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Chapter

Green Space Association with Mental Health and Cognitive Development

Prashanti Rao, Somaina Islary and Kapil Natawadkar

Abstract

Increasing urbanization has resulted in urban stress, which not only has affected the cognitive development of children in schools but also adults at workplace. Various research studies have been conducted in this field, and many computational tests were showcased to prove the facts. Still, there is a huge gap while designing the school campus and workplace. This study is based on comprehensive portrayal of greenness at both these spaces. The findings of the study shall provide an insight to policymakers and architects with evidence for feasible and attainable besieged interventions such as improving green spaces not only outdoors but also integrating them with inside spaces at school campus and at workplace.

Keywords: cognitive development, green spaces, school campus and urban stress at workplace

1. Introduction

Nature is the eternal source of inspiration for mankind. Even the slightest interaction with the environment can refresh the senses and rejuvenate the mind [1]. Today's societies are increasingly compromising and creating a deteriorating natural environment, with far fewer opportunities to experience satisfying contact with nature as an integral part of our daily lives. The development of urbanization leads to urban stress, which affects not only school children but also adult cognitive development in the workplace.

1.1 Relevance and need of the study

• Facts and concerns related to adult at workplace: As office environments become increasingly stressful and people spend more time at work, short breaks in nature can spur them to be more productive and improve their health overall. The benefits of nature are believed to have a huge impact on adults in the workplace who are exposed to high levels of stress. In the workplace, being close to nature not only improves employee satisfaction, but even promotes an individual's productivity, creativity, and happiness. With more and more
employers realizing the importance of employee health, the provision of green space in office buildings is increasingly becoming an important design element. Numerous studies have found that students perceive outdoor spaces on campus as landscaped, well-maintained, and safe; however, they feel that outdoor furniture, sports equipment and lighting are completely inadequate, more importantly; outdoor spaces lack the facilities that can support learning and social connection.

Figure 1. Methodology (source: Author).
• Facts and concerns related to children at school environment: The educational environment in a campus setting holistically entails the interface of indoor and outdoor spaces. At any level of education, the outdoor space is an essential consideration for designers or school administrators. Similarly, the campus environment can be classified into the physical environment and the social environment even as the duo has significant implications for planning and administration. While the physical environment serves as the physical location where campus life or activities takes place, the social environment is the location for interaction, social norms, and connection among students, staff, and other members of the university community. However, the available shreds of evidence are in agreement with the urban studies, which depict improved performance of the students in classrooms with greener views. It also establishes that students can cope with stressful events when they have proximity to nature [2].

• How and why green space promotes mental health? A philosophical point here is whether it matters how and why green spaces can benefit mental health, or only that it does. The green space and health research area should consider directing its efforts along with these two complementary agendas. It is clear that engagement with green spaces offers benefits in terms of mental health and well-being, and thus green space can act as a preventative measure to promote elite mental health. Therefore, a research program needs to investigate the potential benefits of green space through a range of measures of interest unexplored to date and to examine the extent of these benefits (Figure 1) [3].

2. Methodology

2.1 Understanding the terminologies

For humans, nature is an infinite source of inspiration. Even a brief connection with nature can refresh your senses and spirit. Today’s culture has resulted in an increasingly degraded natural environment with far fewer opportunities to enjoy pleasant communion with nature in everyday life. The increase in urbanization leads to urban stress, which affects not only the cognitive development of children at school, but also the cognitive growth of adults at work.

• Cognitive development: Cognitive development is the construction of thought processes, including remembering, problem-solving, and decision-making, from childhood through adolescence to adulthood [4]. Through the interaction of inherited and learned elements, cognitive development refers to how a person observes, thinks about, and understands his or her surroundings. Information processing, intelligence, reasoning, literacy skills, and memory are all components of cognitive development.

• Mental health and green space: Green space is a broad term that refers to both controlled and unprotected natural areas, such as protected areas, wilderness areas, and city parks. Green spaces are often created for recreational or esthetic purposes, especially in urban areas. Although global urbanization has reduced access to and participation in green spaces, there is strong evidence that neighborhood green levels are associated with mental health and well-being.
Compared with cities with less green space, people in urban areas with more green space experience less mental discomfort, anxiety, and depression, feel better, and have a healthier cortisol profile.

• Biophilia: Biophilia is defined as a natural human desire to be associated with nature. Natural materials, natural light, plants, nature views, and other natural world experiences are incorporated into the modern built environment through biophilic design, which is an extension of biophilia. Six principles of biophilic design:
  1. Environmental characteristics—Color, water, air, sunlight, plants, animals, and natural materials are all well-known features of the natural world that can be brought into the built environment. Geology and landscapes.
  2. Natural forms and shapes—Biomorphic art, architecture, and design are all examples of natural feature simulation.
  3. Natural processes and patterns—Using time, change, and transitions to transform the sensory experience of a location; complementary contrasts, the play between balance and tension; rhythm, ratios, and scale.
  4. The use of light and space—Understanding how and why people react to light in all of its forms (warm, cool, shaped, filtered, diffused, inside vs. outside) can help you make better decisions about how to use it.
  5. Place-based relationships—The historical, cultural, geographic, spiritual, or ecological value of a location is linked to its meaning.
  6. Evolved human-nature relationships—We have been transformed by our complex relationship with Nature, and we still react strongly to the echoes of our long history [5].

• The therapeutic application of green space for mental health: Green spaces are often used to provide structured therapeutic interventions to vulnerable groups such as at-risk youth, people with dementia or mental illness, probationers, and stressed employees. For example, wild green spaces are used to care for people with dementia and to improve social contact and a sense of belonging. Reducing stress, agitation, anger, apathy, and depression also improves emotional well-being [6].

3. Models and theories

3.1 Piaget’s theory of cognitive development

The theory of cognitive development developed by French scientist Jean Piaget (1896–1980) is the most well-known and influential theory of cognitive development. He analyzed that a child’s knowledge as being made up of schemas, which are defined as “fundamental units of knowledge used to organize past experiences and provide a foundation for understanding future ones.” Through his studies, Piaget declared that cognitive development occurred in four stages throughout one’s childhood where (as shown in Figure 2),
• Stages occur in order.

• Children did not skip stages but passed through each one.

• There are visible changes from one stage to the next.

• The stages occur as building blocks, each one using pieces from the last stage.

These stages always actually happen in the same order, and each one builds on the previous one. These four stages are as follows [8]:

• Sensorimotor stage (infancy): This phase acknowledges six substages where Intelligence is exhibited through motor activity without the use of symbols. Around the age of 7 months, children learn object permanence (memory). Physical development (mobility) enables an infant to begin developing new psychological capabilities. At the end of this period, some symbolic (language) abilities are acquired.

• Preoperational stage (toddlerhood and early childhood): Intelligence is demonstrated through the use of symbols, language matures, memory and imagination develop, but thinking is done in a nonlogical, nonreversible fashion throughout this stage, which includes two substages. The dominant mode of thought is egocentric.

• Concrete operational stage (elementary and early adolescence): This stage is characterized by seven types of conservation (number, length, liquid, mass, weight, area, and volume). Intelligence is demonstrated through logical and systematic manipulation of symbols related to concrete objects. Operational thinking develops (mental actions that are reversible). Egocentric thoughts get diminished.

• Formal operational stage (adolescence and adulthood): In this stage, intelligence is demonstrated through the logical use of symbols related to abstract concepts. Early in the period there is a return to egocentric thought.
3.2 Healthy academic green space framework

Embracing therapeutic landscapes as part of academic green space—The Healthy Academic Greenery Framework (HAGF) summarizes the most important relationship between academic greenery and the physical, mental, and social well-being of students. This allows for a more detailed discussion of the results of using Hofgarten, its implications and perceived well-being. Comparing health experiences with well-established theories of greenery and well-being, such as Völker and Kiestemann's four-dimensional appropriation and attentive recovery theory that extend the concept of the therapeutic environment, compares the results of the Hofgarten study with those of previous studies conducted in different scenarios or in different populations context. The allocation size is no different (as shown in Figure 3). It is important
to recognize that the relevant dimensions are dynamic and intertwined aspects of the interdependent structure of health promotion rather than easily identifiable dimensions. From intangible experiential or symbolic meanings to tactile interactions such as social contacts and physical interactions, these parameters suggest different approaches to health policy [9].

3.3 Potential pathways linking exposure to green space and health outcomes

Green space’s health benefits can be explained by a multitude of biopsychosocial pathways. It is possible to divide them into three domains, each focusing on a different function of green spaces (as shown in Figure 4).

4. Benefits of green spaces

4.1 Benefits for children

Recent studies have shown that green spaces have positive effects on children’s overall well-being, such as mental health, physical fitness, and social skills.

- Physical development: In medicine, childhood is considered an important age for the development of large and fine motor skills in children, and children who play in their natural environment perform better on relevant tests than on regular playgrounds. Childhood overweight/obesity and sedentary lifestyles are common during epidemics. However, exposure to green space has shown a relatively low prevalence of the aforementioned traits. Myopia is less likely to develop from
exposure to sunlight and spending time on green school grounds. Research shows that children of all ages enjoy physical activities such as walking and biking when they have more access to outdoor spaces.

- Mental development: A study of the link between green spaces and cognitive development in children found that minor associations, such as having a greener window view, could positively affect attention span and academic achievement, as well as improve imagination, creativity, and intelligence. Notable benefits are: (a) stress relief, (b) improved concentration, (c) increased self-confidence, (d) sense of community and sense of community.

- Social development: Observations have shown that children performed better on attention and spatial working memory tasks after walking in nature than walking on city street [11]. Similar studies have found higher standardized test scores. Socialization and community activities among peers, neighbors, and children are usually done in local parks, which can reduce parental stress and improve children’s behavior [12].

4.2 Benefits in workplace

According to a study by the University of Twente, increases in the level of focus and higher productivity are noticed in employees working in offices with green spaces.

- Less sick days: Green spaces carry an effect on health and well-being. A Harvard study revealed that green offices experience 30% lesser sick days when compared with other employees, it was also observed that there were 30% fewer symptoms of sick building syndrome, watering eyes, headaches, dizziness, nausea, heart palpitations, chronic fatigue, tremors, cancer, etc.

- Better office cooperation: Green spaces stand as areas of social interactions. The same goes for office spaces as well. A green office reportedly reduces hierarchical friction, encourages collaboration, cultivates employees’ engagement with others, and allows more worker/user relationship-building opportunities.

- More focus: Like children, greenery affects cognition as much as 26% in adults also, when compared with non-greened buildings. Workplaces end up with less productivity when an employee is physically present and mentally absent. In an experimental study, analysis of participants reveals an increase in subjective concentration levels in the case of green office, whereas, in the typical office, no difference was observed over time.

- Energy savings and the environment: The experimental study reveals that participants in the green office perceived an increase in air quality, which was a persistent effect in the long term since plants’ respiration naturally contributes to the air quality, temperature, and humidity levels in any area, resulting in power savings.

- Curb appeal: Benefits of green offices remain the same for office or employee turnover, such as attracting people to take up the job or enter a rental agreement [13].
5. Case studies

5.1 Gyaan Centre, Jaisalmer, India

**Project** Gyaan Centre (Rajkumari Ratnavati Girl’s School), 2021  
**Area** 500 m$^2$  
**Architect** Diana Kellogg

5.1.1 Introduction

The Gyaan Centre is platform to invite renowned women artists, designers, and education advocates to create artwork, host events, and exhibit art installations. Comfortable environment assimilates and provides opportunities to learn to read, write, and develop traditional artisan skills unique to the region. The school is well equipped with the all-necessary infrastructure include classrooms, a library, a computer center, and a bus facility to transport girls from neighboring villages. The school is essential and core structure of Gyaan Centre, an exhibition space and women cooperative revolve around. The Gyaan Centre is symbol of the infinite possibilities of women’s strength reminiscing the historic, enchanting and sustainable architecture of the Rajasthan (Figure 5).

5.1.2 Concept

The Gyaan Centre is inspired by feminine symbols across cultures, specifically symbols of strength, encompassing on a structure of three ovals to represent the power of femininity and infinity. The spectacular ellipse structure blends seamlessly into the planes of sand dunes within the region of Jaisalmer, with putting arciform walls, which imitate the organic design of Rajasthan’s fort.

5.1.3 Spatial quality

Organization of spaces: Siting and orientation of the ellipse axis with the solar climatic angles, which forms larger and wider shadows through the day to enjoy the central court for various activities (as shown in Figure 6). Introvert spaces
considering the climatic consideration courtyard planning inspired from traditional architecture of the region. The height-to-width ratio is maintained by enhancing the high parapet wall; further it imitates the skyline of the fortress in the region.

Use of landscape elements: Large hardscape paved plaza to accommodate functional aspects of school activities, such as assembly, breakout space in between classes, and outdoor learning spaces as well it traps and captures the rainwater runoff inspired from “Tanka,” the traditional rainwater harvesting system in the arid climatic region. The relatively small softscape pockets compliment as a visual retreat in the monochromatic floors of courtyards. Introduction of flexible shade structure to improve the usability at time of mid-day hours. Water-sensitive landscape design approach considering minimal and locally sourced vegetation pallet associated with cultural roots of the people.

5.1.4 Indoor outdoor experience

The organic form of the building inspired from the sand dunes, cladded with locally sourced material, and inspired from the traditional building design principles the built mass amalgams with the context. The seamless integration of the indoor and outdoor environment is preserved by slight level difference between courtyards and classrooms access passage (as shown in Figure 7). The high ceiling permits thermal comfort by reducing the indoor temperature, the clearstory windows serve to release the hot air and opportunities for filtered indirect light.

5.2 Delta-Plantsoen—urban regeneration and landscape design, Netherlands

**Project** Christian Elementary Jan van Nassau School (SCOH), 2014  
**Area** 8100 m²  
**Architect** Daryl Mulvihill

5.2.1 Introduction

Delta-plantsoen considers for redevelopment to become the first playground in the Grevelingenveneld, which is a neighborhood square in Rivierenbuurt. The design
program was challenging considering the unique requirement of the context, however, strategically resolved during the design process by introducing significant landscape elements and experiences. The promising interface and continuous user pool requirements and the tractability in land use allocation where green spaces are allowed to be used as school play yard provide an endless opportunities for communities, cultures, and livable cities.

5.2.2 Concept

The interplay of contrasting experiences, passive naturalist and active urban characters are assembling with the undulating threshold between the two extremes known as “ribbon.”

5.2.3 Spatial quality

Organization of spaces: The square is divided in the three broader segments; the outer edge is defined by site extent. The ribbon itself encompasses an intermediate zone as well as encasement to innermost core (as shown in Figure 8).

Use of landscape elements: The ribbon, a unique landscape element, is introduced, which acts as buffer between experimental and fundamental play opportunities. The ribbon is confining element to define the extent of urban oasis and provide a contemplative visual retreat for kids and also provide the opportunities for parents to sneak-peak into the wild. The ribbon also hosts a distinctive design program for all the age groups from passive grass mounds around inner core and rock climbing, skating, and leisure seating toward the outer interface facing the active zone. The central natural playground is a space where children are free to construct and destruct their own play spaces from natural materials and fast-growing plants such as willow and reeds.

Figure 8.
Site plan, Christian elementary Jan van Nassau school.
5.2.4 Indoor outdoor experience

Strategically designed access points invite users all cross immediate and larger context. Well integrated with the school interface and allows all-time vehicular conflict free access for all age kids. The interwoven circulation allows the thoroughfare and facilities natural surveillance on the user (as shown in Figure 9).

5.3 Titan Integrity Campus, Bengaluru, India

Project Titan Integrity Campus, Bengaluru, India, 2017
Area 6.5 acre
Architect Mindscape Architects/ Landscape Architect: One Landscape

5.3.1 Introduction

Titan Integrity Campus, in keeping with its vision of creating elevating experiences for the people it touches and significantly impacts the world it works in, wanted to create a safe and sustainable property for its manpower within the urban agglomeration of Bengaluru. Titan Integrity field is placed on 6.5-acre site that contains a waterbody on the eastward and a road toward the north. The design has a very unique attachment with the site and the adjoining lake (as shown in Figure 10).

Figure 9.
Indoor outdoor experience, Christian elementary Jan van Nassau school.

Figure 10.
Titan trinity campus, Bengaluru.
5.3.2 Concept

The aim was to build a campus that retains natural beauty and focuses on energy and resource conservation while enhancing the quality of life of its employees. The aim is of utilizing each potential view and feature to the lakeside makes any user a spectator of this serene setting. Lake and green spaces create an ample microclimate, thus minimizing mechanical cooling (as shown in Figure 11). Also, green terraces are an extension of indoor building areas that enable one to work outdoors and stimulate interaction amidst flora and fauna.

5.3.3 Spatial quality

Organization of spaces: Office building with all its ancillaries is proposed around this bio lake. Building is oriented with longer sides facing North–South to bring in glare free natural light. Porosity in planning and form allows continuous movement of breeze with wind tunnels creating venturi effect. Common areas are open and non-air-conditioned. Porosity in structure allows continuous movement of air with wind tunnels making a venturi effect. The design is in such a way that each department has its own zonal area but is well connected to the various departments through voluminous atria, which brings in light and allows hot air to escape. The depth of area is perceived in such a way that the entire office space is filled with daylight as long as the sun allows, thus reducing the use of artificial light.

Use of landscape elements: The bio-lake alters the micro-climate and makes the place cooler than it would have been, through evaporative cooling, and also by reflection of incoming solar rays. Being quite a large body of water, it absorbs a lot of heat during the day, only to release at night. In total, 405 trees and shrubs, such as Mahagony, Champaka, and Termianila were planted on site, in 2017, and over the years, the vegetation has taken over the building, gradually making it a part of the landscape. The three-floor structure has terrace gardens at every level, which are reminiscent of rice fields, and are connected through stairs inducing a feeling of elevated ground. These terraces also provide insulation to office spaces below, thus reducing electric load, resonating with the idea of a sustainable building.
5.3.4 Indoor-outdoor experience

The design has a very special connect with the site and the adjoining lake. The idea is of exploiting every view possible to the lakeside, makes any user a spectator of this serene setting (as shown in Figure 12).

5.4 Googleplex, California, USA

**Project** Googleplex, California, USA, 2004  
**Area** 26 acre  
Landscape Architect: Sasaki, Walker and Associates

5.4.1 Introduction

The design of Googleplex creates a strong identity for the campus and provides a much-needed civic space, blurring distinctions between the private and public realms.

5.4.2 Concept

The primary vision was to merge the idea of workplace with the experiences found in an educational environment into a new way of working and maintenance of an edge. The campus is designed to mimic the loosely structured nature of a university field. Clive Wilkinson Architects found that the nature of the company as well as the existing building complex was perfectly suited to merge the idea of workplace with the experiences found within an educational environment (as shown in Figure 13).

5.4.3 Spatial quality

Organization of spaces: The existing opportunities were pushed to a new level to better serve the overall goals of the community. The master plan for the entire

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**Figure 12.**  
Indoor outdoor experience—Titan integrity campus.
Green Space Association with Mental Health and Cognitive Development
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The campus incorporates the language of a campus: outdoor sports activities, food, a common, and a park. The resultant building setup follows a straightforward distribution of work neighborhoods on a “Main Street” circulation set up (as shown in Figure 14). All shared resources are settled on this street and vary from meeting rooms, to technical school speak areas, to micro-kitchens and library lounges. The campus’ four buildings are organized to make internal courtyards, connected to at least one another by glass bridges emphasize a way of community. A multipurpose amenities building is at the center of the field within the main court.

Use of landscape elements: At the lower level of the park, a brick plaza provides for frequent concerts and civic gatherings. The plaza’s daring, stripy pattern continues up the slope through a series of terraces and shallow pools. Rows of cherry trees and fern provide color and texture of the composition. The presence of water suggests the fluid boundary between the park and field. Public art has been used extensively throughout the site (Figures 15 and 16).
5.4.4 Indoor-outdoor experience

A sinuate yellow brick path ties the campus’ three gardens. The contemplative East Garden’s circular mounds echo the nearby hills seen within the distance on the far side. The Central Garden acts as a congregation place for the whole community. The West Garden is dedicated to recreation, whereas the tiny low, elegant, rectangular garden contains a boccie court. Natural ventilation is key to all the spaces in order to negate the necessity for mechanical instrumentality.

6. Conclusions and discussions

6.1 Learnings and insights

The detailed deliberation above for both School Campus and Workplace provides a fresh insight to architects and policymakers for designing the spaces as well as formulating bye-laws. The importance of integration of Green Spaces within and around the built environment is witnessed through these case studies. Hence, even small efforts by policymakers for strengthening the bye-laws definitely bring cognitive development for the children at School Campus as well as reduce the urban stress and enhance the productivity at Workplace.
Moreover, architects and policymakers should also put an effort to bring the associative factors such as symbolic, experiential, active, and social spaces while designing School Campus as mentioned in the Healthy Academic Green Space framework responsible for physical, mental, and social well-being, which act as three pillars for cognitive development in children. This also helps in the formal stage development, preoperational

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Table 1. Comparative analysis of case studies: School campus.

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Table 2. Comparative analysis of case studies: Workplace.
and operational stage development as well as sensorimotor stage development in children. The learnings of the case studies as mentioned in Table 1 are indicating the same.

The associative attributes such as energy efficiency, work-leisure congregation spaces, green-blue spaces in its various forms and scales should also be incorporated for better competence and productivity of the employees (as mentioned in Table 2). The integration of these spaces not only improves attention and memory, but also reduces the number of thoughts that lead to depression. Additionally, it also encourages physical activity, which can be considered as a valuable long-term investment in improving health.

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