TEACHING-LEARNING-RESEARCH: DESIGN AND ENVIRONMENTS

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VERTICAL SCHOOLS AND MEDIATED SPACES; THE NECESSITY OF INTERACTION WITH NATURAL ENVIRONMENT

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INTRODUCTION

The idea of integrating schools with nature and community is not a new-found phenomenon. From the end of the 16th century and throughout the 17th century, significant childhood discovery development emerged. However, by the late 18th century, the concept of the child was firmly established as an 'institution'. This institution was seen as a 'walled garden' in which small and weak children are shielded from the harshness of the globe outside .[1] In the early 19th century, the educational garden concept commenced with the kindergartens established by Friedrich Froebel,[2] and emphasised the importance of integrating children's spaces with the natural environment.

Nevertheless, nowadays, children spend less time in natural settings than was normal in the past, due to space competitiveness, which is creating more high-rise buildings, including schools.[3],[4] The growing population, urban sprawl, densification strategies, and digital integration are indicators of time spent in and out of natural environments and have an undeniable impact on children's health and well-being.[5],[6] Given the excellent association between time spent in nature and better community well-being, people spend more than 80% in buildings, deprived of nature's opportunities.[7] As a result, one of the necessary elements for encouraging progressive thinking in educating children is to create a functioning and supportive physical learning infrastructure in vertical buildings,[8] which, in this paper, is called 'mediated spaces'.

This paper aims to propose criteria for designing mediated spaces to integrate indoor and outdoor environments in vertical schools. Moreover, by pursuing literature review on the impact of the natural environment on pedagogy, and reviewing related case studies in vertical schools that integrate with nature argues the importance and strategies of interacting mediated spaces with the natural environment to improve learning outcomes, health and well-being of children.

PROBLEMS IN SCHOOLS

The correlation between human health, well-being and the natural environment is well-documented.[9] However, recently, reduction in time spent in nature and outdoor activities along with increasing inactive mode and indoor sedentary recreational activities may have significant consequences for

children's health, well-being and social improvement. This lifestyle can influence their physical health, increasing the risk of obesity, affect their cognitive performance and relationships.[10],[11]
Richard Louv, the author of the 'Last Child in the Woods', invented the term 'nature-deficit disorder' to describe the lack of free-range children's discovery of 'wildlands' in towns. He also explained possible adverse effects on human well-being and social cohesion as children move indoors and away from direct interaction with the natural environment.[12] It is well documented,[13] that excessive periods spent in buildings can lead to 'Sick Building Syndrome', affecting occupants through ill health effects, discomfort and reduced productivity. For example, an extensive study of over 345,000 people showed the prevalence of major categories of disease was at least 20% higher in people living in less green areas compared to those living in more green areas.[14]

FROM TRADITIONAL TEACHING TO INNOVATIVE TEACHING

In the late 1970s and 1980s, the priority of investing in educating staff and learning resources, made classrooms and school estate go out of fashion. This educational system is called subject-based learning. Nowadays, "the classroom, as the 'learning space', and the school, as the 'community hub', are critical to student-based learning and constructively aligned learning".[15]
Besides, traditional teaching involves students sitting in their assigned seats, and the belief is that the brain is unique from the body, and the body is not involved in the learning process. Nevertheless, it is widely accepted that learning takes place not just in traditional classrooms, but also in interaction with open spaces and physical activities. The research on plasticity and the brain tells us that the body and mind are interconnected. When a person is appropriately engaged in a tricky experience, multiple body/ brain/ mind systems are integrated and working together naturally; and to this matter, child-centred learning theories are responsible for such shift, where school design and planning ultimately found their way into innovation.[16] For example, a survey of more than 800 Australasian schools illustrated that in innovative learning environments, flexible spaces promote deeper student learning compared to traditional classroom arrangements.[17]

BACKGROUND OF INTEGRATING EDUCATION, NATURE & COMMUNITY

Samuel Wilderspin (1792-1866), an English educator, and David Stow (1793-1854), a Scottish educator, both established education systems supported through school building laws and recognised the need for an outdoor playground area.[18]
John Dewey (1859-1952), a pioneering theorist in the education of children, introduced an evolutionary philosophy based on the idea that "children learn by experience".[19] He argued that "the school is primarily a social institution" and "education, therefore, is a process of living and not a preparation for future living".[20] To achieve this, he believed that having interaction with open space environments should be considered in designing learning environments for children. Furthermore, bringing the outside in and naturalising play spaces could effectively join the outer community and landscape and provide unlimited exploration and discovery opportunities.[21]
An eminent Italian educational theorist, Maria Montessori (1870-1952), advocated that the "development of a child's mind comes through his movements". She claimed that mental growth must be related to and based on movement, and there is an almost mathematical correlation between the child's environment, activity, and development.[22]

The importance of educational theory cannot be overstated, as it also impacts design theories. Richard Neutra (1892-1970), a modernist architect and advocate of the beneficial effects of exposure to the natural environment,[23] argued that schools must interact with the existing site. This interaction is for better learning and collaboration between students and teachers as a physical space and forming a connection between the school and the neighbourhood/ town. He also agreed to the advantages of outdoor education, an argument stemming from Ivan D. Illich, an Austrian theorist (1926-2002), and his book "Deschooling Society".[24] According to Illich, the more children spend time in the natural environment; the more outstanding well-being affects them.[25]
Reggio Emilia's concept by Loris Malaguzzi (1920-1994) believed that "by designing the spaces in a way that creates a pleasant learning environment for the child, space itself can become a third teacher for the students". It means that "space becomes a learning tool for the children",[26] and "both children and adults co-construct their knowledge through interactions with people and the environment".[27]

NECESSITY OF CHILDREN'S INTERACTION WITH THE NATURAL ENVIRONMENT

Designing school and learning environments have always been a controversial issue; it is a highly complex interaction between the child's well-being requirements, learning processes, and innovative teaching methods. However, children's learning does not necessarily occur in a defined classroom. Children learn best when they spend unplanned and unstructured time outdoors; exploring, experimenting, exploring, and enjoying; not to mention delightfully planning their syllabus.[28] Furthermore, including the children in unstructured outdoor spaces will allow them to identify the risks of physical activity, mobility, and play and the opportunities for successful physical development and mental stability in unstructured outdoor spaces.[29] Referring to the Australian Curriculum and Assessment Authority (ACARA), the definition of outdoor learning is "learning for, with, and about the natural environment". The four outdoor learning measurements are skills and knowledge, human-nature relationships, conservation and sustainability, and health and well-being.[30]
Evidence indicates that the formative years of an infant's life are the most critical period to cultivate an affinity with the natural world.[31] Many scholars have studied the effects of children participating in the natural world and becoming physically active in open environments.[32],[33],[34],[35] For example, one-hour nature exposure can boost memory performance and attention by 20%.[36] Several empirical studies prove that "spending time in green outdoor environments, as part of a 'balanced diet' of childhood experiences, nurtures lifelong positive attitudes about nature and the wider environment".[37],[38],[39],[40]
Other researchers recorded improvements in children's physical well-being, social interactions, and positive affective conditions due to outdoor recreational interactions in nature.[41] Also, time spent in more natural settings (like parks, woods, nature-based classrooms or playgrounds) triggers the senses, increases the capacity to learn, and lets students link the aspects of the universe.[42] Other benefits found are decreased stress levels, excellent self-regulation capability, and a self-determined commitment to play.[43] Children's executive output, including their cognitive flexibility and emotional control, is enhanced by even limited improvements in urban green space participation.[44],[45] Further studies in educational settings highlight the importance of natural environments in promoting meaningful and rich learning experiences, including changing perceptions of nature and the local plants and animals and enhancing gardening skills, life skills, and interpersonal relationships.[46]

Ming Kuo from the Landscape and Human Health Laboratory at the University of Illinois claimed in a 2019 review that "experiences of nature boost academic learning, personal development, and environmental stewardship". There are clear indicators that nature can encourage learning by enhancing student focus, stress levels, self-command, engagement in learning, physical activity, and fitness. According to Kuo, nature-based teaching exceeds conventional teaching in academic contexts. To improve his statements, he exampled a "controlled trial of school garden-based instruction" involving over 3,000 students, demonstrating the students' improvement in learning in garden-based instruction compared to traditional education systems (Fig. 1).[47] Another study on the effects of school gardens on children's science knowledge found that knowledge scores improved from 46% to 57% when children were presented with a very robust garden intervention.[48] Thus, it is time to acknowledge nature as a learning platform.

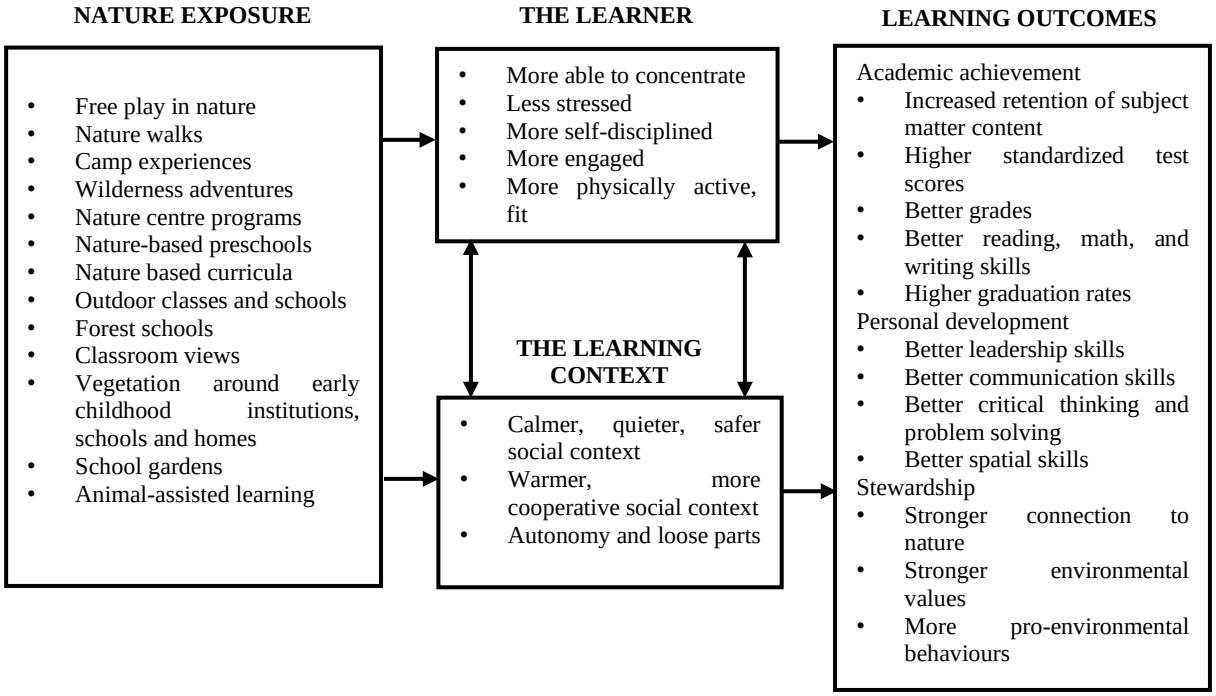


Figure 1: Nature-Based Learning: exposures, probable mechanisms, and outcomes

STUDENT WELL-BEING

One of the compelling elements in designing a learning environment is well-being. As schools shape students' well-being, they provide context and serve as agents for well-being transformation and should prepare children for life, a key consideration for well-being.[49] Fraillon defines student well-being as "the degree to which student is functioning effectively in the school community".[50] Similarly, another definition of student well-being as "a sustainable state of positive mood and attitude, resilience, and satisfaction with self, relationships, and experiences at school".[51] However, optimal student well-being is described as a sustained state of positive emotions and attitudes, resilience, autonomy, relationships, and school experiences.[52] According to PISA, students' well-being is defined as having a "happy and fulfilling life". Students' well-being relates to four domains, including psychological, social, cognitive, and physical.[53]

Psychological dimension includes the "students' sense of purpose in life, self-awareness, affective states, and emotional strength". Social dimension involves students' interaction with their families, peers, teachers, and their perceptions of social life within and outside school. Cognitive dimension includes students' abilities to use academic expertise to address challenges, critical reasoning, and confront concepts from many viewpoints. Physical dimension offers self-reported statistics about how much physical exercise students participate in and what they eat consistently. For example, on average, across OECD countries, students who claimed to participate in mild to intense physical exercise were less likely to report feeling very stressed about school work and feeling like outsiders at school.[54]

VERTICAL SCHOOL AS LEARNING ENVIRONMENT

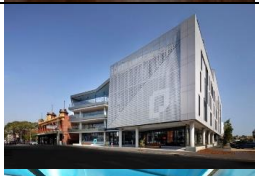
Since urban densification is inextricably connected to today's lifestyles, engagement with the idea of vertical school (VS) is now imminent.[55] VS has been designed as learning environments for all teaching, management, and leisure activities in one or two buildings with elevated outdoor areas with four to 17 floors.[56] VS saves space and takes up less land, so more land can be used for developing other ventures. It enables students to be closer to the resources they need for their future careers since they are so close to the CBD. This leads to closer relationships with local businesses and more opportunities and occupies less space, which helps with overcrowding by building more of them. Multi-story schools, however, require innovative architecture and pedagogical approaches to ensure direct access to nature and green areas. The lack of natural playgrounds and schoolyards, outdoor workouts, and physical activities are the prevalent problems in every VS.[57]

CASE STUDIES IN INTEGRATING NATURE WITH VERTICAL BUILDINGS

Integrating nature with architecture boosts self-regulation, energy usage, and overall efficiency of the building and promotes health and well-being.[58] The following case studies are already working with some types of in-between spaces in VS to maintain health and well-being (Table 1).

Table 1. Top recent case studies in children's related spaces

Building	Nature / outdoor integration concept to maintain well-being	Photo
Loreto Mandeville Centre Toorak, Australia 2015	Integrating the atrium with the courtyard facilitating a pedagogy in which inside and out learning experiences are combined. The north façade creates a seamless relationship with the landscape.[59]	
Early Learning Village Singapore 2017	Consistent with the Reggio Emilia philosophy of children's physical environment, this building focuses on children's well-being in a learning environment. Architects have sought to create an atmosphere bursting with natural light, external awareness, accessible and engaging.	

	Four classrooms are grouped around a central space with an outdoor play area for 100 students. Analysis of stacked 'building blocks' have produced a playful atmosphere while providing weather protection.[60]	
South Melbourne Primary School Melbourne, Australia 2018	This building is designed using the concept, "Learning can take place indoors and outdoors depending on the weather". It provides both a learning hub and a community centre that connects learning and entertainment, students and neighbours.[61]	 
Royal Far West Manly, Australia 2018	The architecture maximises views from an open workspace and enables light penetration through the floor. The integrated education and workplace integrate external terraces and outdoor spaces with indoor areas.[62]	 
Gray Puksand, Melbourne Prahran High School Melbourne, Australia 2019	This building provides some outdoor areas at every level. The lower one is linked to a huge gym, transforming it into an active terrace, while the upper one linked to the food technology and canteen rooms. Indoor spaces have acoustics and a sense of light that make them feel like being outside.[63]	 

MEDIATED SPACE / IN-BETWEEN SPACES

Referring to the above case studies, physical activities and interaction with the natural environment in vertical schools, occur in mediated space or in-between spaces. Mediated spaces are defined as interaction spaces between indoor and outdoor environments[64] including semi-open spaces like sheltered rooftops, patios, internal courtyards, and terrace, as well as transition spaces like corridors, foyers, lobbies, atrium, and staircases. Mediated spaces can be differentiated form open spaces since they create more sense of belonging to the space for the person or community.[65] These spaces facilitate knowledge sharing and peer-to-peer learning in the form of "chance encounters and social interactions".[66] Moreover, learning in informal settings like corridors, breezeways, circulation zones, and expanding in-between spaces outdoors enhances learning ability, well-being and builds relationships in education settings.[67] According to the previous case studies, creating physical, social

relationships and recreational activity environments are the design benchmarks of mediated spaces in these vertical schools.

PRINCIPLES OF DESIGNING MEDIATED SPACES IN VERTICAL LEARNING SCHOOLS

To integrate with nature and design mediated spaces in vertical schools, the following strategies are extracted from the above case studies and literature review. These practices will encourage quality improvements in school design and sustain student-centred learning, health, and well-being.[68]

- Creating an outdoor classroom by connecting a cluster of classrooms to mutual green, sheltered terraces in every level for small groups to study, build social skills, and promote creative play.
- Creating the window seat/ nook in the library or communal spaces of each level provides an informal environment to facilitate students' peer-to-peer and self-directed learning. Besides, daytime views of nature are an efficient use of space that can promote beneficial behavioural and learning effects.[69]
- Creating grass sports pitches, hard game courts and pools in the rooftops since there is not enough land on the ground.
- Creating courtyards provides a secure, shared outdoor space protected and linked to indoor learning spaces for engaging pupils and the wider community. Courtyards will also provide opportunities for studying nature, growing food, and climate observation for environmental education.
- Creating central atria with 'Hellerup stair' to connect the building's spaces vertically. This expanded staircase doubles as a sitting area, encouraging connection, learning and relaxation.[70]
- Creating a connected façade offers views to nature, light penetration through openable doors and windows for students to move outdoors, play and learn.
- Using deciduous trees and plants in the external play areas, which can provide shade for indoor spaces throughout summer, while allowing the sun to reach the classrooms throughout winter. Tree-canopies can minimise the influence of urban heat island in metropolitan areas.[71]
- Using natural materials like wood, sand and grass bring nature in the heart of the learning environment in indoor and mediated spaces.

CONCLUSIONS

In this paper, the importance of integrating learning spaces with the natural environment on improving the quality of student-centred learning, health and well-being has been put forward. Moreover, the necessity of designing mediated spaces as interaction spaces between the indoor and outdoor environment in vertical schools are argued through a systematic literature and case study review.

Despite other studies emphasising designing interacting spaces with natural environment in the conventional horizontal schools, this study focuses on why and how to implement interaction spaces to connect natural environment and learning spaces in vertical schools. Vertical schools are the prevalent result of the overpopulation and land scarcity in today's urbanising world and should adopt new pedagogies both in curricula and architecture to suit innovative learning curricula. This research's significant characteristic is redefining the image of traditional horizontal schools in response to higher demand for land in major dense cities. Proposing design strategies on creating mediated spaces in vertical learning environments to maintain learning outcomes, and well-being is another stunning feature of this paper.

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