

Exploring Pupil Well-being as a Potential Pathway Linking Biophilic School Environments and Academic Performance in Ugandan Primary Schools

Josephine Njoki Marete¹, Wagah Mical Ongachi², Geoffrey Kiplimo Korir³

¹Department of Visual Art and Design, Uganda Christian University, Uganda

²Department of Art and Design, Maseno University, Kenya

³Department of Communication and Media Technology, Maseno University, Kenya

DOI: <https://doi.org/10.47772/IJRISS.2026.1026EDU0595>

Received: 14 September 2026; Accepted: 19 September 2026; Published: 29 September 2026

ABSTRACT

Global research suggests that biophilic school design may support academic performance, but the pathways involved remain insufficiently understood in resource-constrained settings. This exploratory study examined school-level associations among biophilic environments, pupil well-being and academic performance in four government-sponsored primary schools in Uganda. The analysis integrated observational biophilic scores, Emotional and Social Environment (ESE) scores from 302 pupils aged 11–12 years, and aggregated Primary Six mid-term examination results. Because only four schools were available, Spearman correlations and separate simple regression models were interpreted descriptively and with caution. Biophilic scores were not directly associated with academic performance ($\rho = -0.20$, $p = .800$; adjusted $R^2 = -.45$, $p = .821$). By contrast, the reported school-level pattern indicated a very strong relationship between ESE and academic performance (adjusted $R^2 = .995$, $p = .01$). This pattern is consistent with, but does not establish, pupil well-being as a potential pathway linking biophilic school environments and academic outcomes. Biophilic interventions should therefore be investigated as possible supports for the emotional and psychological conditions that enable learning, rather than as immediate solutions for raising examination scores. The findings are specific to the four participating schools and require confirmation using larger school samples, linked pupil-level data and formal mediation analysis.

Keywords: Biophilic Design, Pupil Well-being, Academic Performance, Potential Pathway, Environmental Psychology, Uganda

INTRODUCTION

The pursuit of improved academic outcomes is a central goal of education systems worldwide. While factors like teaching quality and curriculum are rightly emphasized, a growing body of evidence underscores the profound influence of the physical learning environment (Barrett et al., 2015). Within this domain, biophilic design—the integration of natural elements and patterns into built spaces—has emerged as a promising approach. Studies, primarily from the Global North, have linked biophilic elements such as natural light, views of greenery, and access to outdoor spaces to reduced student stress, improved concentration, and higher standardized test scores (Browning & Rigolon, 2019; Kweon et al., 2017).

Theoretical Framework

The theoretical underpinnings for this relationship draw from two frameworks. The Biophilic Design Theory (Wilson, 1984; Kellert et al., 2008) posits an innate human connection to nature that, when fulfilled, supports psychological well-being. Simultaneously, Environmental Psychology Theory (Proshansky & O'Hanlon, 1977) provides a lens for understanding how the built environment directly influences human cognition, emotion, and behavior. The prevailing assumption in much of the literature is that of a direct or mediated pathway from

nature-rich environments to enhanced cognitive performance.

However, this narrative is almost exclusively based on research from high-income countries. In resource-constrained contexts like Uganda, where government-sponsored schools often face systemic challenges including overcrowding, inadequate infrastructure, and high dropout rates (Asad, 2021; Nangonzi, 2023), the relationship is likely more complex. In such environments, the potential of a well-designed physical space to influence academic results may be overshadowed by more immediate socio-economic pressures or mediated through more fundamental psychological prerequisites for learning.

Well-being—conceptualized as positive emotions, engagement, and positive relationships—is increasingly recognized as a critical foundation for academic engagement and success (Seligman, 2012). In this study, well-being is operationalized using the Emotional and Social Environment (ESE), which captures self-reported emotional and psychological states relevant to learning. Evidence from Ugandan government primary schools has already demonstrated a strong positive relationship between pupils' perceptions of biophilic design elements and their emotional and social well-being (Marete, 2025), underscoring the importance of examining how this well-being translates into academic outcomes. A student who feels safe, comfortable, and positively engaged in their school environment is more likely to be cognitively available for learning. It is plausible that in challenging contexts, the primary value of a biophilic school environment lies not in directly boosting test scores, but in first fostering the well-being that makes academic focus possible.

This study moves beyond asking whether biophilic design affects learning and explores the relationship between biophilic interiors and academic performance. The study was guided by the following research question: Is the observed pattern of school-level associations consistent with pupil well-being as a potential pathway linking biophilic interior design and academic performance in the four participating government-sponsored primary schools?

By exploring this proposed pathway, this research provides a more nuanced and actionable understanding for policymakers and educators, suggesting that investments in the school environment are, fundamentally, investments in the psychological resources that underpin learning.

METHODS

Research Design and Data Integration

A cross-sectional, correlational design was employed to integrate three distinct data streams at the school level. This design was chosen to facilitate the initial exploration of complex relationships between environmental, psychological, and performance variables.

Study Setting and Data Sources

The biophilic exposure data used in this analysis were derived from a broader observational audit study. While related data from this program have previously been used to examine pupil well-being outcomes (Marete, 2025), the audit methodology and results are reported separately, and the present analysis focuses exclusively on mediated relationships between environment, pupil well-being, and academic performance. Therefore, data for this analysis were drawn from:

1. **Biophilic Exposure:** The average biophilic score for each school, calculated from the structured observational audit assessing the presence of biophilic attributes across the three domains (Nature in Space, Natural Analogues, Nature of Space).
2. **Pupil Well-being:** The average Emotional and Social Environment (ESE) score for each school, derived from the pupil questionnaire responses collected from 302 pupils (aged 11-12), reflecting collective perceptions of positive emotions and social relationships within the school.

3. **Academic Performance:** Secondary data on academic performance were obtained from school records. Aggregate mid-term examination results for the Primary Six cohort in each school were converted into a weighted Grade Point Average (GPA) using the Ugandan National Examinations Board scale (D1=1, D2=2, D3=3, D4=4, Credit=5, Pass/Fail=6). A lower GPA indicates better performance. For the inferential analyses, GPA was reverse-scored as a performance index ($7 - \text{GPA}$), so that higher index values represented better academic performance.

Ethics Considerations

Ethical clearance for this study was obtained through the relevant institutional research review processes. Permission was granted by school administrators prior to data collection. Informed assent was obtained from participating pupils, participation was voluntary, and no personally identifiable information was collected.

Data Analysis

Given the aggregate nature of the data ($N=4$ schools), the analysis focused on school-level relationships. Data were analyzed using SPSS Version 30.

- **Descriptive Analysis:** Mean scores for biophilic exposure, well-being, and academic performance were calculated for each school to illustrate patterns.
- **Correlational Analysis:** Spearman's rank-order correlation (ρ) was used to assess the monotonic relationships between (a) biophilic score and academic GPA, and (b) well-being score and academic GPA. This non-parametric test was selected for the small school-level sample. Correlations used the reverse-scored performance index, for which higher values indicated better performance.
- **Regression Analysis:** Two separate simple linear regression analyses were conducted to determine predictive relationships: (1) Biophilic Score as a predictor of the Academic Performance Index, and (2) Well-being Score (ESE) as a predictor of the Academic Performance Index.

A formal mediation test was not conducted because only four school-level observations were available. Instead, the pattern across the correlations and separate regression models was examined to determine whether it was consistent with the proposed pathway. Inter-rater reliability was moderate ($\text{ICC} = .43$), indicating some subjectivity in observational scoring. Aggregation of multiple raters improved consistency, but subtle variations in scoring inherent to real-world audits were noted.

RESULTS

Descriptive Overview of School-Level Variables

Table 1 displays the integrated data for the four schools, revealing a complex picture. School A, with the highest biophilic score, demonstrated strong academic performance (lowest GPA). School D, despite a high biophilic score, had the poorest academic outcomes. School well-being scores showed a clear inverse relationship with academic GPA (higher well-being, lower/better GPA).

Table 1. Integrated School-Level Data on Biophilia, Well-being, and Academic Performance

School ID	Biophilic Score (0-5)	Well-being Score (ESE)	Academic Performance (GPA)*
A	4.05	4.28	2.17
B	3.72	3.87	2.75
C	3.21	3.82	2.46
D	3.72	3.82	3.91

Note: A lower Grade Point Average (GPA) indicates better academic performance.

Testing for Direct and Mediated Relationships

Correlation Analysis

Spearman's correlation analysis yielded two critical results, summarized in Table 2.

- **Biophilic-Academic Link:** A weak, non-significant negative correlation was found between the school-level biophilic score and academic performance ($\rho = -0.20$, $p = 0.800$).
- **Well-being-Academic Link:** A statistically significant, near-deterministic association at the aggregated school level was found between the school-level well-being score and academic performance ($\rho = 1.00$, $p < 0.001$).

Table 2. Spearman's Correlation Results (School Level, N=4)

Variable Pair	Spearman's ρ	p-value
Biophilic Score & Academic Performance Index	-0.2	0.8
Well-being Score (ESE) & Academic Performance Index	1	< 0.001

Regression Analysis

The regression analyses provided further evidence for interpreting the correlations, as shown in Table 3.

- **Model 1 (Biophilic Score as Predictor):** The biophilic score was not a significant predictor of academic performance (Adjusted $R^2 = -0.45$, $p = 0.821$). The negative adjusted R^2 indicates that the model fits worse than a null model and has no explanatory power.
- **Model 2 (Well-being as Predictor):** The well-being score (ESE) was a strong and statistically significant predictor of academic performance (Adjusted $R^2 = 0.995$, $p < .01$), explaining a very large proportion of variance in school-level academic scores.

Table 3. Simple Linear Regression Models Predicting Academic Performance

Predictor	Outcome	Adjusted R^2	F-statistic	p-value	Significance
Biophilic Score	Academic Performance Index	-0.45	0.06	0.80021	Not Significant
Well-being Score (ESE)	Academic Performance Index	0.995	403.01	<0.01	Significant

Note: Very high explanatory power reflects aggregation at school level (N = 4).

DISCUSSION

This study provides a nuanced and critical contribution to the discourse on learning environments in resource-constrained settings. The key finding is the lack of a direct statistical relationship between biophilic design and academic performance, contrasted with an exceptionally strong relationship between well-being and academic performance. This pattern of results is consistent with a potential pathway, where biophilic design influences academic outcomes primarily through its positive effect on pupil well-being.

The non-significant direct pathway (Biophilic $\rightarrow$ Academic) challenges a simplistic translation of Global North findings to the Ugandan context. It suggests that in environments where systemic challenges are pronounced, the physical environment alone cannot overcome barriers to learning. The case of School D is illustrative: despite a moderately high biophilic score, it recorded the worst academic performance and notable absenteeism, likely due to factors beyond the scope of this study, such as socio-economic pressures or instructional quality (Browning & Rigolon, 2019).

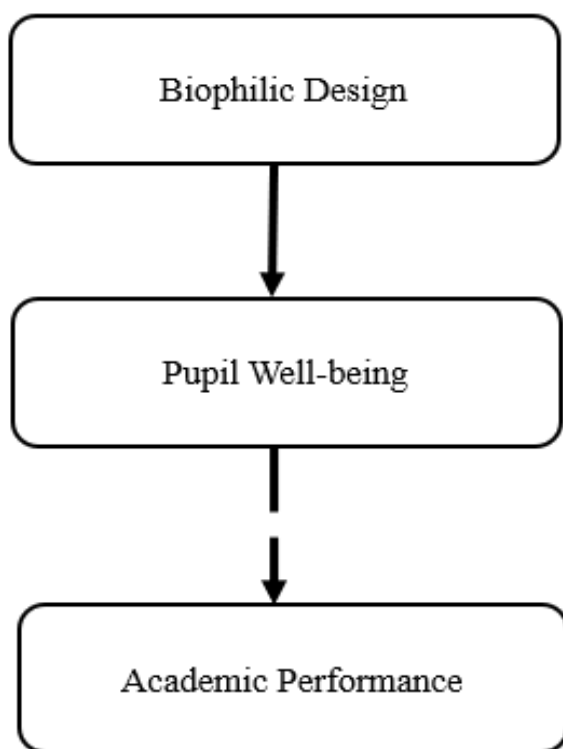
The strong school-level well-being–academic pattern (Well-being $\rightarrow$ Academic) provides the basis for the

proposed model. This school-level pattern is consistent with educational psychology research confirming that positive emotional states reduce cognitive load from stress and anxiety, thereby freeing mental resources for attention, memory, and perseverance (Kasap et al., 2021). Pupils who feel safe, emotionally supported and socially connected may be better positioned to engage in learning.

Therefore, the role of biophilic design may be foundational rather than direct. As demonstrated in a prior mixed-methods study conducted within the same research program (Marete, 2025), biophilic design elements were found to be significant predictors of pupils’ emotional and social well-being.

They create restorative, stress-reducing environments that foster the positive emotions and social cohesion measured by the ESE scale. In this model, depicted in Figure 1, biophilic design does not automatically raise test scores; rather, it cultivates the psychological conditions that may support academic engagement and achievement.

Figure 1. Proposed Potential Pathway Model of the Biophilia-Academics Relationship



Proposed pathway model illustrating the hypothesized relationship between biophilic school environments, pupil well-being, and academic performance. Solid arrows indicate statistically supported relationships, and the dashed arrows indicate a non-significant direct effect.

While these findings highlight the importance of pupil well-being as a potential pathway, it is important to note that the study’s small school-level sample (N=4) limits generalizability. The results should be interpreted as indicative of strong patterns within this context, but further research with larger and more diverse samples is recommended to evaluate the proposed pathway.

Implications for Policy and Practice

Recommendations are based on observed associations at the school level and should be implemented as preliminary strategies that warrant further evaluation. This study offers a strategic re-framing for educational planners:

- **Prioritize Well-being:** Investments in the school environment should be explicitly justified and evaluated based on their impact on student well-being, which this study shows is a powerful proximal driver of academic success.

- **Holistic Advocacy:** Arguments for biophilic and other environmental improvements should be part of a holistic education strategy that includes teacher support and community engagement, rather than being marketed as a standalone solution for improving academic outcomes.
- **Cost-Effective Levers:** Focusing on the biophilic elements most strongly linked to well-being (e.g., natural light, views of nature, safe social spaces) provides a cost-effective blueprint for maximizing impact on the factors that truly enable learning.

LIMITATIONS AND FUTURE RESEARCH

The primary limitation is the school-level sample of four institutions, which severely restricts statistical power and generalizability. Any near-perfect correlation is unstable at this sample size and should be treated as descriptive rather than as precise population evidence. The cross-sectional design cannot establish causality, and the separate regression models do not constitute a formal test of mediation.

Future research should test this proposed pathway with a larger sample of schools and, ideally, with longitudinal or quasi-experimental data. Collecting linked individual-level data on well-being and academic performance would allow for more powerful multi-level modeling and a formal statistical test of mediation.

CONCLUSION

This study moves beyond the question of whether biophilic design improves grades to explain how it can contribute to learning in a resource-constrained context. The findings are consistent with a possible indirect pathway in which biophilic environments support pupil well-being and well-being may, in turn, relate to academic performance. This exploratory pattern does not establish mediation or causality.

For policymakers in Uganda and similar contexts, this provides a preliminary rationale for investing in school environments. It is not merely an aesthetic or ecological pursuit, but a fundamental investment in the mental and emotional resources of the student population. These findings are preliminary and context specific; they should be considered as an exploratory model to guide future research and school-level interventions rather than definitive causal evidence. By creating schools that nurture well-being through connection to nature, schools may strengthen conditions that support a more effective, equitable, and humane education system.

REFERENCES

1. Asad, K. W. (2021). Primary and secondary education in Uganda: Challenges and prospects. *Interdisciplinary Journal of Education*, 4(1). <https://doi.org/10.53449/ije.v4i1.152>
2. Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89, 118–133. <https://doi.org/10.1016/j.buildenv.2015.02.013>
3. Browning, M. H. E. M., & Rigolon, A. (2019). School green space and its impact on academic performance: A systematic literature review. *International Journal of Environmental Research and Public Health*, 16(3), 429. <https://doi.org/10.3390/ijerph16030429>
4. Kasap, E. Z., Ağzitemiz, F., & Ünal, G. (2021). Cognitive, mental and social benefits of interacting with nature: A systematic review. *Journal of Happiness and Health*, 1(1), 16–27. <https://journalofhappinessandhealth.com/index.php/johah/article/view/1>
5. Kellert, S. R., Heerwagen, J., & Mador, M. (Eds.). (2008). *Biophilic design: The theory, science and practice of bringing buildings to life*. John Wiley & Sons.
6. Kweon, B. S., Ellis, C. D., Lee, J., & Jacobs, K. (2017). The link between school environments and student academic performance. *Urban Forestry & Urban Greening*, 23, 35–43. <https://doi.org/10.1016/j.ufug.2017.02.002>
7. Marete, J. N. (2025). The impact of biophilic interior design on pupil well-being in Ugandan primary schools: A convergent mixed-methods study. *International Journal of Research and Innovation in Social Science*, 9(10), 7961–7967. <https://doi.org/10.47772/IJRISS.2025.910000653>
8. Nangonzi, Y. (2023, February 1). UNEB: Why UPE is Failing. *Observer*. <https://observer.ug/news/headlines/76698-uneb-why-upe-is-failing>

9. Proshansky, H. M., & O'Hanlon, T. (1977). *Environmental psychology: Origins and development*. In *Perspectives on Environment and Behavior: Theory, Research, and Applications* . Boston, MA: Springer US. 101-129
10. Seligman, M. E. (2012). *Flourish: A visionary new understanding of happiness and well-being*. Atria Paperback.
11. Wilson, E. O. (1984). *Biophilia: The human bond with other species*. Harvard University Press.