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Integrating Biophilic Design Principles and Human-Centered Strategies for Enhancing Psychophysiological Wellbeing in Higher Education Environments: MSA University Case Study

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Abstract

Considering contemporary transformations in trends related to interior and environmental design, increasing attention has been directed toward the development of educational interior environments that support users' psychophysiological well-being, while fulfilling sustainability requirements and performance-based environmental design. Within this context, both Human-Centered Design (HCD) and biophilic interior design emerge as two complementary approaches that reorient the design process toward users' needs, enhance environmental responsiveness, and integrate natural elements and systems within interior spaces.

This research aims to study the integration of the methodologies and fundamentals of Human-Centered Design with the principles of biophilic design to enhance psychophysiological well-being within educational interior environments. The Faculty of Arts and Design at MSA University is adopted as an applied case study, through which the research explores mechanisms for employing user-centered methodologies in terms of objectives and criteria, and linking them with environmental biophilic standards.

The research adopts a mixed-methods research methodology that combines quantitative and qualitative approaches. Quantitative data are collected through questionnaires directed to several user groups, including students of the Faculty of Arts and Design, alongside conducting qualitative interviews with faculty members. The research also includes an evaluation of the existing interior design of educational spaces, covering spatial designs, lighting conditions, selection of interior finishing materials, and the furniture used in design studios, lecture halls, and computer labs.

This evaluation aims to support the integration of biophilic design principles with a comprehensive response to user requirements by presenting design proposals for the spaces, in line with contemporary trends in sustainable environmental design within educational institutions.

Keywords

Biophilic Design; Human-Centered Design; Psychophysiological Wellbeing; Higher Education Interiors; Sustainable Environmental Design.

1. Introduction

Contemporary interior and environmental design have expanded beyond functional and aesthetic standards to incorporate sustainability, human-centred approaches, and bio-inspired solutions (Kellert et al., 2008). This shift is particularly significant for educational buildings, where indoor conditions, lighting, ventilation, thermal comfort, acoustics, and materials directly affect learning, engagement, and creativity. Psychophysiological wellbeing, the holistic mental and physical state of users within a campus setting, shapes concentration, performance, and creative output while moderating stress and fatigue (Altomonte et al., 2020; Vischer, 2008); with rising academic pressures, it has become a design imperative rather than a purely aesthetic concern.

Traditional learning-space design, however, often prioritises aesthetics and basic function while neglecting occupants' psychological and physical wellbeing (Temple, 2008). Two approaches offer complementary responses: human-centred design (HCD), a process model placing sustained engagement with users at the centre of decision-making (Norman, 2013; International Organization for Standardization [ISO], 2019; Giacomin, 2014), and biophilic design, rooted in the biophilia hypothesis (Wilson, 1984), which draws on natural elements, plants, daylight, views, organic materials, to support wellbeing through engagement with nature (Kellert et al., 2008).

Despite growing recognition of biophilic design's benefits, two gaps persist. First, interventions are typically derived from expert audit alone, with limited structured user research into which deficits most affect occupants, particularly those with access needs, whose experience of nominally identical spaces may differ substantially. Second, evidence from hot-arid MENA contexts remains scarce, although climate, resource constraints, and regional traditions (Mahgoub, 2007) condition which strategies are feasible. This study addresses both gaps by embedding biophilic assessment within an HCD process, in which user research and inclusive-design profiling serve not as a claimed innovation but as the operational framework determining how biophilic principles are prioritised, calibrated, and integrated with ergonomic and accessibility requirements in a real Egyptian higher-education setting.

Taking the Faculty of Arts and Design at MSA University, Egypt, as its case, the study pursues four objectives: to evaluate existing interiors across three high-use space typologies; lecture hall, design studio, and computer laboratory, using biophilic assessment criteria; to identify HCD and biophilic principles relevant to learning spaces; to evaluate student perceptions of environmental quality through mixed-methods data collection, with particular attention to accessibility; and to formulate evidence-based, moderate-cost design guidelines integrating user needs with biophilic standards. It follows a two-stage logic: diagnostic evaluation of existing conditions (Operation 1), then projective design proposals presented as untested hypotheses, and contributes a replicable assessment-to-intervention methodology applicable to comparable MENA institutions.

2. Literature Review

2.1. Contemporary Trends in Interior Design for Educational Institutions

Contemporary interior design for educational institutions has shifted from static layouts to dynamic, student-centred environments responding to evolving pedagogical practices and diverse learner needs; in art and design faculties, interior spaces are especially critical for fostering creativity, experimentation, and collaboration (Salama, 2015; Prince, 2004). Key trends include technology-integrated learning spaces with adaptable lighting and climate control (Oblinger, 2006; Brooks, 2012); flexible, open-plan configurations for individual and group work (Jamieson et al., 2000; Temple, 2008; Oblinger & Oblinger, 2005) and sustainable material practices (Edwards, 2006; Kibert, 2016). These trends establish the context within which HCD and biophilic strategies must be integrated.

2.2. Human-Centred Design as a Process Framework

Human-centred design (HCD) is best understood not as a single theory but as a process model that places sustained engagement with users at the centre of design decision-making (Giacomin, 2014; Buchanan, 2001). Its codified form (ISO, 2019), specifies five principles: explicit understanding of users, tasks and environments; user involvement throughout design; user-centred evaluation; iteration; and attention to the whole user experience. Norman (2013) supplies complementary interaction-level concepts — affordances, signifiers, feedback, mappings and constraints-that translate readily to spatial navigation and furniture use. HCD draws its empirical techniques (surveys, interviews, observation) from the social sciences; these methods are not unique to HCD, and the present study accordingly treats them as user-centred data-collection methods deployed within an HCD process, rather than as "HCD methodologies" in themselves (Sanders & Stappers, 2008; Steen, 2011). In environmental design research, this orientation aligns with Vischer's (2008) user-centred theory of the built environment, in which occupant feedback constitutes the primary evidence for workspace quality. Within the present study, HCD performs two specific functions: it supplies the evaluation logic (occupants, including those with declared access needs, define spatial quality) and the prioritisation logic (interventions are ordered by severity of user-reported deficit rather than by designer preference).

2.3. Biophilic Design, Environmental Psychology, and Restorative Environments

The theoretical foundations of biophilic design lie in environmental psychology, the discipline concerned with transactions between people and their physical settings (Gifford, 2014). Within this field, research on restorative environments examines how particular settings support recovery of depleted psychological resources (Hartig, 2004; Hartig et al., 2014). The biophilia hypothesis (Wilson, 1984) supplies the evolutionary premise, an innate human affinity for life and life-like processes, while two complementary theories specify the mechanisms through which contact with nature benefits wellbeing.

Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995) addresses the cognitive pathway. Sustained academic work depends on directed attention, a limited resource whose depletion produces mental fatigue, reduced concentration, and irritability. ART proposes that recovery occurs in environments exhibiting four properties: being away (psychological distance from routine demands), extent (coherence and scope sufficient to occupy the mind), fascination (stimuli — typically natural — that engage attention effortlessly), and compatibility (fit between environmental affordances and the person's purposes). Environments rich in "soft fascination", such as foliage, daylight variation and outdoor views, permit directed attention to rest and replenish (Berto, 2014). Meta-analytic and systematic-review evidence supports modest but reliable attentional benefits of nature exposure (Ohly et al., 2016; Stevenson et al., 2018).

Stress Recovery Theory (SRT) (Ulrich, 1983; Ulrich et al., 1991) addresses the affective–physiological pathway: unthreatening natural scenes trigger rapid, pre-cognitive positive affective responses and parasympathetic activation, lowering physiological arousal and supporting recovery from stress (Ulrich, 1984). Whereas ART concerns attentional capacity, SRT concerns stress and emotion; together they cover the two constructs bundled in this study's notion of psychophysiological wellbeing, focus and calm respectively, which is why both are retained as the analytical framework.

Two practice frameworks operationalise these theories for design. Kellert and Calabrese (2015) identify 24 attributes across direct experience, indirect experience, and experience of space and place. The 14 Patterns of Biophilic Design (Browning et al., 2024) organise interventions into Nature in the Space, Natural Analogues, and Nature of the Space, with each pattern explicitly cross-referenced to the ART/SRT evidence base; the present study adopts the 14 Patterns as its observational audit instrument precisely because of this theory-to-pattern traceability.

A complementary strand of theory cautions against ocularcentrism, the privileging of vision in architectural thought. Pallasmaa (2005) argues that architecture is encountered through the whole sensing body, engaging hearing, touch, smell, thermal sensation and movement; empirical work in sensory science documents the multisensory basis of environmental experience (Spence, 2020; Malnar & Vodvarka, 2004). The biophilic frameworks adopted here partially encode this position — Patterns 2, 4, 5 and 7 are explicitly non-visual or tactile, but applications tend in practice to foreground the visual. This study treats the multisensory critique as a corrective lens: non-visual patterns are audited and proposed alongside visual ones, and the predominance of visual constructs in the survey instrument is acknowledged as a limitation.

2.4. Integration and Educational Applications

Effective biophilic design in educational settings must be calibrated to occupant activities and contextual constraints (Gillis & Gatersleben, 2015). Gray and Downie (2024) proposed the Biophilic Wellbeing Systems Approach synthesising biophilic design, wellbeing science, and systems science for schools; Browning and Determan (2024) reported reduced student stress and improved outcomes from biophilic classroom interventions; and Barrett et al. (2015) found environmental factors including naturalness explained 16% of variation in learning progress across 153 classrooms. WELL Building Standard v2 (International WELL Building Institute [IWBI], 2020) likewise emphasises biophilic design for mental wellbeing. However, limited research addresses MENA contexts, where hot-arid climates, resource constraints, and cultural considerations, including traditional Islamic biophilic elements (Mahgoub, 2007), require adapted approaches. This gap, combined with the limited integration of HCD and biophilic frameworks in real educational settings, motivates the present study.

2.5. Theoretical Positioning

ART and SRT were selected over alternative frameworks for three reasons. First, the study's outcome construct, psychophysiological wellbeing operationalised as focus, calm, creative inspiration and fatigue, maps directly onto the attentional (ART) and affective–physiological (SRT) mechanisms; theories of environmental preference or aesthetic evaluation would not predict these outcomes as specifically. Second, both theories underpin the 14 Patterns audit framework used here, ensuring coherence between theory, instrument and interpretation. Third, plausible alternatives are either subsumed or complementary rather than competing: prospect–refuge theory (Appleton, 1975) is incorporated within the Nature of the Space patterns and is used in section 5 to interpret observed refuge-seeking behaviour; Ulrich's supportive design theory was developed for healthcare settings and is represented here through SRT, its theoretical core; and embodied, multisensory accounts of architectural experience (Pallasmaa, 2005; Spence, 2020) are adopted as a complementary corrective lens: they inform the non-visual interventions in section 6 and the limitations in section 7, but do not supply testable mechanisms linking nature contact to wellbeing outcomes. ART is therefore employed not as a general reference but as an analytical lens: its four restorative properties serve as interpretive categories in section 5.2–5.4.

3. Research Methodology

3.1. Research Design and Case Rationale

This study adopts a convergent parallel mixed-methods design integrating quantitative and qualitative techniques within a single-phase approach (Creswell & Plano Clark, 2018). The Faculty of Arts and Design at MSA University was selected as a representative (typical) instrumental case (Yin, 2018; Flyvbjerg, 2006): its learning spaces exemplify the prevailing condition of Egyptian private higher-education interiors, conventionally designed, functionally driven environments in which biophilic qualities are largely absent. The case was therefore chosen not because it exhibits the qualities under study, but because it typifies their absence; the research object is the deficit itself, its consequences for occupants, and the retrofit potential within ordinary institutional constraints.

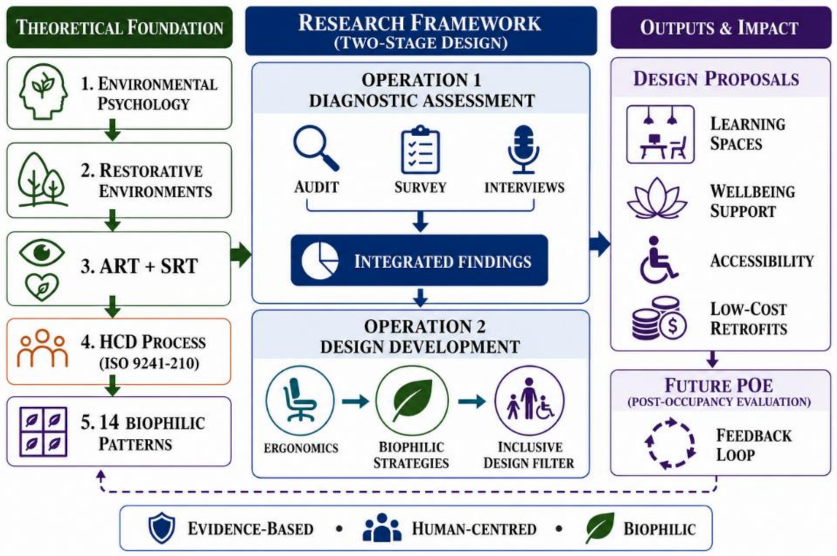

Figure 1. Conceptual framework of the study: theoretical foundations feed the two-stage framework.

Accordingly, as shown in **Figure 1**, the study comprises two explicitly distinct research operations. Operation 1 is diagnostic: a systematic evaluation of the existing environment, triangulating an observational biophilic audit (environmental supply), a student survey (perceived environmental quality), and faculty interviews (operational and behavioural explanation). Operation 2 is projective: the development of evidence-based retrofit proposals derived from the diagnosis and framed by the 14 Patterns and HCD prioritisation. The empirical claims of this paper rest entirely on Operation 1; the proposals of Operation 2 are presented as theoretically grounded design hypotheses whose effectiveness remains to be tested through post-occupancy evaluation. The theoretical framework is grounded in ART (Kaplan & Kaplan, 1989; Kaplan, 1995), SRT (Ulrich, 1983; Ulrich et al., 1991), and the 14 Patterns of Biophilic Design (Browning et al., 2014).

3.2. Data Collection

Three instruments capture distinct and complementary dimensions of spatial quality. First, a structured questionnaire measures perceived environmental quality and self-reported wellbeing. Items were adapted from the Building Occupants Survey System Australia (BOSSA) (Candido et al., 2016), reworded for educational settings for this study. The final instrument comprised 41 five-point Likert items (13–14 per space) organised into three core subscales: Environmental Comfort (4–5 items), Connection to Nature (4 items), and Psychophysiological Wellbeing (3 composite items: focus, calm, and creative inspiration; fatigue and space-specific items were analysed descriptively), answered separately for each of the three spaces, plus open-ended improvement questions. Internal consistency ranged from marginally acceptable to good across the nine subscale × space combinations (Cronbach's $\alpha = .64–.84$; median $= .78$), with only the computer-laboratory comfort subscale falling below .70. The questionnaire was administered via an online form during February 2026 to students enrolled in courses timetabled in the three audited spaces, using non-probability convenience sampling, yielding 131 valid responses.

Second, semi-structured interviews were conducted with the faculty members holding primary teaching responsibility for each space (purposive selection; $n = 3$). Interviews of 20–30 minutes followed a four-domain protocol (perceived interior conditions; observed effects on student behaviour and engagement; spatial and operational deficiencies; intervention priorities) and were documented through detailed notes, with informed consent.

Third, a systematic observational audit assessed each space against the 14 Patterns of Biophilic Design (Browning et al., 2014), supplemented by WELL Building Standard v2 "Mind"-concept indicators (IWBI, 2020), with photographic documentation of existing conditions. Each pattern was rated on a three-point anchored scale (absent / partially present/present). Both authors completed the audit independently and resolved discrepancies by consensus; aggregate integration levels (very low/low/moderate/high) summarise pattern coverage and implementation quality. This multi-instrument approach ensures that the evaluation covers spatial configuration, natural and artificial lighting, interior finishing materials, and furniture across the three space typologies.

3.3. Analysis, Integration, and Ethics

Quantitative data were analysed in two stages. Descriptive statistics (means, standard deviations, response distributions) summarise perceptions by subscale and space. Because Likert-derived scores cannot be assumed normal and group sizes were unequal, differences between students with declared access needs and those explicitly reporting none (respondents who preferred not to say or did not answer were excluded from group comparisons) were tested using two-sided Mann–Whitney U tests with effect sizes; given the exploratory design, results are interpreted in terms of effect magnitude and consistency of direction rather than dichotomous significance, and no causal inference is made. Open-ended responses and interview material were analysed using reflexive thematic analysis (Braun & Clarke, 2022), with ART's restorative properties (being away, extent, fascination, compatibility), SRT's stress constructs, and HCD/inclusive-design principles serving as sensitising concepts during theme development.

Integration followed a convergent mixed-methods logic with merging at the point of interpretation (Fetters et al., 2013); the observational audit establishes what the environment supplies, the survey establishes how it is perceived and by whom, and the interviews explain why patterns arise operationally. Convergence and divergence across the three sources are reported through a joint display (**Table 1**; **Section 5.4**), which links each integrated finding to its theoretical interpretation and the intervention it motivates. Ethical approval was granted by the MSA University Research Ethics Committee (reference number FAD-REC-2026-2); participation was voluntary, informed consent was obtained, and data were anonymised.

4. Case Study: MSA University Faculty of Arts and Design

This section and section 5 report the diagnostic operation (Operation 1): the systematic evaluation of existing conditions on which the empirical claims of the study rest.

4.1. Context and Setting

MSA University, established in 1996, is a private institution located in 6th of October City, Greater Cairo. The Faculty of Arts and Design occupies a dedicated building featuring diverse educational spaces serving approximately 800 students across interior design, cinema & theatre, fashion design, graphic design, and media arts programmes. While the wider campus contains substantial landscaped greenery, this is concentrated primarily at the university entrance and in dispersed external zones, with comparatively limited green presence surrounding the Faculty of Arts and Design building. As a result, the building is experienced within an arid suburban setting characterised by sparse immediate vegetation and intense solar conditions typical of Egypt's climate. Three representative spaces were selected for systematic biophilic assessment and user evaluation: a large lecture hall (capacity 130), a design studio (capacity 40), and a computer laboratory (capacity 36).

4.2. Observational Biophilic Assessment

Each space was assessed against the 14 Patterns of Biophilic Design framework using the anchored procedure, evaluating visual connection with nature, material connection, non-visual sensory cues, dynamic and diffuse light, biomorphic forms, prospect, refuge, mystery, and complexity.

Lecture Hall. The hall features tiered seating with red upholstered chairs arranged in a theatre configuration, with high ceilings and herringbone wood flooring contributing partial material connection with nature. However, the space has only two small regular windows with curtains, providing minimal natural light and very limited visual connection to the exterior. No indoor plants or nature imagery are present. The artificial lighting system provides uniform illumination without dynamic or diffuse qualities. Assessment: very low biophilic integration; only herringbone wood flooring provides partial pattern activation, with most of the 14 Patterns absent.

Design Studio. The studio represents the primary creative workspace for interior design students, featuring an open-plan layout with drafting tables and adjustable seating. The space benefits from high ceilings and a distinctive curved corner window wall providing panoramic views of the campus and surrounding landscape, the strongest visual connection with nature among all assessed spaces. The granite flooring provides a durable surface, and the generous proportions offer excellent prospect qualities supporting collaborative activities. However, heavy curtains frequently obscure the windows, blocking natural light and views during occupied hours. No indoor plants or biomorphic design elements are present, and the artificial lighting system lacks integration with daylight harvesting strategies. Assessment.

Computer Laboratory. The laboratory accommodates approximately 30 workstations arranged in linear rows. The room demonstrates partial material connection with nature through wood-tone laminate desks and light wood flooring. Large windows with fabric curtains provide potential for natural light, though curtains are typically drawn during use. The linear desk arrangement facilitates instructor movement and student visibility. Despite these positive attributes, the space lacks indoor plants, nature views are obscured by curtaining, and technology equipment visually dominates the environment. Assessment: low biophilic integration; wood-tone desks and wood flooring provide partial material connection, but most patterns remain absent.

4.3. Cross-Space Diagnosis

Across all three spaces, the observational assessment indicates consistently low biophilic integration. All spaces share core deficits: restricted visual access to nature, limited daylight variability, and absence of indoor planting. Although isolated material cues exist (timber flooring, wood-tone desks), curtain use and technology dominance neutralise available window connections. In ART terms, the diagnosed condition is one of low fascination, low extent, and constrained being-away: the environmental supply offers little involuntary engagement through which directed attention could recover. These findings informed the questionnaire design and subsequent intervention priorities.

5. Findings and Discussion

5.1. Participant Profile

A total of 131 students completed the questionnaire, rating the three high-use educational space types within the Faculty of Arts and Design. The sample was predominantly from Interior Design, with additional respondents from Cinema and Theatre. Participants were distributed across academic Levels 2 (45.8%), 3 (31.3%), and 4 (22.9%). Importantly, 58.0% of respondents declared at least one access need affecting their use of learning spaces (e.g., vision, hearing, neurodiversity/attention, mobility, or chronic health/fatigue), underscoring the relevance of inclusive design considerations in the interpretation of perceived spatial quality.

5.2. Quantitative Findings

Likert-scale items (1 = strongly disagree to 5 = strongly agree) were organised into three thematic areas aligned with the study's conceptual framework: Environmental Comfort (lighting, acoustics, temperature, seating), Connection to Nature (visual connection, material connection, natural elements), and Psychophysiological Wellbeing (focus, calm, creative inspiration, and fatigue). Responses were summarised using mean scores, standard deviations, and percentage distributions to identify patterns across the three space types.

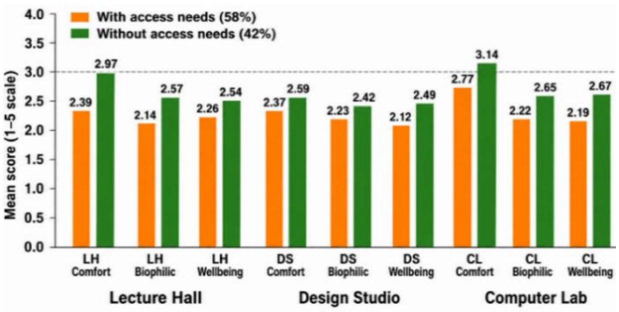

Figure 2. Perceived performance by space type (n = 131). Values are means on a 1–5 scale. Dashed line indicates neutral midpoint (3.0). Wellbeing is the average of focus, calm, and creative inspiration items.

Across all spaces, perceived connection to nature was low (means approximately 2.3/5), indicating that students generally did not experience the learning environments as restorative or nature-connected. In ART terms, all three spaces are environments of low fascination and low extent: they offer little involuntary engagement through which directed attention could recover, predicting precisely the depressed focus and inspiration scores observed (Kaplan, 1995). Environmental comfort varied noticeably across space types: the computer laboratory achieved the highest comfort rating (M = 2.89), followed by the lecture hall (M = 2.59), with the design studio scoring lowest (M = 2.47). That the studio, the space demanding the longest periods of sustained directed attention, records the lowest comfort indicates a compatibility deficit in ART terms: the environment's affordances are least aligned with the activities it must support. However, biophilic connection scores were consistently low across all three spaces (M = 2.32–2.37), suggesting that nature-related deficits are a shared condition rather than space-specific. **Figure 2** presents performance across the three thematic areas.

Item-level patterns revealed consistent deficiencies aligned with the observational assessment. In the lecture hall, visual connection to nature was the weakest single item (M = 1.71; 78.6% disagree; the original space has only two small windows), followed by low ratings for creative inspiration (M = 2.16) and seating comfort (M = 2.22). In the design studio, seating and workstation comfort were the dominant concern (M = 1.77; 77.9% disagree), and students also reported limited visual/material connections to nature (M ≈ 2.10–2.20) and low calm/focus outcomes (M ≈ 2.26–2.27). The computer laboratory performed comparatively better acoustically (quietness M = 3.35), yet still exhibited weak perceived biophilic connection (visual connection M = 1.93) and low calm/inspiration outcomes (M ≈ 2.25–2.30).

Students reporting declared access needs consistently rated several dimensions lower than their peers, suggesting that current spatial conditions disproportionately burden learners who require higher sensory and physical support. For example, lecture hall comfort averaged 2.39 for students with declared access needs compared to 2.97 for those without, a gap of 0.58 points on the 5-point scale. Similar patterns were observed in the computer laboratory for comfort and biophilic connection, and in the design studio for positive wellbeing. Exploratory two-sided Mann–Whitney U tests comparing students with declared access needs (n = 76) and those explicitly reporting none (n = 45; ten respondents who preferred not to say or did not answer were excluded from group comparisons) indicated differences at the .05 level in six of the nine subscale × space comparisons, with small-to-moderate effect sizes (r = .08–.31) and gaps consistent in direction across all nine; the largest difference was lecture-hall environmental comfort (U = 1080, z = −3.38, p < .001, r = .31). From an SRT perspective, students with sensory, attentional or mobility-related needs face elevated baseline environmental stressors (glare, noise, postural strain); this consistency suggests the current environment imposes a differential restorative penalty rather than a space-specific one. These findings reinforce the importance of coupling biophilic strategies with accessibility and universal design principles, consistent with the HCD principle that design solutions must address the physical, psychological, and emotional needs of all users (ISO, 2019; Vischer, 2008). **Figure 3** presents the access needs comparison.

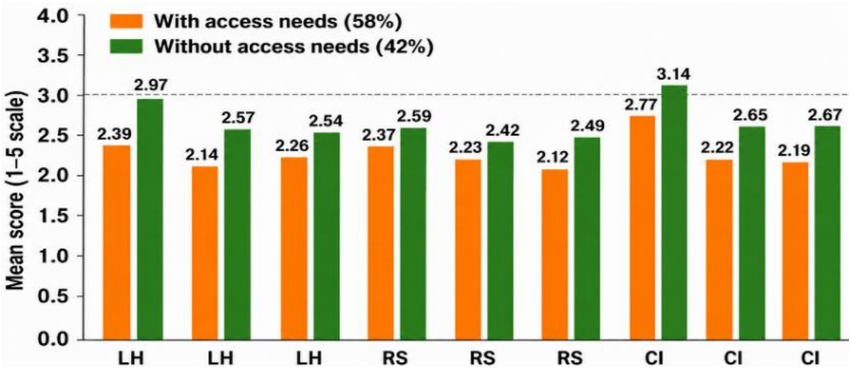

Figure 3. Comparison of perceived spatial quality between students with and without declared access needs. LH = Lecture Hall; DS = Design Studio; CL = Computer Lab. Dashed line indicates neutral midpoint (3.0).

5.3. Qualitative Findings

Reflexive thematic analysis of open-ended responses (n = 131) and faculty interviews (n = 3) generated four themes, developed using ART, SRT, and inclusive-design constructs as sensitising concepts (section 3.3).

Theme 1 - Ergonomic strain as the dominant stressor. Furniture and ergonomics dominated student comments (cited by approximately 62% in the design studio, 40% in the lecture hall, and 19% in the computer laboratory), followed by lighting/glare control (12–20%) and technology/equipment quality (≈35% in the computer laboratory). All three instructors independently corroborated chronic seating discomfort: laboratory students routinely switch seats in search of a comfortable one, and the lecture-hall chairs were confirmed as extremely uncomfortable for long lectures, with the red upholstery described as producing an unpleasant affective tone. In SRT terms, sustained postural strain constitutes a persistent low-grade physiological stressor that environmental restoration cannot offset; in Vischer's (2008) hierarchy of workspace comfort, failures at the physical level pre-empt psychological comfort. This theme explains why ergonomic repair is sequenced before biophilic enhancement in section 6.

Theme 2 - Operational suppression of available nature. The most consequential interview insight is that biophilic deficits are partly operational rather than architectural: the studio's panoramic window wall and the laboratory's large windows exist, but heavy curtains, drawn to manage glare that the glazing-and-screen configuration makes otherwise unmanageable, eliminate both daylight variability and views. The standard pull-drape curtains require full removal to open the windows, causing intense screen glare and forcing a binary choice between daylight/ventilation and screen visibility (the curtain–daylight dilemma). In ART terms, available sources of soft fascination and being away are present in the building envelope but suppressed in everyday use. This finding could not have been produced by the audit or survey alone and illustrates the explanatory contribution of the interview data.

Theme 3 - Compensatory spatial behaviour. The lecture-hall instructor described systematic student migration to back rows, towards the only windows, the air conditioning, and relative dimness that allows students to avoid attention. Interpreted through prospect–refuge theory (Appleton, 1975), as operationalised in Pattern 12, this is compensatory behaviour: deprived of designed refuge and environmental comfort at the front, students manufacture refuge at the cost of engagement. Similarly, studio students were observed clustering around scarce electrical outlets to charge laptops, spatial behaviour organised around infrastructure deficits rather than pedagogy, a compatibility failure in ART terms, while laboratory students seated at the back reported difficulty seeing and hearing the instructor, indicating an equity dimension to spatial configuration.

Theme 4 - Atmospheric and identity deficit. The studio was characterised as having a factory-like atmosphere with no visual identity reflecting an arts faculty; the bright white lighting was described as functional but emotionally cold, and the absence of wall artwork was noted. Across all interviews, noise, uncomfortable furniture, and the lack of nature-connected or stimulating elements were shared concerns. This theme aligns with SRT's emphasis on rapid affective appraisal of settings and with the indirect-experience patterns (P2, P7): the environment communicates institutional neutrality rather than creative affordance. It motivates the material, artwork and colour interventions in section 6.

5.4. Triangulation and Implications

Table 1 presents the joint display through which the three data sources were merged at the point of interpretation (Fetters et al., 2013), linking each integrated finding to its converging sources, its theoretical interpretation, and the intervention it motivates. Overall, while isolated natural analogues exist (wood tones, prospect qualities), the three sources converge on the conclusion that the absence of accessible views, planting, and dynamic daylight substantially limits the restorative potential predicted by ART and SRT.

Table 1. Joint display: integrated findings, converging sources, theoretical interpretation, and motivated interventions.

Integrated finding	Converging sources	Theoretical interpretation	Intervention motivated
Pervasive low nature connection	Audit: most patterns absent · Survey: M ≈ 2.3 · Interviews: no greenery or identity	Low fascination and extent (ART); absent positive affective triggers (SRT)	Planting, restored views, nature imagery, natural material palette (all spaces)
Ergonomic strain dominates experience.	Survey: DS seating M = 1.77 · Open comments: 19–62% · All three interviews	Physical-comfort failure pre-empts restoration (Vischer, 2008; SRT stressor)	Ergonomic seating; adjustable accessible workstations (priority 1)
Curtain–daylight dilemma	Audit: curtains drawn in use · Survey: visual connection M = 1.71–1.93 · Interviews: glare mechanism	Operational suppression of soft fascination and dynamic light (ART; P1, P6)	Light-filtering roller blinds; glare-managed daylighting
Compensatory refuge-seeking (LH)	Interview: back-row migration · Survey: comfort and inspiration deficits	Compensatory refuge (prospect–refuge; P12)	Comfortable and accessible seating at front; environmental rebalancing
Differential burden on access-needs students	Survey: gaps consistent in direction across all nine comparisons · 58% prevalence	Elevated baseline stressors → differential restorative penalty (SRT); inclusive-design imperative	Universal-design filter applied to every intervention.

The integrated evidence provides a clear prioritisation logic for the design proposals: (i) address ergonomic deficits (seating, posture support) as the most severe barriers; (ii) layer biophilic enhancements as a restorative enabling system (views, planting, daylight variability); and (iii) filter all interventions through inclusive design requirements to ensure equitable benefit for students with access needs.

6. Evidence-Based Design Proposals

This section reports the projective operation (Operation 2): the proposals are design hypotheses derived from sections 4–5, presenting moderate-cost retrofit strategies for each space type, grounded in the 14 Patterns framework (Browning et al., 2014) and calibrated through HCD principles to address the deficits identified in Sections 4 and 5. Although several headline interventions are visual (views, daylight, imagery), each proposal set deliberately layers non-visual sensory measures: acoustic absorption (cork, timber slats, fabric panels, ceiling tiles); tactile material variety (cork, timber, rattan) at touch height; planting selected for scent and texture as well as appearance (P3); ceiling fans introducing perceptible airflow variability (P4); and ergonomic seating addressing proprioceptive and postural experience. The proposals are therefore better characterised as multisensory retrofits with a visual emphasis than as visual interventions alone.

As low-cost retrofits contained entirely within the existing spatial envelopes, the proposals involve no structural alterations or changes to spatial subdivision: modifications are limited to furniture, finishes, lighting, planting, acoustic treatment and window treatments within the existing plan. Spatial strategies are therefore communicated through schematic, not-to-scale wall elevations (**Figure 4b**, **Figure 6b** and **Figure 8b**) that convey the planting integration, acoustic layers, and material composition without disclosing measured geometry, alongside before-and-after visualisations (**Figure 4**, **Figure 5**, **Figure 6**, **Figure 7**, **Figure 8** & **Figure 9**). **Table 2** summarises the intervention programme across the three spaces, with biophilic pattern mapping and evidence base.

Table 2. Consolidated intervention programme across the three spaces (DS = design studio; LH = lecture hall; CL = computer laboratory).

Intervention	Marker no. (DS / LH / CL)	Biophilic pattern + HCD principle	Evidence base
Light-filtering / motorised roller blinds replacing heavy curtains	DS 1 · LH 12 · CL 1	P1 + P6: visual connection + dynamic light	Resolves the curtain–daylight dilemma; restores suppressed views and daylight (visual connection M = 1.71–1.93)
Indoor planting (troughs/planter boxes/windowsill planters)	DS 2 · LH 2, 3 · CL 2	P1 + P3: visual + non-visual connection	Low nature connection (M ≈ 2.3); scent and texture; ART fascination
Planter dividers with integrated cable routing	DS 3 · — · —	P1 + P3 + HCD: functional integration	Only four power outlets served ~35 students, forcing clustering around sockets; routing distributes power to each workstation.
Ergonomic seating (task chairs/auditorium seating/mesh chairs)	DS 4 · LH 7 · CL 3	HCD: physical comfort	Most acute deficit (DS M = 1.77; LH M = 2.22; ≈19% CL comments)
Cork pin-up / wood-slat acoustic panels	DS 5, 9 · LH 6 · CL 3	P7 + P10: material + complexity	Tactile material connection; acoustic absorption; student display surface
LED cove / suspended / indirect lighting (2700–5000 K)	DS 6, 7 · LH 9 · CL 6	P6: dynamic + diffuse light	≈12–20% cited lighting/glare; circadian-responsive
Acoustic ceiling/fabric panels/screen dividers	DS 8 · — · CL 5, 9	P10 (+ P8): complexity + refuge	Speech clarity; sensory refuge for neurodivergent students

Intervention	Marker no. (DS / LH / CL)	Biophilic pattern + HCD principle	Evidence base
Wood-grain / timber flooring	DS 10 · LH 10 · —	P7: material connection	Warmth; acoustic comfort; replaces granite (DS)
Wider circulation / accessible seating / adjustable workstation	DS 11 · LH 11 · CL 7	HCD + Universal Design	58% declared access needs; equitable sightlines and reach
Restored exterior views	DS 12 · CL 2· —	P1: visual connection	Clear windows reveal campus greenery
Acoustic timber-slat panels between wood cladding	DS 5 · LH 1, 6, 8 · CL 11	P7 + P10: material + complexity	Material/acoustic connection; addresses bare institutional walls
Wood-blade ceiling fans	— · LH 5 · —	P11 + P4: biomorphic form + airflow	Biomorphic element; perceptible airflow variability
Rattan woven pendant fixtures	— · LH 8 · —	P7: material connection	Natural handcrafted material
Warm-toned accent/nature imagery	— · LH 13 · CL 8	P2: indirect experience of nature	Counters institutional sterility (Theme 4)
Windowsill desk planters	— · LH 12 · CL 2	P1 + P3: visual + non-visual	Workstation-scale greenery; ART fascination
CPU relocation + desktop cable management	— · — · CL 10	HCD: technology ergonomics	Visual clutter (≈35% of comments); frees desk space
Secondary rear-wall display	— · — · CL 12	HCD: equitable learning	Back-row visibility/audibility (survey + interview)

6.1. Design Studio Intervention

The studio intervention responds to the most acute user-reported deficit: seating and workstation ergonomics (M = 1.77; 77.9% disagree). **Figure 4a** shows the existing condition; **Figure 4b** presents a schematic wall elevation of the proposed treatment; **Figure 5** presents the proposed intervention visualisation. The design strategy layers biophilic enhancements over ergonomic upgrades, restoring the panoramic window wall's visual connection potential while introducing indoor planting, natural materials, and improved acoustic performance. A key feature is the integration of cable management within planter dividers, intended to address the studio's critical shortage of power access; only four outlets served approximately 35 students, forcing them to cluster around the few available sockets. By distributing power to each workstation while introducing biophilic spatial rhythm. All interventions are filtered through inclusive design requirements, including wider circulation corridors and an adjustable-height accessible workstation.

Figure 4. Design studio: (a) existing condition; (b) schematic wall elevation of the proposed treatment (not to scale) showing acoustic fabric and wood-slat panels, built-in planter units with integrated LED lighting, acoustic ceiling grid, and timber-look flooring.

Figure 5. Design studio: proposed biophilic intervention with annotated design modifications.

6.2. Lecture Hall Intervention

The lecture hall intervention addresses the near-total absence of visual connection to nature (M = 1.71; 78.6% disagree), driven by the space's minimal window provision. **Figure 6a** shows the existing condition; **Figure 6b** presents a schematic rendered wall elevation of the proposed treatment; **Figure 7** presents the proposed intervention visualisation. The design strategy introduces multiple biophilic layers: indoor planting, natural material finishes, and tuneable lighting, while simultaneously upgrading ergonomic seating (the second-highest concern, M = 2.22) and integrating accessible positions at the front row.

Figure 6. Lecture hall: (a) existing condition; (b) schematic rendered wall elevation of the proposed treatment (not to scale).

Figure 7. Lecture hall: proposed biophilic intervention.

6.3. Computer Laboratory Intervention

The computer laboratory intervention builds on the space's existing partial material connection, wood-tone desks and flooring, while addressing the technology-dominated visual environment and restoring daylight access. **Figure 8a** shows the existing condition; **Figure 8b** presents a schematic rendered wall elevation of the proposed treatment; **Figure 9** presents the proposed intervention visualisation. The design strategy introduces living greenery and nature imagery to counterbalance screen dominance, adds wood wainscoting to strengthen material connection, and reorganises technology infrastructure (CPU relocation, cable management) to reduce visual clutter, the primary qualitative concern (≈35% of comments). Acoustic screen dividers support neurodivergent students, and a secondary rear-wall display addresses visibility equity.

Figure 8. Computer laboratory: (a) existing condition; (b) schematic rendered wall elevation of the proposed treatment (not to scale) showing roller-blind-fitted glazing, wood cladding with planting integration, and workstation organisation.

Figure 9. Computer laboratory: proposed biophilic intervention with annotated design modifications.

7. Conclusion

This study investigated the integration of biophilic design within a human-centred assessment framework for psychophysiological wellbeing across three educational space typologies at MSA University, Egypt. By triangulating observational assessment, a student survey (n = 131), and faculty interviews (n = 3), the diagnosis indicated consistently low biophilic integration across all spaces, corroborated by student perceptions averaging 2.3/5 for nature connection, well below the neutral midpoint. Faculty interviews provided critical operational insights, including the curtain–daylight dilemma, refuge-seeking back-row migration in the lecture hall, and the studio's factory-like atmosphere. The consistently lower ratings among the 58% of respondents reporting access needs indicate that, in this setting, biophilic enhancement should be coupled with inclusive design if benefits are to be equitably distributed.

The findings suggest that user-centred data-collection methods, deployed within an HCD process, can surface priorities, such as the primacy of ergonomic deficits over biophilic absence, that observational audit alone did not reveal in this case. This user-driven prioritisation ensured that the design proposals respond to occupants' reported experience rather than designer assumptions, with all interventions filtered through inclusive-design requirements.

The study offers an exploratory extension of ART and SRT to a MENA educational context, indicating that operational factors, exemplified by the curtain–daylight dilemma, warrant consideration alongside architectural features when assessing restorative potential. Methodologically, it presents a replicable assessment-to-intervention framework combining biophilic audit, student survey, and faculty interviews, in which the interviews supplied behavioural explanations (back-row refuge-seeking, outlet clustering) that survey data alone could not provide. Practically, the retrofit proposals illustrate how improvements might be pursued within existing spatial envelopes and institutional budget constraints (Jamieson et al., 2000; Temple, 2008); their actual effects on comfort and wellbeing remain to be established through post-occupancy evaluation.

Several limitations qualify these findings. First, the single-case design supports analytic rather than statistical generalisation (Yin, 2018): the transferable contribution is the assessment-to-intervention framework and the theoretically interpreted patterns, operational suppression of daylight, compensatory refuge-seeking, and the differential burden on students with access needs, which are plausible in comparable hot-arid MENA institutions facing similar typologies and retrofit budgets, rather than the specific parameter estimates. Second, the data are cross-sectional and self-reported; wellbeing was measured perceptually, not physiologically, and convenience sampling may over-represent students with stronger views. Third, the proposed interventions have not been implemented; their predicted effects are extrapolations from theory and prior evidence. Fourth, both the audit instrument and the survey privileged visual constructs; although the proposals incorporate acoustic, tactile, olfactory and thermal measures, the diagnosis itself under-represents non-visual dimensions of environmental experience. Finally, the exploratory inferential analyses are unadjusted for multiple comparisons and should be read as indicative patterns.

Future research should implement the proposed interventions and evaluate pre/post-occupancy outcomes using physiological and behavioural measures; incorporate acoustic, thermal and olfactory assessment to redress the visual emphasis of the present instruments; extend the methodology to other MENA contexts; and explore seasonal variation in biophilic strategy effectiveness under hot-arid conditions.

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Ethics Approval

The study, including the student questionnaire and the faculty interviews, was approved by the Research Ethics Committee of MSA University (reference number: FAD-REC-2026-2). All participants provided informed consent, participation was voluntary, and data were anonymised.

Conflict of Interest

The authors declare that there is no competing interest.

References

Altomonte, S., Allen, J., Bluyssen, P. M., et al. (2020). Indoor environmental quality and occupant well-being in educational buildings. Building and Environment, 185, 107275.

Appleton, J. (1975). The Experience of Landscape. Wiley.

Awad Aly, A. (in press). Human-Centered AI in Interior Architecture: Supporting Accessible and Inclusive Spaces. In A. G. Radwan, L. A. Said, H. Kaoud, A. Godwin, & G. Bouattour (Eds.), *Sustainable and multidisciplinary advanced research trends for an AI-driven future in Africa*. CRC Press.

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning. Building and Environment, 89, 118–133.

Berto, R. (2014). The role of nature in coping with psycho-physiological stress: A literature review on restorativeness. Behavioral Sciences, 4(4), 394–409.

Braun, V., & Clarke, V. (2022). Thematic analysis: A practical guide. SAGE.

Brooks, D. C. (2012). Space and consequences: The impact of different formal learning spaces on instructor and student behavior. EDUCAUSE Review.

Browning, W. D., Ryan, C. O., & Clancy, J. O. (2024). 14 Patterns of Biophilic Design: 10th Anniversary Edition. Terrapin Bright Green.

Browning, W., & Determan, J. (2024). Outcomes of biophilic design for schools. Architecture, 4(3), 26.

Buchanan, R. (2001). Human dignity and human rights: Thoughts on the principles of human-centered design. Design Issues, 17(3), 35–39.

Candido, C., Kim, J., de Dear, R., & Thomas, L. (2016). BOSSA: A multidimensional post-occupancy evaluation tool. Building Research & Information, 44(2), 214–228.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE.

Edwards, B. (2006). Environmental design and educational buildings. Routledge.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs — principles and practices. Health Services Research, 48(6 Pt 2), 2134–2156.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative Inquiry, 12(2), 219–245.

Giacomin, J. (2014). What is human-centred design? The Design Journal, 17(4), 606–623.

Gifford, R. (2014). Environmental psychology matters. Annual Review of Psychology, 65, 541–579.

Gillis, K., & Gatersleben, B. (2015). A review of psychological literature on the health and wellbeing benefits of biophilic design. Buildings, 5(3), 948–963.

Gray, F., & Downie, A. (2024). Designing thriving school ecosystems: The synergy of biophilic design, wellbeing science, and systems science. Architecture, 4(3), 594–612.

Hartig, T. (2004). Restorative environments. In C. Spielberger (Ed.), Encyclopedia of Applied Psychology (Vol. 3, pp. 273–279). Academic Press.

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. Annual Review of Public Health, 35, 207–228.

International Organization for Standardization. (2019). ISO 9241-210:2019 ergonomics of human-system interaction—Human-centred design for interactive systems.

International WELL Building Institute. (2020). WELL Building Standard v2.

Jamieson, P., Fisher, K., Gilding, T., Taylor, P. G., & Trevitt, A. C. (2000). Place and space in the design of new learning environments. Higher Education Research & Development, 19(2), 221–236.

Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology, 15(3), 169–182.

Kellert, S. R., & Calabrese, E. F. (2015). The practice of biophilic design. www.biophilic-design.com.

Kellert, S. R., Heerwagen, J. H., & Mador, M. L. (2008). Biophilic design: The theory, science, and practice of bringing buildings to life. Wiley.

Kibert, C. J. (2016). Sustainable construction: Green building design and delivery (4th ed.). Wiley.

Mahgoub, Y. (2007). Bioclimatic architecture in the Middle East. Journal of Architectural Education, 61(1), 25–30.

Malnar, J. M., & Vodvarka, F. (2004). Sensory Design. University of Minnesota Press.

Norman, D. A. (2013). The design of everyday things: Revised and expanded edition. Basic Books.

Oblinger, D. G. (2006). Learning spaces. EDUCAUSE.

Oblinger, D. G., & Oblinger, J. L. (2005). Educating the net generation. EDUCAUSE.

Ohly, H., White, M. P., Wheeler, B. W., et al. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. Journal of Toxicology and Environmental Health, Part B, 19(7), 305–343.

Pallasmaa, J. (2005). The Eyes of the Skin: Architecture and the Senses (2nd ed.). Wiley.

Prince, M. (2004). Does active learning work? Journal of Engineering Education, 93(3), 223–231.

Salama, A. M. (2015). Spatial design education: New directions for pedagogy in architecture and beyond. Routledge.

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. CoDesign, 4(1), 5–18.

Spence, C. (2020). Senses of place: Architectural design for the multisensory mind. Cognitive Research: Principles and Implications, 5, 46.

Steen, M. (2011). Tensions in human-centred design. CoDesign, 7(1), 45–60.

Stevenson, M. P., Schilhab, T., & Bentsen, P. (2018). Attention Restoration Theory II: A systematic review to clarify attention processes affected by exposure to natural environments. Journal of Toxicology and Environmental Health, Part B, 21(4), 227–268.

Temple, P. (2008). Learning spaces in higher education: An under-researched topic. London Review of Education, 6(3), 229–241.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. F. Wohlwill (Eds.), Behavior and the Natural Environment (pp. 85–125). Plenum.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420–421.

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology, 11(3), 201–230.

Vischer, J. C. (2008). Towards an environmental psychology of workspace: How people are affected by environments for work. Architectural Science Review, 51(2), 97–108.

Wilson, E. O. (1984). Biophilia. Harvard University Press.

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE.