University of
Technology
Sarawak

ORIGINAL ARTICLE

Vertical School: Innovative Urban School Design Strategies in Kuala Lumpur, Malaysia

Khairyl Fahmy Mokhtar, Zuraini Denan and *Nayeem Asif

Department of Architecture, Kulliyyah of Architecture and Environmental Design, IIUM, Gombak, Malaysia

ABSTRACT - Rapid urbanization in Kuala Lumpur has led to increased demand for schools, resulting in a scarcity of land for traditional horizontal school designs. The lack of space poses challenges in fostering effective learning environments and addressing the psychological needs of students. This study aims to propose design strategies for Vertical Schools in Kuala Lumpur to provide conducive and modern learning environments suitable for the 21st century. By examining case studies of existing vertical schools, the research seeks to develop recommendations for the next generation of school designs. Three case studies, including the School of Arts in Singapore, Singapore International School in Hong Kong, and William Jones College Preparatory School in Chicago, were selected through a sampling process to reflect regional characteristics and challenges. The comparative analysis was conducted through tabular examination, facilitating a systematic comparison of architectural elements and student activities. The study recommends several design strategies for urban vertical schools, including providing outdoor spaces, optimizing circulation, integrating facilities, utilizing natural light, designing flexible room layouts, and maximizing vertical space utilization. These recommendations aim to enhance collaboration, foster community interaction, and promote student well-being and learning experiences. While this study provides valuable insights into vertical school design, further research is needed to refine design strategies and adapt to evolving educational needs and urban contexts. Ongoing research and development in vertical school architecture are essential to address future challenges and optimize learning environments for students in urban areas.

INTRODUCTION

As Kuala Lumpur continues to increase in density, so does the demand for schools. Currently, Kuala Lumpur has around 300 public schools, but this number is insufficient to accommodate the rapidly growing population [1]. The city has seen a significant rise in the need for new schools, with an estimated annual increase of 5-7% in student enrollments [2]. Traditionally designed in a horizontal, dispersed fashion, schools are meant to provide space that promotes learning and growth. However, as the population within the city increases, land becomes scarce, creating challenges in fostering an effective learning environment.

Schools are commonly connected by their open spaces of courtyards and fields, which are viewed as essential components of the school environment [3]. These spaces connect different school buildings and foster essential social connections. Due to land scarcity and unplanned urban growth, providing sufficient land for schools is challenging, resulting in the loss of passive learning spaces like playgrounds and creative zones.

To accommodate increasing student populations, classrooms are often placed in multi-storied buildings without considering passive learning spaces, hindering overall student development. Innovative strategies, such as vertical schools, are needed to address this. Vertical schools can integrate outdoor

*Corresponding Author: Nayeem Asif. International Islamic University Malaysia (IIUM), email: nayeem@iium.edu.my

spaces, green roofs, and communal areas within the building, preserving essential elements of traditional school design in a vertical format [4].

Turning this large population into competitive human capital requires the provision of proper learning spaces without compromise. By rethinking the architectural design and incorporating vertical school concepts, Kuala Lumpur can ensure that students have access to both academic and developmental resources necessary for their success [5]. The objective of this study is to propose design strategies for Vertical Schools in Kuala Lumpur by examining case studies of existing vertical schools to develop recommendations for creating conducive and modern learning environments suitable for the 21st century.

URBANIZATION AND CONVENTIONAL SCHOOL DESIGN

The rapid urbanization and population growth in Kuala Lumpur have led to significant challenges, particularly in the realm of education. As cities expand and land becomes increasingly scarce, traditional, horizontally spread school designs are no longer feasible. Wilayah Persekutuan Kuala Lumpur, with a population density of over 1,500 persons per square kilometre [2], is experiencing an acute shortage of space for essential services, including schools. This issue is exacerbated by the complete urbanization of areas like Kuala Lumpur and Putrajaya. Consequently, some schools, such as Sekolah Jalan Batu, Kuala Lumpur, have been demolished to make way for commercial developments, reflecting the pressing need for innovative educational infrastructures [6].

A conducive learning environment is a fundamental right and essential for a child's psychological, physical, and social development. Standard educational spaces, complemented by passive learning areas, are crucial for fostering overall growth. Recent national surveys indicate a troubling trend among Malaysian adolescents aged 13 to 17, with high rates of mental health issues: 18.3% suffer from depression, 39.7% from anxiety, and 9.6% from stress. These figures suggest a direct correlation between the learning environment and students' mental health [7]. The Education Ministry's Healthy Mind Programme (Program Minda Sihat) in 2017 highlighted this issue, with 5,104 students out of 284,516 requiring counselling, and some needing further medical intervention [1].

To address these challenges, this study aims to propose design strategies for Vertical Schools, which can provide a conducive and modern learning environment suitable for the 21st century. Vertical schools utilize smaller land footprints while integrating sustainable and efficient design principles. This includes innovative classroom arrangements, the incorporation of green and open spaces, and seamless vertical circulation, ensuring that the psychological needs of students are met despite spatial constraints.
By examining case studies of existing vertical schools, this research seeks to develop recommendations for the next generation of school designs in Kuala Lumpur. These designs not only respond to the scarcity of land but also aim to enhance the overall educational experience and well-being of students.

Evolution of School Design: Historical and Modern Perspectives

Historically, school design has evolved significantly. Although classrooms were often seen as overly militaristic "small barracks", they became a dominant architectural feature. Schools before the 1870 Act were typically smaller, often consisting of just one room. These classrooms were designed to accommodate around sixty children. Despite Robson's criticisms, his design philosophy prevailed, highlighting the early controversies in school architecture.

Furniture in these schools was basic, often comprising fixed wooden benches and desks, reflecting a rigid, teacher-centred learning environment. However, Robson emphasized the importance of quality manufacture, linking it to children's value of education. Object lessons, central to pedagogy by 1895, included globes, abacuses, slates, and display cabinets with educational items.

In contrast, contemporary school design has shifted towards open or semi-open plan designs, reacting against traditional classrooms that many find disheartening. Modern designs emphasize flexibility and the integration of technology as a facilitator of personalized learning. However, the open plan model presents challenges, such as balancing individualization with managing large groups of children [16].
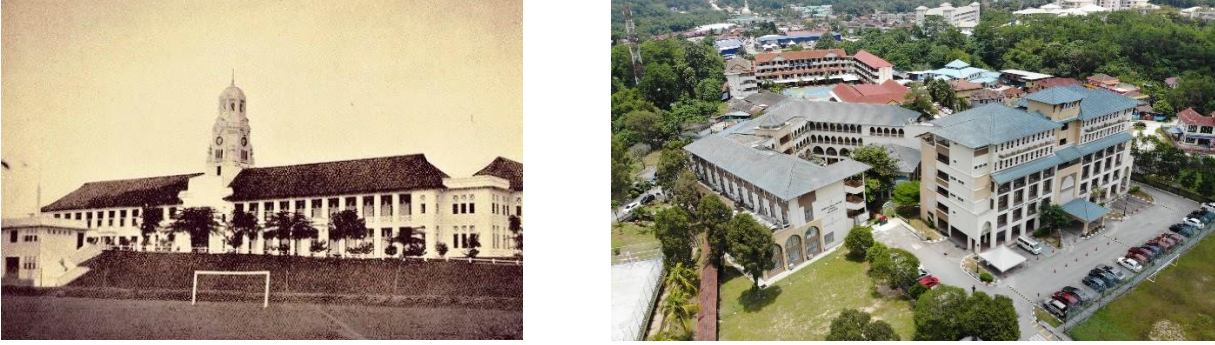
Figure 1. Victoria Institution, the oldest secondary school in Kuala Lumpur (1893) [Left], International Islamic School, a multistoried school in greater Kuala Lumpur Established in 1997 [Right] Source: https://britishmalaya.home.blog and https://says.com/my/lifestyle/international-islamic-school-malaysia-cambridge

A strong contrast in the external form of early and modern schools can be seen in Figure 1, where the early Victorian institution shows a linear layout compared to the vertical blocks with an integrated courtyard of the International Islamic School.

New school designs also explore the relationship between indoor and outdoor environments. Schools like Larmenier and Sacred Heart Primary aim to blur these distinctions, stimulating learning by allowing children to move freely. However, it remains important to understand how children perceive their outdoor spaces and whether these areas should remain free from formal learning to maintain their territorial integrity.

Innovative spatial design for 21st century curriculum

Childhood is a critical stage in the development of human intelligence and character. Mark Dudek, a researcher and architect, describes the unique neurological state of children that enables them to absorb knowledge more quickly during their early years than at any other time in life. He states, "Children's environment must be conceived of as a 'world within a world'; it should be a special place with all the aspects that make the environment safe and a rich landscape for exploration and play". The learning environment, where children spend the majority of their time, is crucial to their growth. Dudek argues that successful learning environments can significantly expand children's experiences during this critical formative stage. He asserts, "The best form of learning takes place within an integrated environment of architecture, technology, and teaching" [8].

Specialists in education, such as Maria Montessori, have also emphasized the role of integrated learning spaces. Montessori's educational philosophy advocates for environments that foster independence, exploration, and hands-on learning, which aligns with Dudek's emphasis on integrated environments [9; 10].

Active learning experiences reinforce the social development and educational growth of children who are engaged with the world around them. The traditional educational system needs re-evaluation and modification to support the changing demands of the 21st century. Data from the National Assessment of Educational Progress (NAEP) reveals a declining trend in the traditional U.S. educational system since the 1950s. The NAEP reports, "80% of high school students graduate in the U.S.; however, only 30% of those graduates can read well enough to understand and use the information found in technical materials, literary essays, historical documents, and college-level texts" [11].

This decline is partially due to the gap between changes in learning needs and the physical environment of educational facilities. The lack of supportive physical environments is alarming to parents and educators, as it is pushing unprepared children into the real world to solve increasingly complex issues. A new approach to educational architecture is needed to support children's learning for the future.

Re-defining the school design strategies

The safety and comfort of schools must be addressed both inside and outside the building to foster an environment conducive to learning and progressive thinking. Achieving a safe and comfortable school environment requires a functioning and supportive physical infrastructure. Despite significant annual investments in school facilities, many traditional school buildings, averaging 40 years old, fall short of meeting 21st-century educational demands. Educational consultant Prakash Nair argues, "This failure is not surprising, because older school buildings were not designed to facilitate modern methods of teaching and learning" [12; 13].

Typical physical classrooms are designed as 'Teacher-Centered Learning' environments, with double-loaded corridors that reinforce isolation from other classes. Conformity is encouraged in a layout where the teacher remains fixed at the front of the room. Lee & Hannafin (2016) assert that environments should mirror the learning they are designed to support. "To be sustainable, we must simultaneously design for greater longevity and increased flexibility of use". Student-Centered Learning design calls for a new approach that provides greater flexibility. An emerging approach to classrooms is based on contingency, meaning conditions are not yet established. Lee & Hannafin (2016) observe, In learning, one formulates thoughts in the mind that did not exist there before. Learning is a creative action [14]. To enhance the quality of learning and the safety of schools, more creative and flexible learning spaces are needed.

The importance of adapting educational spaces to modern needs is underscored by a study highlighting the correlation between school environment and student outcomes. The study found that well-designed learning environments significantly impact student engagement and achievement. Additionally, incorporating elements like natural light, flexible seating, and collaborative spaces can improve student well-being and academic performance [15].

VERTICAL SCHOOL: A NEW APPROACH FOR SMART URBAN EDUCATION

The conventional low-rise, sprawling school structures have been predominant since the 1950s, following a teacher-centred learning approach. However, a new concept is emerging to address the challenges of urban education: The Vertical School Campus. Al-Kodmany and Ali, authors of "The Future of the City: Tall Buildings and Urban Design," propose that vertical campuses can redefine educational spaces in densely populated urban areas, offering cities a unique identity [17]. This concept not only optimizes land use but also emphasizes the significance of education in urban life and economic development.

Integrating vertical schools into urban landscapes can enhance safety for elementary students while reshaping traditional school perceptions and fostering community engagement. By extending after-school activities to the neighbourhood, vertical schools become community hubs, strengthening ties between residents and educational institutions. Recent case studies showcase the successful integration of vertical schools into urban environments, demonstrating their potential to enrich surrounding areas [18].

In addition to addressing spatial constraints, vertical schools offer sustainability benefits crucial for accommodating urban population growth. With the global urban population projected to rise by 72% by 2050, innovative solutions like vertical schools are imperative. The Smart School initiative in Malaysia underscores the importance of adapting educational models to meet evolving needs. Aligning with this initiative, vertical schools can provide sustainable learning environments that support holistic student development. Furthermore, vertical school design promotes cost-effective operations and enhanced learning environments, fostering social interaction and peer learning. Implementation of advanced educational programs, such as Effective Education Programs, can further elevate public school systems within vertical school contexts. As urban centres like Kuala Lumpur continue to expand, research into vertical school design strategies becomes increasingly vital. Embracing innovative educational models, such as vertical schools, will ensure equitable access to quality education for all students, aligning with the objectives of the Smart School initiative in Malaysia.

METHODOLOGY

This study employed a qualitative research approach to assess and validate the relevance of established objectives. To achieve this, several methods were utilized, including preliminary literature review, theoretical studies, and data collection. Information was gathered from three case studies representing different regions, all classified as vertical schools: the School of Arts in Singapore, the Singapore International School in Hong Kong, and the William Jones College Preparatory School in Chicago. These case studies were selected through a sampling process that initially focused on identifying vertical schools within the Southeast Asian context. However, due to the limited availability of such schools in the region, an additional case study from North America was included to provide a standard example of innovative and sustainable vertical school design.

Case Study Selection

The sampling process prioritized identifying vertical schools within the Southeast Asian context, aiming to reflect regional characteristics and challenges. However, the limited availability of vertical schools in this region necessitated broadening the scope to include examples from North America. The addition of William Jones College Preparatory School in Chicago serves as a benchmark for innovative and sustainable vertical school design, offering valuable insights and best practices that can inform the development of similar initiatives in Southeast Asia.

Data collection and analysis

The data for the selected case studies were gathered from online resources, specifically the official websites of the schools, newspaper articles, and architectural blogs highlighting the physical characteristics of the buildings. The collected information was categorized into six distinct features for comparative analysis and synthesis.

The comparative analysis was conducted through tabular examination, facilitating a systematic comparison of architectural elements and student activities across the selected case studies. This approach enabled the identification of best practices and key considerations for optimizing vertical school environments.

Figure 2. School of Arts in Singapore [Left], the Singapore International School in Hong Kong [Middle], and the William Jones College Preparatory School in Chicago [Right]. Source: https://www.e-architect.com/singapore/school-arts-singapore, https://www.tatlerasia.com/profile/singapore-international-school, https://primeraeng.com/work/william-jones-college-preparatory-academy/

FINDINGS AND ANALYSIS

Through an extensive literature review and analysis of precedent and case studies, it becomes evident that Vertical School design offers an optimal spatial and circulatory organization, particularly in high-density settings, thereby fostering improved learning environments for 21st-century students. The selection of international buildings as precedent studies and local buildings as case studies provides a robust foundation for guiding the design of the proposed Vertical School. Key considerations include the general building description, functions, facilities, and architectural significance, all of which are evaluated to determine appropriate design features and architectural characteristics suitable for the Malaysian context.

Synthesizing information from the comparative table allows for the identification and application of viable and feasible design strategies in the proposed Vertical School.

Table 1. Synthesis of study cases

Comparative features	School of Arts, Singapore	Singapore International School, Hong Kong	William Jones Preparatory School, Chicago
Providing Outdoor Spaces	Rooftop "New Ground Level", Sky gardens, Rooftop Sky Park	Rooftop spaces, Science Garden breakout space	Pockets of exterior space, amenities with city view, separate spaces for teachers
	Synthesis: Incorporate rooftop spaces, sky gardens, and exterior pockets for recreational and educational purposes, and utilize city views for amenity areas.		
Circulation	Accessible to public and students, a series of escalators, visually connected strata	Additional lifts and stairs, central stair as a meeting point, a bridge for cross-campus integration	Four large staircases, stairs utilized for functions, central corridor as spine
	Synthesis: Ensure efficient vertical circulation with features like central stairs as meeting points and bridges for integration between floors, and prioritize visually connected spaces.		
Integration of Facilities	N/A	Shared facilities between primary and secondary school, plaza as leisure hotspot	N/A
	Synthesis: Incorporate rooftop spaces, sky gardens, and exterior pockets for recreational and educational purposes, and utilize city views for amenity areas.		
Utilization of Natural Light	N/A	Plaza location for overflow space, highlights for natural light in the corridor	Highlights for natural light in the corridor
	Synthesis: Maximize natural light through design elements like highlights and strategically placed windows to enhance learning environments and reduce energy consumption.		
Flexibility in Room Design	Operable end walls for flexibility, modular classroom design	Plaza used as informal space, classrooms formal, adaptable spaces	Classrooms and hallways struggle with single-purpose design, cells and bells layout
	Synthesis: Design flexible spaces with modular features and adaptable layouts to accommodate diverse learning activities and evolving educational needs.		
Utilization of Vertical Space	5th storey assembly, recreational areas on academic floors, visually connected strata	Rooftop spaces, bridge for cross-campus integration, utilization of exterior pockets	Exterior pockets on most floors, central corridor as spine, minimal additional floors for travel efficiency
	Synthesis: Optimize vertical space utilization by incorporating recreational areas, exterior pockets, and efficient circulation paths to maximize functionality and minimize footprint.		

RECOMMENDATIONS

In designing urban vertical schools, careful consideration of various factors is essential to create dynamic and efficient learning environments. The following recommendations offer insights into key aspects such as providing outdoor spaces, circulation, integration of facilities, utilization of natural light, flexibility in room design, and utilization of vertical space. By aligning with these recommendations, urban vertical schools can optimize their design to promote collaboration, foster community interaction, and enhance student well-being and learning experiences.

Providing Outdoor Spaces

- Common Meet Level Model: Implement a common meet level within the building to serve as a collaborative hub, reducing the need for extensive circulation to access common spaces.
- Open Space: Incorporate large open spaces, such as elevated areas or rooftop gardens, to provide recreational areas, assembly spaces, and overflow areas for events.
- Richer Communities: Foster community interaction by maximizing shared spaces, such as atriums or plaza areas, to promote connectivity and idea exchange among students and staff.

Circulation

- Provide Desirable Path Options: Design multiple circulation paths throughout the building to alleviate congestion and provide efficient access to different areas.
- Fire Stair Utilization: Optimize the use of fire stairs for inter-floor travel within the school while addressing security concerns to ensure safe and accessible vertical circulation.
- Lift Transportation Studies: Conduct studies on lift transportation to optimize efficiency and minimize wait times, ensuring comfortable and timely vertical movement for students and staff.
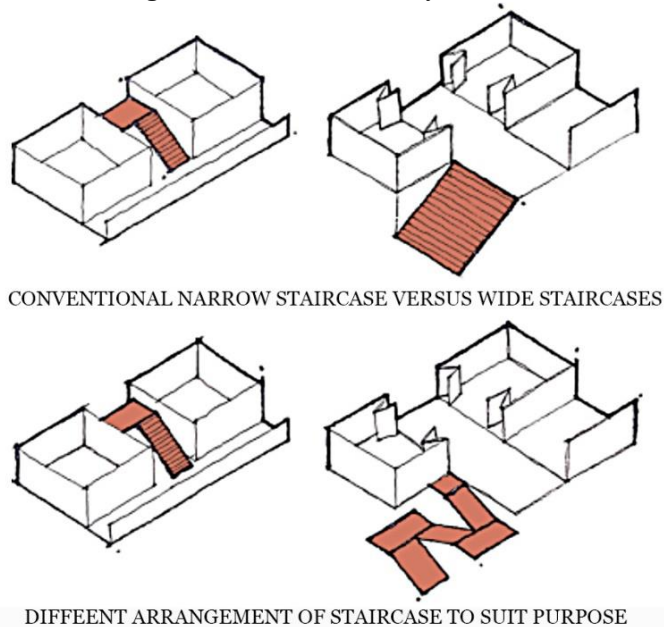

CONVENTIONAL NARROW STAIRCASE VERSUS WIDE STAIRCASES

DIFFEENT ARRANGEMENT OF STAIRCASE TO SUIT PURPOSE

Figure 3. Innovative arrangement of the staircase to suit flexible needs.

Integration of Facilities

- Foster collaboration by integrating facilities and shared spaces between different school levels, promoting cross-campus interaction and community cohesion.
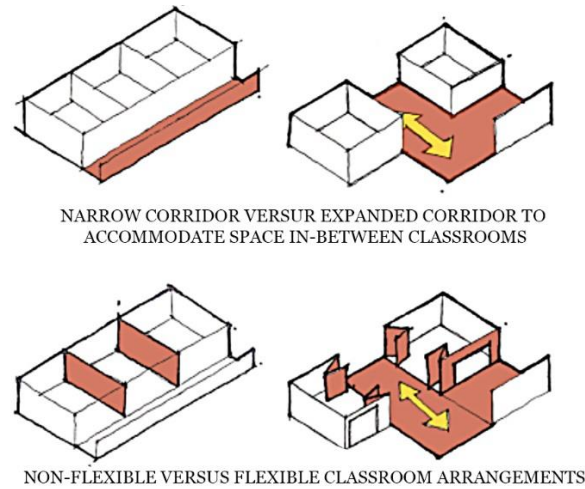
NARROW CORRIDOR VERSUR EXPANDED CORRIDOR TO
ACCOMMODATE SPACE IN-BETWEEN CLASSROOMS

NON-FLEXIBLE VERSUS FLEXIBLE CLASSROOM ARRANGEMENTS

Figure 4. Strategies for integrating classrooms through external spaces.

Utilization of Natural Light

- Maximize natural light through thoughtful design strategies, such as highlights and strategically placed windows, to enhance learning environments and reduce reliance on artificial lighting.

Flexibility in Room Design

- Design flexible learning spaces with modular features and adaptable layouts to accommodate diverse educational activities and evolving student needs.
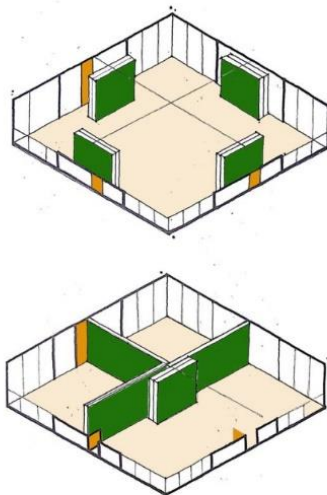

FLEXIBLE INTERIOR PARTITION TO
ACCOMMODATE DIFFERENT CLASS SIZES

Figure 5. Flexible interior partitions

Utilization of Vertical Space

- Scale: Consider the scale of vertical spaces to ensure they are welcoming and comfortable for students of all ages, transitioning from intimate domestic scales to larger collaborative environments.
- Views: Utilize framed views to the outside to enhance orientation and create a sense of openness, reducing the need for excessive signage and aiding navigation across different floors.

CONCLUSION

Children today are the architects of tomorrow's society, shaping the future with their innovative thinking and problem-solving abilities. Investing in their education is investing in the future, and institutions play a pivotal role in providing the necessary platform for their development. In the context of Kuala Lumpur's urban landscape, where population growth and the demand for educational infrastructure are steadily increasing, traditional horizontally spread school designs are no longer feasible due to land scarcity. As a result, the concept of vertical schools emerges as a viable solution to accommodate the growing student population within limited urban spaces. Just as low-rise sprawling campuses reflected the suburban conditions of the past, the densification of city centres in the 21st century calls for innovative high-rise vertical campuses. However, the design of vertical schools must transcend mere utilitarianism and consider elements that enhance the overall educational experience and contribute meaningfully to the urban fabric.

The recommendations proposed in this study emphasize the importance of integrating outdoor spaces, fostering visual and physical connections between floors, and ensuring a secure school environment above publicly accessible shared facilities. By incorporating these design principles, vertical schools have the potential to provide a positive and enriching learning experience while serving as integral components of the city's civic infrastructure. Furthermore, the study underscores the need for ongoing research and development in the field of vertical school architecture to refine design strategies and adapt to evolving educational needs and urban contexts. In essence, vertical schools represent a paradigm shift in educational infrastructure, offering a holistic approach to learning that responds effectively to the challenges of urbanization while nurturing the potential of future generations. These innovative designs can significantly influence urban planning, making educational facilities a central aspect of city development. Additionally, by fostering community engagement, vertical schools can become vibrant social hubs that enhance civic life by incorporating flexible innovative classroom layout, enhanced indoor-outdoor symbiosis and efficient vertical circulation with extended visibility and accessibility.

The limitation of this current study is the lack of primary data on the effectiveness of the existing vertical schools in contrast with their conventional counterparts. Hence, while this study offers valuable insights into vertical school design, further research is required to refine these strategies and adapt to the evolving needs of education and urban environments. Continuous research and development in vertical school architecture are crucial to addressing future challenges and optimizing learning environments for urban students.

REFERENCES

[1] Ministry of Education Malaysia, "Public School Data." 2023. [Online]. Available: https://www.moe.gov.my

[2] Department of Statistics Malaysia, "Education Statistics." 2023. [Online]. Available: https://www.dosm.gov.my

[3] C. Groesbeck, "Creating a Vertical University in an Urban Environment," *CTBUH Journal*, vol. 2013, no. 1, 2013, [Online]. Available: https://global.ctbuh.org/resources/papers/download/263-creating-a-vertical-university-in-an-urban-environment.pdf

[4] E. A. Lomba, J. M. Alves, and I. Cabral, "Systematic Literature Review of Innovative Schools: A Map and a Characterization from Which We Learn," *Educ Sci (Basel)*, vol. 12, no. 10, p. 700, Oct. 2022, doi: 10.3390/educsci12100700.

[5] A. P. Swinburn, "VERTICAL SCHOOL ARCHITECTURE: A Research Manual to Support Best Practice in an Urban Context." 2021. [Online]. Available: http://hdl.handle.net/10453/162101

[6] Plan Selangor Kuala Lumpur, "Urban Development Report." 2020. [Online]. Available: https://www.pskl.gov.my

[7] L. Caprara and C. Caprara, "Effects of virtual learning environments: A scoping review of literature," *Educ Inf Technol (Dordr)*, vol. 27, no. 3, pp. 3683–3722, Apr. 2022, doi: 10.1007/s10639-021-10768-w.

[8] M. Dudek, *Children's Spaces*, 1st ed. Routledge, 2005.

[9] C. R. Rinke, S. J. Gimbel, and S. Haskell, "Opportunities for Inquiry Science in Montessori Classrooms: Learning from a Culture of Interest, Communication, and Explanation," *Res Sci Educ*, vol. 43, no. 4, pp. 1517–1533, Aug. 2013, doi: 10.1007/s11165-012-9319-9.

[10] C. Marshall, "Montessori education: a review of the evidence base," *NPJ Sci Learn*, vol. 2, no. 1, p. 11, Oct. 2017, doi: 10.1038/s41539-017-0012-7.

[11] O. V. Pavlov and E. Katsamakas, "Will colleges survive the storm of declining enrollments? A computational model," *PLoS One*, vol. 15, no. 8, p. e0236872, Aug. 2020, doi: 10.1371/journal.pone.0236872.

[12] P. Cardellino and C. Deed, "Interactions between Design Innovation and Educational Change in Non-Western Schools," *Buildings*, vol. 14, no. 3, p. 716, Mar. 2024, doi: 10.3390/buildings14030716.

[13] Y. Hod, "Future Learning Spaces in Schools: Concepts and Designs from the Learning Sciences," *J Form Des Learn*, vol. 1, no. 2, pp. 99–109, Dec. 2017, doi: 10.1007/s41686-017-0008-y.

[14] E. Lee and M. J. Hannafin, "A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it," *Educational Technology Research and Development*, vol. 64, no. 4, pp. 707–734, Aug. 2016, doi: 10.1007/s11423-015-9422-5.

[15] G. R. Sturrock and D. B. Zandvliet, "Citizenship Outcomes and Place-Based Learning Environments in an Integrated Environmental Studies Program," *Educ Sci (Basel)*, vol. 13, no. 3, p. 292, Mar. 2023, doi: 10.3390/educsci13030292.

[16] N. Gislason, "Building Paradigms: Major Transformations in School Architecture (1798-2009)," *Alberta Journal of Educational Research*, vol. 55, pp. 230–248, 2009, [Online]. Available: https://api.semanticscholar.org/CorpusID:142777643

[17] K. Al-Kodmany and M. Ali, *The Future of the City: Tall Buildings and Urban Design*. Southampton: WIT Press, 2013.

[18] S. Truong, M. Singh, C. Reid, T. Gray, and K. Ward, "Vertical schooling and learning transformations in curriculum research: points and counterpoints in outdoor education and sustainability," *Curriculum Perspectives*, vol. 38, no. 2, pp. 181–186, 2018, doi: 10.1007/s41297-018-0053-y.