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The Interrelationship Between Restorative Environments and Visual Preferences in University Campus Landscapes

*** Dr Yasser Farghaly [1], Dr. Nermine Aly Hany [2] and B.A. Yasmin Moussa [3]**
Arab Academy for Science, Technology, and Maritime Transport, Alexandria, Egypt [1,2,3]
E-mail [1]: yfarghaly@aast.edu, E-mail [2]: nermine.aly.hany@aast.edu.eg ,E-mail[3]: yasminmm94@gmail.com

Abstract
Educational settings are considered some of the most mentally depleting environments since they require high concentration, creativity, and efficiency. University campuses clearly portray these environments. Therefore, there is an immense need for campus settings where users can take outdoor breaks to restore and redirect their attention. Well-designed outdoor landscapes can have restorative effects on users, and in turn increase their concentration and overall productivity. This interdisciplinary research explores key literature on restorative concepts and visual preferences from the field of environmental psychology. It also examines the restorative campus landscape character from an urban design perspective. However, there are no coherent frameworks that correlate the three dimensions: restorative landscape design concepts, visual landscape preferences, and appropriate campus planning strategies. Therefore, the research summarizes the key literature findings, and merges the three parameters into a comprehensive assessment tool designed explicitly for university campuses. The paper concludes with a proposed tool (framework) that can provide guidelines to help landscape architects and planners to design restorative campus open spaces and recognize their insufficiencies.
Keywords: Landscape visual character, Restoration concepts, Restorative environments, Visual preferences, University campus landscape.

1. Introduction

Urban environments have become a major part of people's daily lives and have contributed to their well-being directly or indirectly. Experiencing nature has become difficult, leading to an increase in psychological disorders such as stress, anxiety, and depression. Stress, as a matter of fact, is the primary cause of 60% of all human diseases and illnesses. It has been named the "Health Epidemic of the 21st Century" by the World Health Organization. [1] Therefore, there is a pressing need to provide landscape architects and planners with information about the attributes of natural environments that can help in recovery from stress and fatigue; this can be attained using Restorative Environments.

Restorative landscape design is a growing trend; however, it is usually associated with healthcare settings because of its therapeutic benefits [2]. Even so, many of its concepts and design considerations can be applied to other settings, such as university campuses. Restorative landscapes are designed to affect people in specific ways, such as healing or contemplation [3]. Additionally, environments are perceived differently through sensory input, of which vision represents 80%, and people also have different preferences [4]. Therefore, this study focuses on the visual aspect of restorative environments and preferences.

Previous studies have reviewed restorative environments, visual preferences, and campus landscape dimensions separately [12,17,28,32,33,34,35,36,37]. Nevertheless, there are no known studies that have established a relation between the three dimensions. Hence, this paper aims to correlate these dimensions to enhance the outdoor experiential quality of university campuses and improve the cognitive and psychological well-being of the users.

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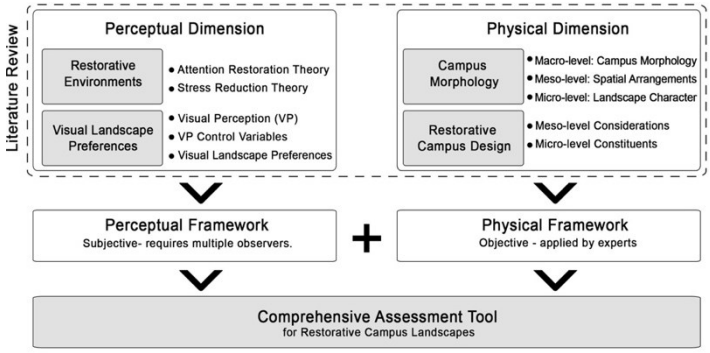

Figure 1. Structure of the Study (Developed by Author).

2. Material and Methods

To provide guidelines on designing restorative campus landscapes, this study first summarizes the previous body of literature. The literature review is divided into two parts as shown previously: Physical and Perceptual. The first discusses key findings on restorative environments and visual landscape preferences, while the latter explores campus morphology and restorative campus design. The main points from each section are then converted into two frameworks: Physical and Perceptual (Figure 1). The research then proposes a comprehensive assessment tool (matrix) by merging the two tables and outlining the relationship between each of the components.

3. The Perceptual Dimension: Restorative Environments

The term 'restorative' refers to the psychologically rejuvenating effects on human well-being. Restorative landscapes are typically designed to evoke specific effects for people, such as healing or contemplation. Joye and Van den Berg define restoration as "the experience of a psychological and/or physiological recovery process that is triggered by particular environments and environmental configurations" [3]. Literature concerning the health benefits of nature on human wellbeing can be regarded as physiological, psychological social or cognitive [5,6]. Restoration is a multidimensional process and can be approached using different theories [7,9]. Therefore, this study focuses on the cognitive and psychological dimensions.

The two influential theories on restorative environments are developed by R. Ulrich (Stress Reduction Theory (SRT)) and Racheal and Stephan Kaplan (Attention Restoration Theory (ART)). According to the ART, there are two kinds of attention: involuntary and voluntary attention. Involuntary attention is evoked with something exciting or fascinating in an environment (such as observing a lake or watching birds) [10]. On the other hand, voluntary (directed) attention requires a person to focus on something in an environment, which may not be interesting, and to engage in advanced mental processing (like listening to a lecture or reading a book) [10]. For an environment to be restorative, according to Kaplan et Al., it has to provide involuntary attention and include four essential qualities that reflect the human-environment relationship which are as follows: being away, fascination, extent, and compatibility. Being away is being distant from unwanted distractions and routines. Fascination is being 'effortlessly engaged' by interesting environmental content. When fascination is sustained it allows a sense of extent, and finally compatibility reflects the relation between what the person needs and what the environment provides [10].

On the other hand, the second theory- the SRT- focuses on stress reduction from an "affective and aesthetic response to the environment" [11]. The SRT states that the appreciation of a scene, particularly a natural scene starts with a rapid, affective response to the "gross configurational properties of the scene", i.e., the dominant landscape elements. Purcell et al. (2001) state that environments that score higher in perceived restorativeness also score higher in terms of preference judgments. This indicates that the perceived restorative value of an environment can be used as an outline for preference judgments. Therefore, the following section explores perception and outlines the preferred environmental qualities [12].

3.1 Perception and Preferences

Perception

Perception is how information is derived through senses, organized and interpreted [31]. More than 80% of peoples' sensory input is through sight [4]. Hence, most of the environmental perception, and similarly landscape assessment studies, focus on the visual aspect of perception. Therefore, this study focuses on the visual dimension of restorative environments and landscape preferences.

Visual Perception Control Variables

Nevertheless, there are some variables that can influence perception. Some of these variables have to be considered when assessing landscape preferences. As a matter of fact, various studies have acknowledged the effect of three main variables: individual, cultural and physical [14,15,16]. A summary of these control variables is shown in figure 2, along with the connections established between the subcategories to be added to the final framework later on as control variables.

Visual Landscape Preferences

To assess visual landscape preferences and understand its dimensions, this study relies on the two main frameworks which established to assess landscape visual character: R. Ulrich's Preference Model (1977) and Tveit et al.'s theory-based framework [17,18]. The frameworks are based on visual preference theories, including Biophilia, Information Processing Theory, Aesthetic of Care, Prospect-Refuge, the Savannah Hypothesis, and others. These theories are summarized into nine main concepts: Complexity, Coherence, Disturbance, Stewardship, Imageability, Visual Scale, Naturalness, Historicity, and Ephemera (Shown in Figure 2), [18].

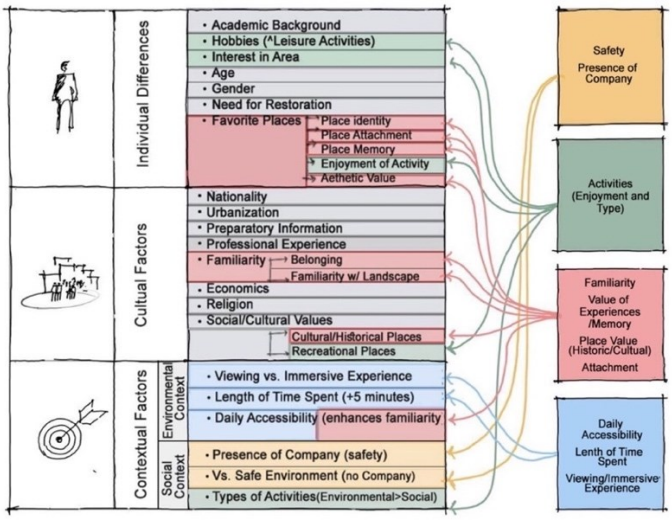

Figure 2. Visual Perception Control Variables and Relations (Developed by Author).

VISUAL CONCEPT	DIMENSIONS	DEFINITION	LANDSCAPE ATTRIBUTES	POTENTIAL INDICATORS
Stewardship	Sense of Order Sense of Care Upkeep	The presence of a sense of order and care, contributing to a perceived accordance to an 'ideal' situation. Stewardship reflects human care for the landscape through active and careful manageme	Signs of use/non-use; Vegetation succession; buildings, Linear features (fences, paths etc management detail; drainage; waste	percentage of abandoned land and stage of succession; status of maintenance of buildings; management type and frequency; length and condition of linear features (for example fences and walls); presence of waste; wet areas in crop fields; presence of weed.
Coherence	Harmony Unity Uniformity Holistic Balance and Proportion Intactness	A reflection of the unity of a scene, where coherence may be enhanced through repeating patterns of colour and texture. Coherence is also a reflection of the correspondence between land use and natural conditions in an area.	land use; water; pattern.	percentage land use in correspondence with natural conditions; water presence and its spatial location; repeating colours and patterns.
Disturbance	Intrusion Alteration Impact Lack of Contextual Fit Lack of Coherence	A lack of contextual fit and coherence, where elements deviate from the context. Disturbance is related to constructions and interventions occurring in the landscape, of both temporary and permanent character.	extraction; natural disturbance (Eg: fire and windfall); constructions (for example: motorway; infrastructure; urban elements; temporary constructions).	number of disturbing elements; percentage area impacted by disturbance, visibility of disturbing elements.
Historicity	Historical Continuity Historical Richness	Historicity is determined by two dimensions, historical continuity and historical richness. Historical continuity reflects the visual presence of different time layers, also influenced by the age of the layers, while historical richness relates to the amount, condition and diversity of cultural elements.	Visible time layers; cultural elements; Traditional agricultural structures.	presence of cultural elements; shape and type of linear historical elements; age of historical elements; number of time layers; percentage area of historic continuity; presence of traditional land use and pattern.
Visual Scale	Landscape Room Visbility Openness Enclosure Spaciousness	we define visual scale by the perceptual units that reflect the experience of landscape rooms, visibility and openness.	topography; vegetation; man made obstacle.	viewshed size; viewshed form; depth of view; degree of openness; grain size; number of obstructing objects.
Imageabiloty	Sense of Place Genius Loci Grandness Place Identity Vividness Uniqueness	Qualities of a landscape present in totality or through elements; landmarks and special features, both natural and cultural, making the landscape create a strong visual image in the observer, and making landscapes distinguishable and memorable.	Spectacular elements; panorama; landmarks; water; Iconic elements.	viewpoints; presence of spectacular, unique or iconic elements and landmarks; presence of historic elements and patterns, presence of water bodies, percentage area of moving water.
Complexity	Diversity Variety Richness Spatial Pattern Pattern Combination	The diversity and richness of landscape elements and features, their interspersion as well as the grain size of the landscape.	linear features; point features; land cover; land form	number of objects and types; evenness index; dominance index; diversity indices; shape diversity; size variation, aggregation& heterogeneity indices; edge density;
Naturalness	Intactness Wilderness Natural Ecological Robust Vegetation Health	closeness to a preconceived natural state.	natural feature; structural integrity of vegetation; vegetation/land-cover type; water; management; patch and edge shape;	fractal dimension; vegetation intactness; percentage area with permanent vegetation cover; presence of water; percentage area water; presence of natural feature; lack of management; management intensity (type and frequency), naturalism index, degree of wilderness.
Epherma	Seasonal change (human imposed and natural); Weather related changes.	elements and land-cover types changing with season and weather.	land cover/vegetation; animals; land use (ploughing, etc.); water (colour reflections and waves); weather.	percentage of land cover with seasonal change; presence of animals; presence of cyclical farming activities; percentage area water; projected and reflected images; presence of weather characteristics.

Figure 3. Visual Preference Concepts and Indicators (Adapted by Author from Tviet et al,2006)

4. The Physical Dimension: Restorative Environments

The process of restoration in terms of landscape and the built environment requires a deep understanding of spatial configurations and material elements- as stated by Thwaites et al.- and how they can offer mental restoration [19]. Hence, this section consists of two parts. The first explores campus morphology, planning goals and guidelines. This is more concerned with the macro/meso-scale components of the built environment. The second part focuses on the physical (material) elements of restoration (micro-level). This data is used to create a framework specifically designed for assessing both scales of restorative campus landscape elements focusing on the visual aspect.

4.1 Campus Physical Dimension

4.1.1 Macro-level: Campus Morphology (Problems and Goals)

Hajrasouliha et al. reviewed collective problems and goals for campus planning [20]. The study shows campuses face several problems that are sorted in high to low order: insufficient square footage, diminished quality of educational facilities and infrastructure, disconnection (placelessness), car dependency, pedestrian-unfriendly campuses, poor landscape quality, facing potential threats or recovering from natural disasters, and finally, deficits in land (for potential growth [20]. Kenny et al. and Hajrasouliha et al. have developed two frameworks for solving the previously mentioned problems [20, 21].

4.1.2 Meso-level: Spatial arrangements

Spatial configurations can significantly shape how people experience open spaces [19]. Research shows that the main elements that form campus open spaces are as follows; Common turfs which are large scale spaces between buildings that are not tied to a specific building and include the university entrance, parks, plazas, and central courtyards. Academic spaces adjacent to specific buildings include the front entrance, front yard, backyard, and service entrances. Spaces for sports activities include open courts and sports facilities provided on campus. Finally, spaces for roads, pathways and parking areas [22,26].

4.1.3 Micro-level: Landscape Character

According to the literature, the main landscaping elements are Landform, Plant Materials, Buildings, Pavement, Site Structures, and Water [23]. Plant materials include trees, shrubs, ground covers and grasses [24]. They are used in different design areas according to their required functions like accent, softening, screening, framing, and shading. On another note, hard landscapes are the inorganic materials which are stationary and the man-made elements of space. Meanwhile, soft landscapes refer to the living or natural materials used in landscaping (Shown in Figure 4),[25].

Table 1. Microlevel Landscape Elements

Landscape Constituents		
Soft Landscape	Water Bodies	Artificial Falls
		Ponds
		Lakes
		Pool
		Fountains
	Plant Materials	Grass
		Shrubs
		Trees
		Groundcover
Hard Landscape	Man-made Elements	Roads
		Benches
		Wall steps
		Ramps
		Sculptures
		Outdoor Lighting
		Pathways
		Wall Fences

4.2 Restorative Campus Physical Dimensions

4.2.1 Meso-level Constituents: Restorative Campus Open Spaces

To assess the impact of the built environment on people, the intimate scale is required. Micro-level landscape constituents on their own do not make sense without considering spatial experiences. Therefore, this review focuses on the Meso-level (spatial experiences) and micro-level (landscape elements) of the campus open spaces and built environment in order to examine their restorative potential on users. Most assessment tools concerned with restorative spaces covered urban environments in general. However, Barnes et Al. designed a framework for campus open spaces [26, 27]. It applies the typologies delineated by Marni Barnes, Clare Cooper Marcus, and Stefanos Polyzoides, with a few alterations to correspond to university campus settings [27]. Barnes et al. filtered the typologies for higher education campuses and restorative landscapes under the classifications designated by Clare Cooper Marcus in 'People Places' [27] (Shown in Figure 4).

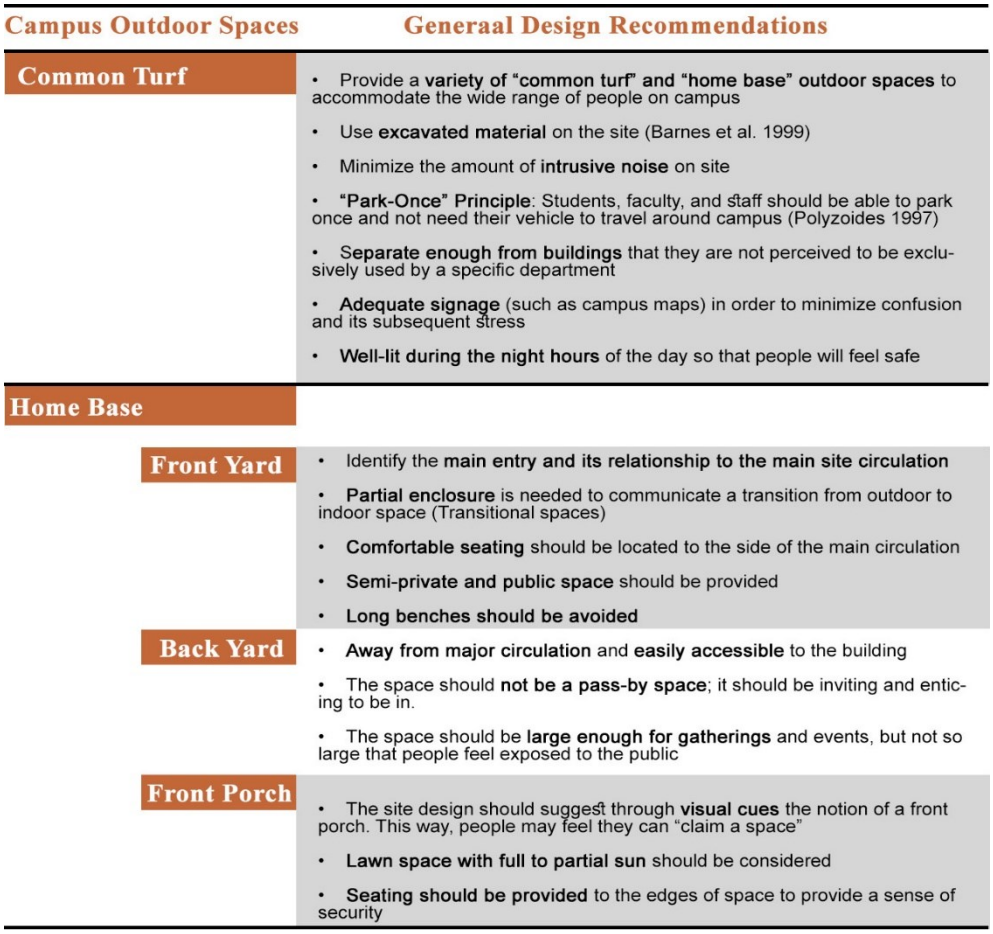

Figure 4. Restorative Spatial Configurations within Campus Settings (Modified from Gutierrez, J. (2013), Barnes et. Al, 1999).

4.2.2 Micro-level Constituents: Restorative Landscape Elements

After identifying spatial typologies for a restorative campus landscape, specific (micro-level) design elements were researched in order to determine how they can add to the campus restorative potential. Based on the literature and research, the following design components are considered central to creating a restorative campus environment. [13,17, 26,27,28,29,30] The list includes 18 landscape constituents as shown in Table 2.

Table 2. Restorative Campus Micro-Level Constituents and Considerations (Modified from J.Gutierrez, 2013)

	Landscape Constituent	Restorative Qualities	Design Considerations	Reference
Water	**Water Features**	Engages senses-Soothing Positive distraction	• Natural forming edges-ponds, Fountains • Semiprivate seating for contemplation • No flooding nor polluted water.	Kaplan, 1998
Plant Materials (Softscape)	**Trees**	Preferred for Shade, Shelter, and Environmental Benefits	• Large, mature trees or small groups of trees • spreading canopies, rounded forms, and short trunks • Form a natural boundary for spaces in vertical and/or horizontal planes without creating total visual isolation • Avoid dense foliage, dark environments, and single planted trees.	Tyson 1999; Barnes et al. 1999; Kaplan 1998; Cooper Marcus, 1998, Ulrich, 1986
	Sensory Engaging Plant Palette	Being Away, Positive Distraction	• Inviting tactile qualities. Foliage that easily moves draws visual attention.	(Barnes et al. 1999).
	Native Vegetation	Sense of place, Comfort	• Less landscape maintenance. • Along major pedestrian paths, • within small study areas, • In areas of limited sun	Barnes et al. 1999

	Vegetative Planter	Closeness to plants, Legibility	• Height of 2.5 feet (0.75m) for easy accessibility).	Barnes et al. 1999; Kaplan,1998
	Vegetated Buffer	Separation, Contemplation, Concentration	• Provide when neighbouring a building for privacy • Near private outdoor spaces to offer protection	Barnes et al. 1999
	Terraces	Socializing/contemplation. Interesting views	• Located adjacent to the front of the building, Semi-private • Provide sufficient space for seating.	Barnes et al. 1999
Man-made Elements (Hardscape)	**Natural/Familiar Materials**	Quiet fascination. Soothing and reassuring.	• Site furnishings • Ground textures affect coherence of the site. • Smoother textures guide pedestrian circulation and enhance exploration. • Rough textures, discourage circulation	Barnes et al. 1999; Kaplan 1998
	Shade Structures	Sense of security, protection	• A gazebo, garden house, trellis, or tree cover. • Placement along edge provides security to people's backs	Barnes et al. 1999
	Views	Quiet fascination, contemplation, mystery	• Birds and wildlife • Provide seating to view scene and plants to frame view • Too little or too much vegetation can influence preference	Barnes et al. 1999; Kaplan 1998, Ulrich 1999
	Landmarks	Wayfinding, Familiarity, Orientation, Sense of Control, And Less Fear of Getting Lost.	• Placed on focal point ,"roughly in the middle". • Distinctive and in harmony with surroundings. • Too little or too many may cause confusion. • Structures such as gazebo, or natural features such as tall free-standing tree	Kaplan, 1998
	Pathways	Physiological or Psychological restoration through contemplation and exercise.	• Public areas- provide space for walking and sitting • A brisk walk-circular routes, smooth surfaces, resting places, a mix of sun and shade, and changing views. • Contemplative stroll- narrower paths • Paths should connect nodes, less than 30 meters apart. • Security, safety, and interesting walkways.	Barnes et al. 1999, Tyson 1998
	Seating Variety	Accessible, comfortable, relaxing, and contemplative.	• Carefully plan location • Cooler climates - seating faces sun and wind protection • Hotter climates - shaded seating • Place near activities • Enclosure around seating using planting or walls • Informal and formal seating should be provided • Use movable seating • Use Primary (benches and chairs) and secondary seating (stairways, steps, low walls, etc.)	Barnes et al. 1999. Tyson 1998. Cooper Marcus 1998. Gehl, 1980
	Gateways	Coherence, Legibility, Mystery, Anticipation	• Placed where majority of students enter on foot • Provide subspaces for waiting, eating, and casual studying • Signage or visual communication to help with wayfinding	Cooper Marcus,1998; Cooper Marcus,1999; Kaplan, 1998
	Usable Edge	Fascination, Place-Based Relationships	• Serve function as origin of any activity • Provide places to sit and stand	Gehl, 2011
Spatial Aspects	**Interior-Exterior Connections**	Restorative Views, mystery, continuity, Fascination	• Provide a panoramic view • Consider Design Guidelines from 'views'	Kaplan 1998; Barnes et al. 1999
	Public/Private Space	Quiet contemplation, Being Away, studying, socializing, Eating	• For each main space, create smaller subsequent spaces • Provide at least one space where people can "get away" • The front area of the building is more public. • The back area where people can "claim" and have privacy • Hierarchy of spaces to create different levels of privacy.	Barnes et al. 1999; Cooper Marcus 1998, Tyson 1999
	Interconnected Open Space	Sense of Identity, Place-based Relationships	• Establish a network of outdoor campus space. • Consider the existing surrounding outdoor space and maintain a connection.	Polyzoides 1996

The meso and micro-level restorative campus design considerations previously discussed will be used to assess the physical aspect of campus landscapes. Since they are solely based on physical observations, and are objective, therefore they can be assessed by landscape design experts.

5. Results

To create the perceptual framework (Table 2), the theoretical concepts on visual preference and restorative environments are used. The selection of the attributes is based on creating interrelations between the ART concepts, visual preference theories, and the variables which influence perception. When comparing the dimensions of each of the visual preference concepts, some of them appeared similar to restorative environments' concepts. Others cannot be applied to campus landscapes and were hence disregarded. This provided a basis for investigating the relationship between the restorative potential and landscape preference of an environment. The perceptual framework is divided into three main categories: Restorative Concepts, Visual Preference Dimensions, and Spatial Usage (Variables). Restorative Concepts are concerned with the individual effect of the environment on a person, and the individual relationships a person (or a group) has with their environment. Visual Preference Dimensions reflect the different restorative aspects of the landscape important for visual quality. Spatial Usage Preferences are the daily usage requirements of people varying from one person to the other.

Table 3. Perceptual Dimensions of Restorative Landscapes and Visual Preferences (Adapted by Authorr)

Perceptual Dimensions															
Restorative Concepts					**Visual Preference Dimensions**						**Spatial Usage (Variables)**				
Compatibility	Familiarity	Place-based Relationships	Fascination	Being Away	Openness	Complexity	Extent (Coherence + Scope)	Ephemera	Naturalness (%water+green)	Stewardship/ Comfort	Savanna Environments	Activities (Types/Enjoyment)	Social Context (Alone/Company)	Viewing/Immersive Experience	Length of Time Spent	Daily Accessibility

The second part of the framework, that is, the physical dimension (table 3) of restorative campus spaces is divided into two levels: meso-level spatial arrangements, and micro-level landscape elements. Since research shows that in order for people to experience the environment and establish connections, intimate level experiences are required. Therefore, this can only be achieved through the analysis of the meso-level (for the spatial experiences) and the micro-level elements.

Table 4. Physical Dimensions of Restorative Campus Landscapes (Adapted by Author)

Physical Dimensions																														
Meso-level Standards									**Micro-level Constituents**																					
Front Porch			**Backyard**			**Front Yard**			**Common Turf**																					
Seating Near Edges	Lawn	Visual Cues (Identity)	Large Enough for Events	Inviting vs. Pass-by Space	Away from Main Circulation	Easy Access	Semi-private + Public Spaces	Comfortable Seating	Partial Enclosure	Night Lighting	Adequate Signage	Park-once Principle	Interconnected Open Space	Public/Private Space	Interior-Exterior Connections	Usable Edge	Gateways	Seating Variety	Pathways	Landmarks	Views	Shade Structures	Natural/Familiar Materials	Terraces	Vegetated Buffer	Vegetative Planter	Native Vegetation	Sensory Engaging Plant Palette	Trees	Water Features

The final framework (proposed assessment tool) intertwines the two previous tables: Physical and Perceptual dimensions. Relationships between each of its constituents are indicated whether the relation is high, moderate, low or non-existent (Figure 5) based on the literature shown in Figures 2,4 and Table 1. However, the 'Spatial Usage' dimension is not added since all its constituents can vary from one person to another. Yet, these variables must be taken into consideration and should be controlled when applying the framework.

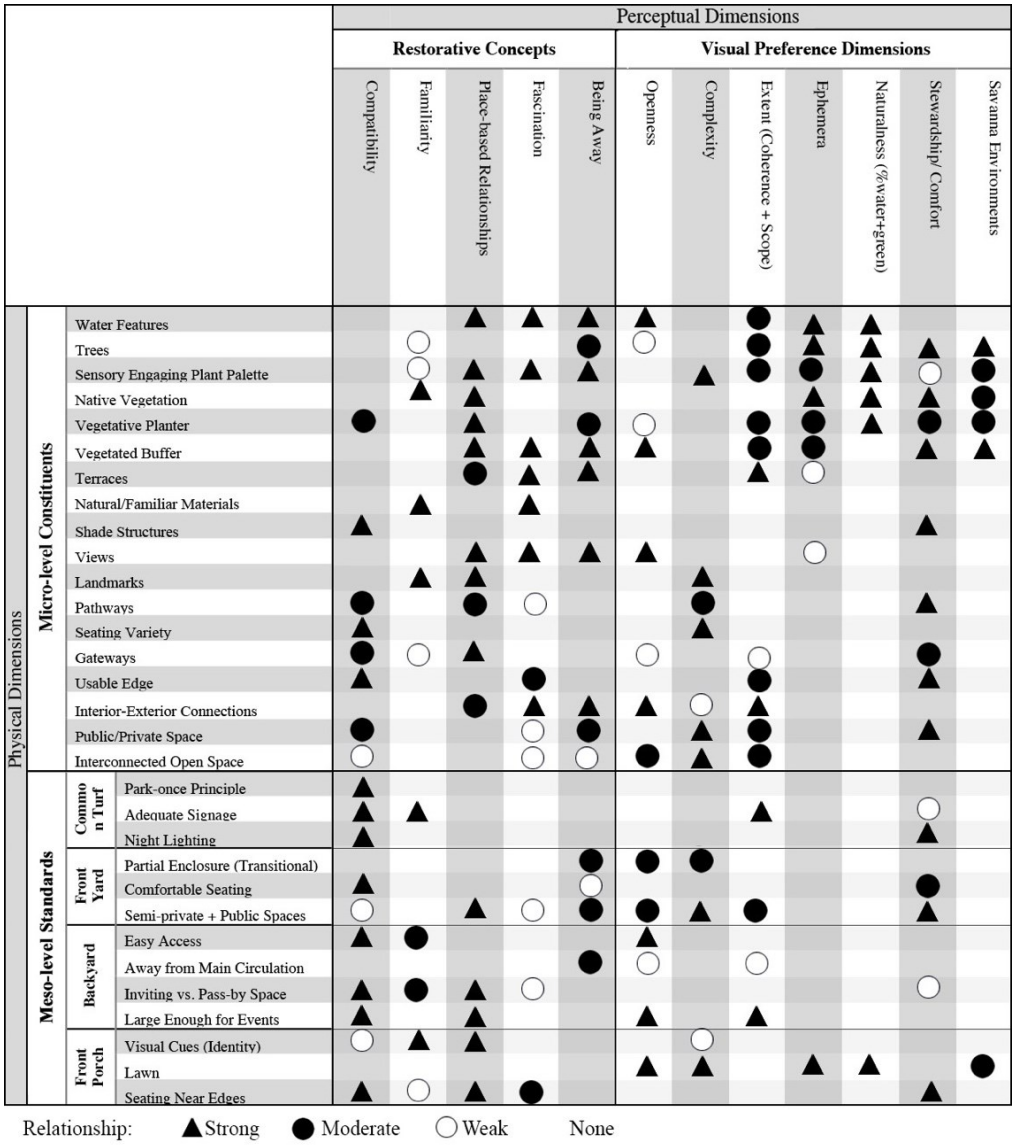

Figure 5. Comprehensive Framework, Author.

6. Discussion

There has been extensive research on Restorative Environments since most people face stress in their daily lives and can use a 'break'. Universities, in fact, can be very stressful. Also, given the current campus planning problems, there remains a need for designing better campus landscapes. However, this notion hasn't been reflected in research, and hence, there are no clear guidelines on how to design campuses that can make people feel better.

This research reviews and summarizes the main concepts and design considerations in order to develop a comprehensive assessment tool for evaluating campuses. The perceptual dimension requires individual opinions as each of its categories relies on personal experiences. Hence, it can be filled out using questionnaires. However, the physical dimension is rather more straightforward, and can be used by landscape architects and planners through solely observing the environmental components. However, when it comes to perception, different variables can alter it. They are mentioned earlier, nevertheless, not all of them can be controlled like age, gender, need for restoration, economics, religion, professional experience, and academic background.

6. Conclusions

The notions of Restorative Environments and Visual Preferences and their application through landscape design in different contexts can significantly improve people's cognitive and psychological well-being. This paper presented one of the educational settings where people are always stressed- university campuses- and how restorative design can help with that. Moreover, this can further be employed in other stressful environments. In addition, further research is required to develop a method for statistical analysis using the proposed tool on several campuses while controlling the variables which affect perception (daily accessibility to the landscape, length of time spent, viewing or immersive experience, social context (alone or with company), and the presence of activities). Using quantitative methods similar to the empirical work previously done by psychologists would help to prove the validity of the framework. This framework can also be used to provide universities with information on the shortcomings of landscape in campuses, and also deliver guidelines on how to make their open spaces more restorative. This is particularly important as open spaces are needed for learning ever since the emergence of the Covid'19 pandemic. Further studies are also required to implement it and prove its validity in different landscape design settings.

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Conflict of Interests

The authors declare no conflict of interest.

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