan student union center, Ibadan Oyo state.	√	Ø	√	√	√	√	√	√

2	Obafemi awolowo university student center, Ile-Ife Osun state.	√	Ø	√	x	√	√	√	x
3	University of Maiduguri student center, Maiduguri Borno state	Ø	Ø	√	√	√	√	x	x
4	University of Ilorin, Ilorin Kwara state.	√	Ø	√	Ø	√	Ø	√	x
	Total (%)	75	0	100	50	100	75	75	25

Adequate – √ Inadequate – x Unavailable – Ø

(Source: Authors Fieldwork, 2023)

Table 4.9 shows that 75% of the student centers had staircases with widths of at least 1.5 meters, which meets the standard for adequate staircase width, although none of these staircases featured natural elements along their routes. Additionally, all student centers had lobbies and halls with widths of at least 2 meters, which is acceptable, and 50% included natural features within these spaces. All student centers also had walkways with widths of at least 1.2 meters, with 75% featuring natural elements along the walkways. However, only 25% of well-spaced public spaces such as receptions and visiting areas included any connection to nature. These findings demonstrate that while basic spatial standards were met, the biophilic integration of natural elements in transitional and bounded spaces was only moderately considered.

Table 4.10 Assessment of key elements that reveal experience of place and spaces (mobility and way finding) in the Sample student's centers

s/no	List of student's centers	Circulation spaces	Ease of locating staircases, elevators, lobbies	signage
1	University of Ibadan student union center, Ibadan Oyo state.	√	√	Ø
2	Obafemi awolowo university student center, Ile-Ife Osun state.	√	√	Ø
3	University of Maiduguri student center, Maiduguri Borno state	√	√	x
4	University of Ilorin, Ilorin Kwara state.	√	√	Ø
Total (%)		100	100	0

Adequate – √ Inadequate – x Unavailable – Ø

(Source: Authors Fieldwork, 2023)

Table 4.10 reveals that all the student centers provided adequate circulation spaces and that staircases and lobbies were easily locatable, which reflects adequate provision for mobility and wayfinding. However, none of the centers included elevators or adequate signage to support intuitive navigation.

Table 4.11 Assessment of key elements that reveal experience of place and spaces (spatial harmony and spacious) in the Sample student's centers

s/no	List of student's centers	Floor to ceiling height ≥3m	Harmony of interior spaces
1	University of Ibadan student union center, Ibadan Oyo state.	√	√
2	Obafemi awolowo university student center, Ile-Ife Osun state.	√	x
3	University of Maiduguri student center, Maiduguri Borno state	√	x
4	University of Ilorin, Ilorin Kwara state.	√	x
Total (%)		100	25

Adequate – √ Inadequate – x Unavailable – Ø

Observation data in Table 4.11 indicate that all the student centers had interior ceiling heights of at least 3 meters, but only 25% achieved spatial harmony within their interior arrangements. This shows that despite the generous ceiling heights, the spatial harmony and overall spaciousness were insufficiently addressed.

Table 4.12 Assessment of user's perception of security and protection that reveal experience of place and spaces in the Sample student's centers.

s/no	List of student's centers	General feeling of insecurity	Protection of balconies terraces in upper floor
1	University of Ibadan student union center, Ibadan Oyo state.	75%	70%
2	Obafemi awolowo university student center, Ile-Ife Osun state.	60%	70%
3	University of Maiduguri student center, Maiduguri Borno state	40%	0
4	University of Ilorin, Ilorin Kwara state.	65%	70%
Average (%)		60	70

Semi-structure interview

From the results of the interviews summarized in Table 4.12, it was found that an average of 60% of the students reported feeling a general sense of insecurity within the student centers. However, 70% of the respondents considered the balconies and stairways to be adequately protected and safe. These findings suggest that while specific structural elements were perceived as safe, the general feeling of security within the centers was still an area of concern.

Table 4.13 Assessment of user's perception of attraction and beauty that reveal experience of place and spaces in the Sample student's centers.

s/no	List of student's centers	Aesthetics of building facade	Aesthetics of interior spaces	Use of natural decorative features within interior spaces
1	University of Ibadan student union center, Ibadan Oyo state.	75%	30%	40%
2	Obafemi awolowo university student center, Ile-Ife Osun state.	60%	20%	10%
3	University of Maiduguri student center, Maiduguri Borno state	35%	10%	15%
4	University of Ilorin, Ilorin Kwara state.	50%	40%	35%
Average (%)		45	25	25

(Source: Authors Fieldwork, 2023)

Semi-structure interview

Based on the results presented in Table 4.13, it was found that an average of 45% of the users of the studied student centers expressed satisfaction with the aesthetics of the building facades on site. However, only an average of 25% of the users reported satisfaction with the aesthetics within the interior spaces of the student centers. Furthermore, just 25% of the respondents affirmed that natural decorative elements were incorporated into the interior spaces for aesthetic purposes. These findings collectively indicate a notable level of dissatisfaction with the overall aesthetic appeal and biophilic quality of both the exterior and interior environments of the student centers. The limited integration of natural decorative elements and insufficient aesthetic considerations likely contributed to the users' low satisfaction levels, emphasizing the need for improved design strategies that prioritize both natural aesthetics and biophilic design principles.

RESULTS OF ALL THE VARIABLES OF BIOPHILIC DESIGN PRINCIPLES FROM SELECTED STUDENT CENTERS

Table 4.14: Summary of Direct Contact with Nature in the Sample Student Centers

Biophilic Design Features	**Variables**	**Results (%)**
Natural Feature (Ventilation and Daylighting)	**Number of Openings**	**25**
	Sizes of Openings	**50**
	Skylight	**0**
Natural Feature (Indoor Plants and Water Bodies)	**Indoor Plants**	**0**

Biophilic Design Features	Variables	Results (%)
	Water Bodies	**50**
Views and Vistas	**Courtyards**	**75**
	Vegetation in Courtyards	**50**
	Atriums	**0**
	Sit-outs/Balconies	**25**
Natural Landscapes and Ecosystem	**Number of Trees**	**75**
	Shrubs	**75**
	Tree Cover	**50**
Façade Greening	**Green Roof**	**0**
	Use of Climbers on Walls	**0**
	Flower Pots/Flower Beds	**100**

Source: Author's Fieldwork, 2023

Table 4.15 Indirect Contact with Nature

BIOPHILIC DESIGN FEATURES	VARIABLES	RESULTS (100%)
Natural Materials and Natural Colors	Use of natural construction materials	25
Use of natural finishes		25
Use of natural colors for finishes		50
Natural Shapes, Forms, Pattern and Images	Use of natural building forms	50
Use of natural shapes and patterns		0
Use of images of nature in interior spaces		25

Table 4.16 Experience of Space and Place

BIOPHILIC DESIGN FEATURES	VARIABLES	RESULTS (100%)
place and spaces (translational and bounded spaces)	staircases	75
Lobbies/halls		100
walkways		100
place and spaces (mobility and way finding)	Circulation spaces	100
Ease of locating staircases, elevators, lobbies		100
signage		0
place and spaces (spatial harmony and spacious)	Floor to ceiling height ≥3m	100
Harmony of interior spaces		25
Security And Protection	General feeling of insecurity	60
Protection of balconies terraces in upper floor		70
Attraction And Beauty	Aesthetics of building facade	45
Aesthetics of interior spaces		25
Use of natural decorative features within interior spaces		25

SUMMARY OF FINDINGS

Direct Contact with Nature

The analysis from Table 4.2 reveals that only 25% of the student centers had an adequate number of openings, and just 50% possessed openings of adequate sizes. Furthermore, none of the student centers incorporated skylights into their designs. These findings suggest that the interior spaces of the student centers generally lacked sufficient exposure to natural daylight and ventilation, which are critical components of biophilic design. The limited number and size of openings also significantly restricted the ability of students to visually connect with the surrounding natural environment, thereby limiting natural views and vistas that could support cognitive restoration and concentration.

According to the results in Table 4.3, only 50% of the student centers featured outdoor water bodies, and none of the centers had indoor plants integrated into their interior spaces. This lack of indoor vegetation and minimal integration of water elements within the buildings further emphasizes the insufficient direct contact with nature within the student centers, depriving users of the psychological and physiological benefits associated with these natural features.

Combining the evidence from Tables 4.2 and 4.3, it becomes evident that natural features were minimally incorporated into the interior spaces of the sample student centers studied. The absence of sufficient natural ventilation, sunlight exposure, and indoor greenery highlights a major deficiency in biophilic design within these learning environments.

As presented in Table 4.4, 75% of the student centers had courtyards, but only 50% of these courtyards featured vegetation. Moreover, none of the centers incorporated atriums into their designs, and just 25% provided sit-outs or balconies. These results, along with the inadequacies identified in Table 4.2 concerning the number and size of openings, underscore the limited availability of views to natural elements and vistas from the student centers, further restricting meaningful interaction with outdoor natural features.

Further analysis in Table 4.5 shows that 75% of the student centers had an adequate number of trees on site, and 75% also featured an adequate number of shrubs. However, only 50% of the centers provided sufficient tree cover to offer essential ecological benefits such as sun shading, noise reduction, air purification, and microclimate regulation. This suggests that while natural landscaping was moderately considered in the planning of the student centers' surroundings, its integration was not fully optimized to maximize the potential benefits for students.

The findings from Table 4.6 reveal that none of the student centers had green roofs or wall climbers as part of their building facades, though all the centers (100%) had flower pots or flower beds contributing to minimal façade greening. This demonstrates that while some attempt was made to introduce greenery, the absence of more advanced façade greening techniques signifies a limited application of biophilic principles in building envelope design.

Cumulatively, the data from Tables 4.2 to 4.6 clearly indicate that the students' opportunities for direct contact with nature, both within the interior spaces and in the external surroundings of the studied student centers, were significantly restricted. This limited exposure to natural elements potentially reduces the cognitive, psychological, and health benefits that biophilic environments are known to provide.

Indirect Contact with Nature

The results from Table 4.7 show that only 25% of the student centers used natural construction materials in their buildings. Additionally, just 25% of the centers utilized natural finishes for both interior and exterior spaces, and only 50% incorporated natural colors within the interior designs. These findings collectively indicate a low level of commitment to integrating natural materials and natural color schemes, which are essential aspects of providing indirect contact with nature in biophilic environments.

Moreover, the combined insights from Tables 4.7 and 4.8 further highlight that indirect contact with nature, a fundamental aspect of biophilic design, was not sufficiently prioritized in the studied student centers. The minimal use of natural materials, textures, and colors limits the sensory experiences that can positively influence students' cognitive function, concentration, and emotional well-being within these learning spaces.

Experience of Space and Place

The findings in Table 4.9 indicate that 75% of the assessed student centers had staircases with widths equal to or greater than 1.5 meters, which meets the standard for adequate stair width; however, none of these staircases incorporated natural features such as plants or water elements. Additionally, all the student centers (100%) featured lobbies and halls with widths of at least 2 meters, which is considered acceptable, yet only 50% included natural features along these spaces. Furthermore, all the student centers (100%) had walkways with widths of 1.2 meters or more, suitable for pedestrian circulation, with 75% of these walkways integrating natural elements. The analysis also showed that while 75% of the student centers had adequately spaced public areas such as receptions and visiting zones, only 25% of these spaces provided any meaningful connection to nature. These findings reveal that while the physical dimensions of transitional and bounded spaces within the student centers generally meet acceptable standards, the incorporation of biophilic elements in these spaces was only moderately considered, limiting the overall biophilic experience of space and place in the studied centers.

Further insights from Table 4.10 show that 100% of the student centers provided adequate circulation spaces, which support user movement and accessibility throughout the buildings. Additionally, all the student centers (100%) demonstrated ease in wayfinding with clear visibility of staircases and lobbies; however, none of the centers had elevators or proper signage to aid navigation, which could limit accessibility, particularly for people with disabilities. This indicates that while mobility within the student centers is structurally sufficient, the absence

of elevators and signage diminishes the potential for a fully inclusive wayfinding system.

Table 4.11 presents the observations on users' experiences within the student centers, showing that all interior spaces (100%) had ceiling heights equal to or greater than 3 meters, indicating sufficient volumetric space for users. However, only 25% of the student centers exhibited spatial harmony, as reflected in the users' feedback regarding the arrangement and connectedness of spaces. This finding suggests that despite the physical spaciousness of the interior environments, many of the student centers lacked cohesive and harmonious design, which could negatively impact the psychological comfort and concentration of users.

From the results in Table 4.12, interviews conducted with students of the assessed centers revealed that an average of 60% of respondents consistently expressed feelings of insecurity within the facilities, citing concerns about safety in some public spaces. Nonetheless, an average of 70% of students affirmed that stairways and balconies were adequately protected and safe for use. These findings point to a paradox where, despite specific areas such as stairways and balconies being physically secure, students still experience a general sense of insecurity within the broader spatial environments of the centers, indicating the need for improvements in the psychological and environmental quality of these spaces.

Results presented in Table 4.13 reveal that only an average of 45% of users expressed satisfaction with the exterior facades of the student centers, while an even lower average of 25% reported satisfaction with the aesthetics of interior spaces. Moreover, just 25% of the students acknowledged the presence of natural decorative elements within interior spaces. These results indicate a significant level of dissatisfaction with both the interior and exterior aesthetic qualities of the student centers, particularly regarding the integration of biophilic design features that could enhance the visual and sensory appeal of these learning environments.

DISCUSSION OF FINDINGS

The findings from the assessment of natural features, user perceptions, and performance summaries in the sampled student centres across Nigerian universities strongly align with the conclusions of past studies in the empirical review. The tables reveal that natural ventilation, daylight, and visual access to natural elements were largely inadequate or unavailable in most of the assessed centres, which corroborates the findings of Abdulraheem, Olalekan, and Adebayo (2022) that inadequate learning environments negatively impact student performance in Nigerian universities. This study also confirms the position of Kellert and Calabrese (2015), who emphasized that direct and indirect contact with nature, including natural lighting, ventilation, and natural forms, improves human cognitive performance and psychological well-being. Similarly, the inadequacy of natural features in the assessed centres supports Browning, Ryan, and Clancy's (2014) assertion that the absence of biophilic patterns in the built environment diminishes concentration, increases fatigue, and limits cognitive engagement. The poor ventilation and insufficient daylight in the sampled centres are consistent with Li and Sullivan's (2016) findings that students deprived of exposure to green spaces and natural light experience reduced attention and mental restoration. Additionally, the low user satisfaction levels reported in the perception tables reflect the cognitive strain and discomfort emphasized by Leung, Fung, and Fung (2017), who linked poor indoor environmental quality to declining cognitive functions. Therefore, the findings from this study not only agree with the empirical evidence from international studies but also reinforce the urgency of integrating biophilic design principles into Nigerian university classrooms to enhance cognitive function, concentration, and overall student well-being.

SUMMARY

The assessment of natural features such as ventilation, daylight, and skylights across the sampled student centres in Nigerian universities revealed significant inadequacies in providing biophilic design elements. Specifically, the analysis indicated that most of the student centres lacked sufficient natural openings and appropriate skylight provisions, with only the University of Ibadan student centre meeting the adequate standard for both ventilation and daylight. This deficiency highlights the poor integration of direct contact with nature, which is a crucial aspect of biophilic design. The absence of these natural features contributes to an environment that does not support optimal air circulation or access to natural light, both of which are essential for enhancing cognitive function and improving indoor environmental quality.

User perception data further confirmed the limited satisfaction with the physical and environmental conditions of the student centres. The majority of students rated the ventilation, lighting, visual comfort, and overall environmental quality as poor or inadequate, indicating that these spaces fail to meet users' psychological and cognitive needs. The negative perceptions suggest that the current design of these centres does not promote concentration, comfort, or well-being, which aligns with previous studies emphasizing the importance of natural elements in learning environments. Furthermore, the lack of biophilic design features likely contributes to discomfort, reduced cognitive performance, and diminished user engagement within these educational spaces.

The summary of performance and user evaluations underscores the need for urgent improvements in the design and functionality of student centres to incorporate biophilic elements. The findings strongly support past research advocating for the inclusion of direct and indirect nature connections, such as natural ventilation, daylight, visual access to greenery, natural materials, and spatial harmony. Integrating these features would not only enhance the cognitive and psychological experiences of students but also foster improved learning outcomes and user satisfaction. These results emphasize that adopting biophilic design principles in educational facilities is essential for creating healthier, more supportive learning environments in Nigerian universities.

CONCLUSION

This study has conclusively established that the current design and environmental conditions of student centres in selected Nigerian universities significantly lack biophilic design elements, which are essential for supporting students' cognitive function, concentration, and overall well-being. The findings revealed substantial inadequacies in the provision of natural ventilation, daylight, skylights, and other nature-integrated features, indicating a widespread neglect of both direct and indirect contact with nature within these educational spaces. The poor user perceptions regarding indoor environmental quality, ventilation, lighting, and spatial comfort further confirm that these spaces do not meet the cognitive and psychological needs of their users, thereby undermining students' learning performance and concentration.

The implications of these findings highlight that integrating biophilic design features—such as natural ventilation, access to daylight, views of greenery, the use of natural materials, and creating transitional and harmonious spaces—can significantly improve the cognitive and environmental experience of Nigerian university students. Each inadequacy identified, whether in ventilation or visual comfort, directly limits the potential benefits of biophilic environments that have been shown in past studies to reduce stress, enhance cognitive function, and promote psychological well-being. Therefore, adopting biophilic design strategies in the planning, renovation, and construction of student centres is essential to improve the educational environment and support students' cognitive development and academic performance. These findings provide strong evidence for stakeholders, architects, and university administrators to prioritize biophilic principles in creating healthier and more conducive learning spaces.

RECOMMENDATIONS

Recommendation 1:

Improving Natural Ventilation and Daylighting in Student Centres

Based on the finding that most of the student centres assessed lack adequate natural ventilation and daylighting, it is recommended that university management, in collaboration with architects, should prioritize the retrofitting and redesign of existing student centres to incorporate more openings, skylights, and façade greening that will promote direct contact with nature. This can be achieved by strategically increasing window sizes, installing operable louvres for cross ventilation, and integrating skylights to allow more natural light penetration. The **Federal Ministry of Education (FME)** and **Federal Ministry of Environment (FMEV)** should develop and enforce design guidelines that make natural ventilation and daylighting compulsory in student-centred facilities across Nigerian universities. The architects responsible should ensure that the spatial configuration of these centres maximizes air circulation and daylight exposure without compromising safety.

Recommendation 2:

Integrating Indirect Contact with Nature through Natural Materials and Aesthetics

The study revealed poor user perception regarding the aesthetic quality and indirect experience of nature within student centres. Therefore, it is recommended that university facilities managers, in partnership with architects and interior designers, should incorporate natural materials such as wood, stone, and earth-toned finishes, as well as introduce natural shapes, patterns, and biomorphic designs in furniture, wall treatments, and flooring. The **National Universities Commission (NUC)** and the **Federal Ministry of Works and Housing** should develop policies encouraging the use of locally sourced, sustainable natural materials in the renovation and construction of educational facilities. Architects must work to blend the natural aesthetic seamlessly with the functional requirements of student centers to ensure that these spaces become psychologically supportive learning environments.

Recommendation 3:

Creating Biophilic Spatial Experiences through Transitional and Harmonious Spaces

The findings also indicated a lack of transitional spaces, spatial harmony, and visually stimulating environments that are essential for students' psychological well-being and concentration. It is recommended that architects and university planners intentionally create semi-open courtyards, terraces, and green transitional areas within and around student centres to facilitate indirect and experiential engagement with nature. The **Federal Ministry of Lands, Housing and Urban Development** and university physical planning units should lead the effort to implement master plans that promote biophilic spatial planning. These transitional spaces should be designed to offer students secure, attractive, and accessible areas that encourage mobility, relaxation, and interaction with natural elements, ultimately enhancing concentration and cognitive function.

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