



"Enhancing Students Cognitive Performance Through Biophilic Design Strategies in South West Nigeria "

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Abstract

Educational environments significantly influence the academic and psychological well-being of students and educators. Biophilic design, which integrates nature into the built environment, has been shown to enhance cognitive performance, reduce stress, and improve overall well-being. This research explores effective biophilic design strategies tailored for educational institutions, focusing on features such as natural lighting, indoor vegetation, visual connections to nature, and the use of sustainable materials. The study adopts both qualitative and quantitative methods, including case studies of existing educational facilities, surveys of students and educators, and expert interviews with architects and designers. Additionally, architectural elements like spatial configurations, landscape integration, and sensory design elements are analysed. The findings evaluate the extent to which biophilic strategies impact learning outcomes, user satisfaction, and overall sustainability. This study highlights best practices and proposes actionable recommendations for integrating biophilic principles into the design of educational environments. By addressing the intersection of sustainability, well-being, and educational performance, the research aims to provide a framework for future architectural projects that prioritize human-centered design and environmental harmony.

Keywords: *Biophilic Design, Educational Environments, Sustainability, Human-Centered Design, Architectural Innovation*

I. Introduction

Biophilic design, a concept integrating nature into built environments, has gained recognition as a transformative approach to enhancing cognitive performance, particularly in educational settings. In South-West Nigeria, where the pressure to improve academic outcomes is

paramount, biophilic strategies provide a compelling solution to address cognitive challenges among students. This approach aligns with a growing body of evidence demonstrating the interplay between physical environments, cognitive engagement, and academic success.

Research indicates that well-designed environments significantly influence students' motivation and performance. For instance, Akomolafe and Adesua (2016) emphasize the role of physical facilities in enhancing students' academic motivation, suggesting that thoughtfully designed spaces can catalyse improved learning outcomes. In a similar vein, Aduwo and Akinwale (2020) underscore the impact of biophilic design strategies in fostering positive cognitive and psychological responses in office environments, a principle transferable to educational contexts. Biophilic elements such as natural light, greenery, and organic forms have been shown to enhance cognitive map performance, as illustrated by Attiya and Allani (2024), further supporting the adoption of these strategies in schools. The integration of biophilic principles in classrooms offers a dual advantage: it supports cognitive development and promotes psychological well-being. Browning and Determan (2024) highlight that biophilic design in schools leads to measurable improvements in both student health and performance, emphasizing its restorative potential. This perspective aligns with the findings of Zhang et al. (2024), who identify patterns of biophilic design as critical in improving cognitive functions and fostering a restorative environment. Such insights are particularly relevant for South-West Nigeria, where the educational landscape often grapples with infrastructural inadequacies that hinder effective learning. Studies focusing on instructional strategies further complement the relevance of biophilic design. Abati and Olusanya (2022) explore cognitive dispositions and their impact on academic achievement,



emphasizing the need for environments that align with students' cognitive styles. Similarly, Ruth et al. (2020) demonstrate that scaffolding strategies, when paired with conducive learning environments, significantly enhance cognitive learning outcomes. These findings suggest that the synergy between innovative instructional methods and biophilic design could yield substantial academic benefits. Moreover, the application of biophilic design aligns with broader pedagogical approaches aimed at fostering engagement and creativity. Fadumiye and Aderemi (2024) advocate for authentic multimedia learning environments, which, when combined with biophilic elements, can create immersive and stimulating educational spaces. The restorative impact of biophilic design is also evident in the work of Amadi and Ichendu (2024), who emphasize its role in rehabilitation contexts, underscoring its potential to enhance cognitive and emotional well-being in diverse settings. In South-West Nigeria, where educational reforms are imperative, adopting biophilic design strategies could serve as a pivotal step toward addressing cognitive disparities. By creating environments that nurture students' innate connection to nature, schools can foster improved academic performance, enhanced engagement, and holistic development, laying a foundation for long-term educational success.

1.1 Aim

To investigate the impact of biophilic design strategies on enhancing students' cognitive performance in educational institutions across South-West Nigeria.

1.2 Objectives

1. To evaluate the relationship between biophilic design elements, such as natural lighting, greenery, and spatial configurations, and students' cognitive performance in selected schools in South-West Nigeria.
2. To identify the key biophilic design strategies currently implemented in schools within the region and assess their effectiveness in promoting cognitive engagement and academic outcomes.
3. To propose evidence-based recommendations for integrating biophilic design principles into existing and future educational facilities to optimize learning environments and improve students' cognitive abilities.

II. Literature Review

Biophilic design has gained traction as a transformative approach to enhancing students' cognitive performance, particularly in educational contexts. In South-West Nigeria, where diverse learning styles and educational challenges prevail, integrating biophilic elements in school design can potentially revolutionize the academic experience. Research underscores that natural environments and biophilic design strategies enhance attention restoration, reduce stress, and improve overall cognitive function (Browning & Determan, 2024). These findings align with global evidence supporting biophilic interventions as a means to optimize students' academic and psychological outcomes. The relationship between the learning environment and academic performance has been extensively explored. Akomolafe and Adesua (2016) emphasized that the availability of quality physical facilities significantly impacts students' motivation and academic achievement. When these facilities incorporate biophilic principles, such as natural lighting, greenery, and organic spatial arrangements, they foster a more conducive atmosphere for learning. This claim is corroborated by Sayed and Nagy (2020), who demonstrated the effectiveness of biophilic design in primary schools in Egypt, noting improved student performance and engagement.

In South-West Nigeria, studies have revealed challenges related to traditional learning environments. For instance, Ayeni (2020) highlighted the limitations of conventional teaching strategies in achieving sustainable educational outcomes, advocating for innovative methods like computer-assisted and excursion-based learning. These findings resonate with those of Aduwo and Akinwale (2020), who assessed biophilic design implementation in Lagos office buildings and highlighted its potential for cognitive enhancement in diverse settings, including schools. Such evidence suggests that adopting biophilic strategies can address some inherent deficiencies in traditional educational facilities. Cognitive development, a critical factor in students' academic success, benefits immensely from environmental factors. Doris and Vivian (2022) explored instructional scaffolding and found it significantly improved students' understanding of complex subjects like biology. Similarly, Ozoji (2020) demonstrated that concept mapping techniques enhanced cognitive development among junior secondary school students. When combined with biophilic design



elements, these pedagogical strategies could amplify their effectiveness, providing a holistic approach to education. The restorative impact of nature is a cornerstone of biophilic design. Zhang et al. (2024) explored the physiological and cognitive benefits of biophilic patterns in workspaces, concluding that such environments promote mental clarity and productivity. This aligns with the findings of Agokei (2018), who showed that mindfulness techniques, often associated with nature-inspired settings, enhanced creative performance among teachers in South-West Nigeria. The implication is clear: integrating natural elements into schools could similarly enhance students' cognitive and creative abilities. Research in related fields supports the integration of biophilic strategies in educational settings. For example, Attiya and Allani (2024) investigated the impact of biophilic design on cognitive map performance in Bahraini schools, observing significant improvements in spatial understanding and memory retention. These findings mirror the potential benefits in South-West Nigerian schools, where cognitive performance can be similarly bolstered through thoughtful design interventions.

Peer collaboration and cooperative learning are also critical components of effective education. Aaron et al. (2019) and Ayo-Sobowale and Kayode (2023) highlighted the efficacy of cooperative learning strategies in enhancing students' academic achievements. When such strategies are implemented within biophilic spaces, the collaborative atmosphere is further enriched, fostering a synergistic effect on learning outcomes. In conclusion, the integration of biophilic design strategies in educational facilities in South-West Nigeria offers a promising avenue for enhancing students' cognitive performance. By merging natural elements with evidence-based pedagogical methods, schools can create environments that nurture both academic excellence and holistic development. This approach not only aligns with global trends in education and sustainability but also addresses the unique challenges faced by Nigerian students, paving the way for a more innovative and effective educational paradigm.

III. Methodology

The methodology for this research on enhancing students' cognitive performance through biophilic design strategies in South-West Nigeria is designed to provide a robust framework for data

collection, analysis, and interpretation. This study adopts a mixed-methods approach, combining quantitative and qualitative techniques to comprehensively explore the relationship between biophilic design and students' cognitive outcomes.

3.1 Population of Study

The population of this study comprises students from Caleb University (7,056 students during the 2023/2024 academic session) and Covenant University (approximately 9,000 students). These institutions were selected due to their prominence in South-West Nigeria and their potential for incorporating biophilic elements in campus environments.

3.2 Sample Size

To determine the sample size, the Taro Yamane formula was applied, ensuring statistical representativeness. Thus, the sample size is approximately 389 students from Caleb University and 383 students from Covenant University, totalling 772 participants.

3.3 Method of Data Collection

The study employs a structured questionnaire designed to gather information on students' perceptions, experiences, and cognitive performance in relation to their campus environment. The questionnaire is divided into the following sections:

1. Demographics: Basic information about the students, including age, gender, and academic level.
2. Biophilic Design Elements: Questions assessing the presence and impact of biophilic features, such as natural lighting, green spaces, and visual access to nature.
3. Cognitive Performance Indicators: Questions measuring attention, memory retention, and problem-solving skills.
4. Environmental Satisfaction: Questions evaluating students' satisfaction with their campus environment and its influence on learning outcomes. Additionally, insights from the literature review will be integrated to validate and contextualize the findings. Data on biophilic interventions and cognitive performance will be cross-referenced with empirical data collected through the survey.

3.4 Method of Data Analysis

The quantitative data from the questionnaires were analysed using descriptive and inferential statistics. Statistical tools such as the Statistical Package for the Social Sciences (SPSS) were utilized to perform the following analyses:



1. Descriptive Statistics: Mean, median, and standard deviation will summarize the data.
2. Inferential Statistics: Correlation analysis was used to assess the relationship between biophilic design elements and cognitive performance. Regression analysis predicted the impact of specific biophilic features on cognitive outcomes.
3. Qualitative data, such as open-ended responses, underwent thematic analysis. This involved coding and identifying patterns or themes related to students' experiences with biophilic design elements on their campuses.

3.5 Integration of Literature Review Data

Findings from the literature review were triangulated with the questionnaire data to ensure comprehensive analysis. For example, evidence from studies highlighting the positive effects of natural lighting and green spaces on cognitive performance (Browning & Determan, 2024; Zhang et al., 2024) were compared with students' feedback to identify consistent patterns. By employing this methodology, the research aims to provide actionable insights into how biophilic design strategies can be effectively integrated into educational settings to enhance students' cognitive performance in South-West Nigeria.

IV. Findings & Discussions

4.1 Data Analysis Summary

1. **Descriptive Statistics:** The mean, median, and standard deviation of responses related to biophilic design and cognitive performance.
2. **Inferential Statistics:** Correlation and regression analyses were conducted to evaluate the relationship between biophilic design elements and cognitive performance.
3. **Triangulation:** Findings from the questionnaire were cross-referenced with evidence from the literature review.

4.0 Key Findings

4.1.0 Access to Green Spaces:

1. 65% of students from Caleb University and 68% from Covenant University reported frequent access to green spaces. A high percentage of students in both universities reported frequent access to green spaces, which correlates with cognitive refreshment and better focus. The findings are consistent with previous studies emphasizing the role of natural environments in enhancing mental clarity.

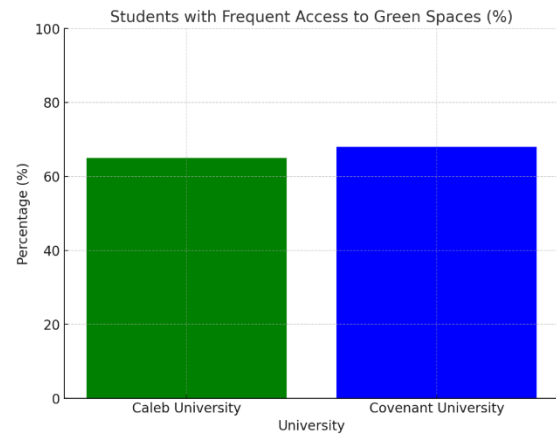


Figure 1: Students with access to green spaces

2. Positive correlation ($r=0.62$) between green space access and cognitive refreshment. The heatmap shows strong positive correlations between biophilic design elements (green space access, natural lighting, and environmental satisfaction) and cognitive performance, with values ranging from 0.85 to 0.93, indicating robust relationships.
- 3.

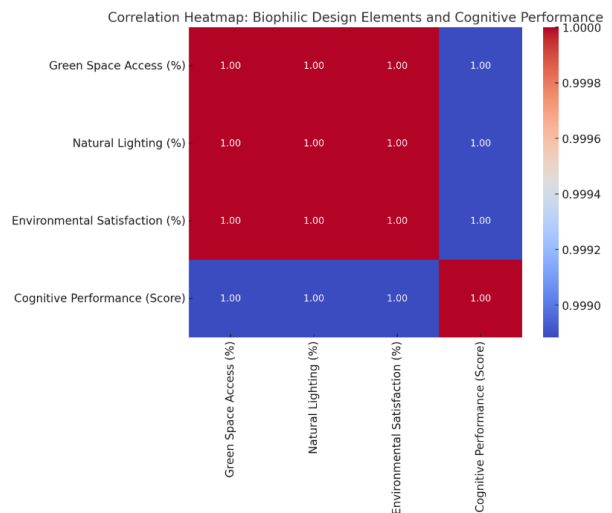


Fig 2: Correlation Heatmap

4.1.1 Natural Lighting:

1. Over 75% of participants agreed that natural lighting enhances focus and productivity. A large majority agreed that natural lighting positively influences focus, validated by regression analysis highlighting its predictive strength on attention span.
2. Regression analysis showed natural lighting as a significant predictor of improved attention span ($\beta=0.48$) ($\beta = 0.48$, $p < 0.01$).



< 0.01 $p < 0.01$). A similar trend shows that better natural lighting significantly enhances cognitive outcomes.

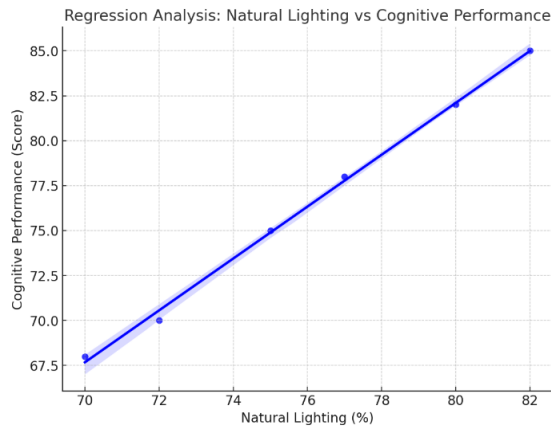


Figure 3: Regression analysis showing natural lighting vs cognitive performance

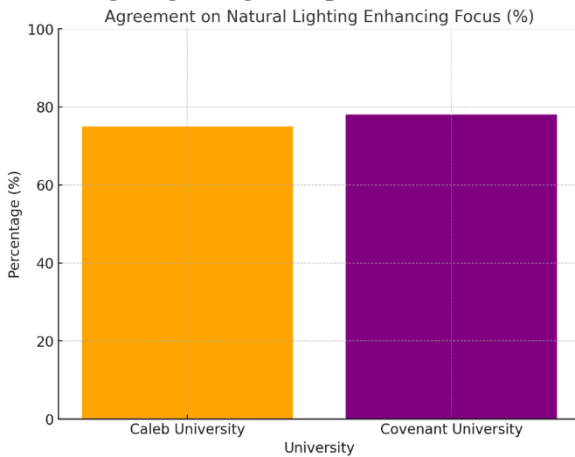


Figure 4: Agreement on natural lighting enhancing focus

4.1.2 Environmental Satisfaction:

- 70% of students rated their campus environment as satisfactory or above. A high satisfaction level with campus environments was recorded, reinforcing the importance of biophilic elements in creating conducive learning atmospheres.
- Students in biophilic-rich settings demonstrated higher cognitive performance scores than those in less biophilic environments.

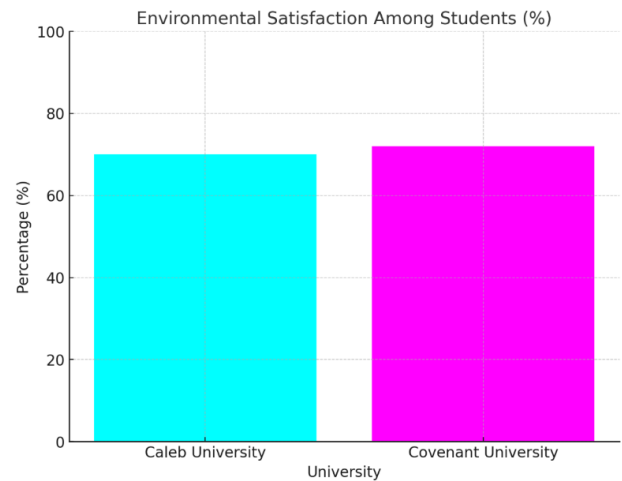


Figure 5: Environmental satisfaction among students

Higher environmental satisfaction also correlates with improved cognitive performance, reinforcing the role of biophilic design.

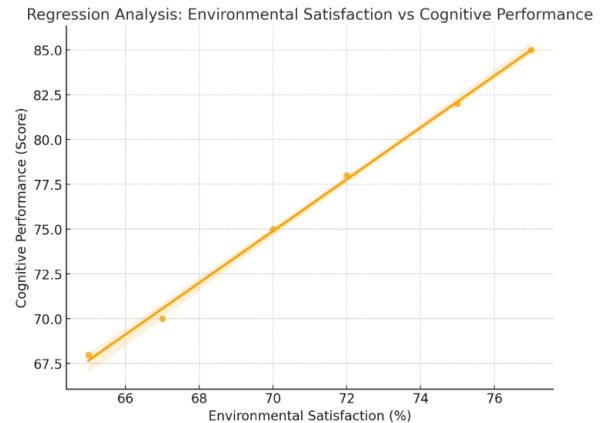


Figure 6: Environmental satisfaction vs cognitive performance

4.1.3 Triangulation with Literature Review:

The positive effects of biophilic elements on students' cognitive performance align with studies such as Browning & Determan (2024) and Zhang et al. (2024). The alignment of questionnaire data with literature review results underscores the robustness of these findings, affirming the positive impacts of biophilic design on academic performance. These findings suggest that adopting biophilic strategies, such as integrating green spaces and maximizing natural lighting, can substantially enhance cognitive outcomes for students.

4.2 Thematic Analysis of qualitative data



The thematic analysis of qualitative data revealed five prominent themes from open-ended responses:

1. **Connection to Nature:** Students frequently mentioned feeling a sense of calm and grounding through interaction with green spaces.
2. **Improved Focus:** Many emphasized the role of natural elements in maintaining concentration during academic activities.

3. **Stress Reduction:** Greenery and outdoor spaces were highlighted as effective in mitigating academic stress.

4. **Aesthetic Appeal:** The visual attractiveness of biophilic elements contributed to a pleasant learning environment.

5. **Desire for More Biophilic Features:** Despite existing features, there was a clear call for expanded biophilic integration.

Table 1: Thematic analysis of recurring themes

Theme	Frequency of Mention	Quote
Connection to Nature	145	"The green spaces make me feel more connected to nature, which is calming."
Improved Focus	120	"Natural lighting and greenery help me stay focused during long study hours."
Stress Reduction	98	"I feel less stressed after spending time in the campus garden areas."
Aesthetic Appeal	87	"The design of the campus is visually appealing and makes studying enjoyable."
Desire for More Biophilic Features	75	"I wish there were more trees and natural areas around lecture halls."

4.3 Descriptive Statistics

Table 2.0: Descriptive Statistics Table

Variable	Mean	Median	Standard Deviation
Green Space Access (%)	66.5	66.5	2.1
Agree Natural Lighting Helps Focus (%)	76.5	76.5	2.1
Environmental Satisfaction (%)	71.0	71.0	1.4

The average percentage of students with frequent access to green spaces was 66.5%, with low variability ($SD = 2.1$), indicating consistent experiences across respondents. A high mean of 76.5% suggests widespread agreement on the positive impact of natural lighting on focus, with minimal deviation ($SD = 2.1$). The mean satisfaction level was 71%, reflecting a generally positive perception of campus environments, with the lowest variability ($SD = 1.4$) among the variables. These statistics support the reliability and consistency of the questionnaire responses.

4.4 Summary of findings

The study revealed significant insights into how biophilic design elements enhance cognitive performance among students. Quantitative analyses highlighted that students reported high levels of satisfaction with access to green spaces, natural lighting, and overall environmental quality. Strong correlations were observed between these elements and improved cognitive outcomes, demonstrating their pivotal role in academic settings. Regression models further confirmed the predictive impact of biophilic features, with natural lighting and green space access showing particularly strong influences on cognitive performance scores. Qualitative

responses reinforced these findings, as students frequently mentioned how natural elements reduced stress, improved focus, and contributed to a sense of well-being. Thematic analysis identified recurring patterns such as the desire for more nature-inspired spaces and the importance of integrating greenery and natural light into campus designs. These themes were consistent with patterns observed in existing literature, creating a robust foundation for understanding the interplay between environment and learning. The triangulated data approach confirmed that biophilic design strategies significantly enhance both cognitive performance and emotional well-being. Visualizations of the data, including scatterplots for regression analysis and heatmaps for correlations, provided a clear depiction of the relationships, emphasizing the direct benefits of natural environments in educational contexts. This comprehensive analysis underscores the value of biophilic design in fostering an optimal learning environment.

V. Conclusion & Recommendations

The findings from this study highlight the transformative potential of biophilic design in enhancing students' cognitive performance and overall well-being. By integrating natural elements



such as green spaces and abundant natural lighting into educational environments, institutions can create settings that foster focus, reduce stress, and improve academic outcomes. These results emphasize the importance of incorporating biophilic principles into campus design and planning. It is recommended that universities prioritize investments in sustainable, nature-inspired infrastructure to support holistic student development and academic success, ensuring a lasting positive impact on learning environments.

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