

Children's experiences of nature in primary school environments: Contextual influences and Child-Nature-Distance ranges

Case studies in Glasgow, Scotland and Ho Chi Minh City, Vietnam

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ABSTRACT (150-250)

The aim of this study is to measure the extent of children's direct experiences of nature within primary school environments, in relation to contextual differences according to urban, social, and pedagogical aspects. In order to achieve this, we have identified primary schools in Glasgow and Ho Chi Minh City as case studies, allowing the collection of information provided by parents of children studying in six investigated schools, and demonstrating the application of the 'Child-Nature-Distance' methodology. The results indicate: - a global trend in declined natural experiences of children across different social contexts; - educational approaches and urban environments importantly dominate the opportunities for children to be in contact with nature in both living and studying environments. In primary school spaces (indoor and outdoor), findings also indicate that children's multi-sensorial natural experiences are significantly influenced by factors relating to a school's neighbourhood areas, its built environment master planning, architectural features, and its interior design. These findings have decisive implications for the decision-making process involved in primary school architecture, and an enhanced ability to (re)connect children and nature.

Key words: Primary school architecture, Sensorial natural experiences, Spatial environments, Natural environment, Comparative study

1 INTRODUCTION

The evidence of wide-ranging research reveals that playing and learning within natural environments plays a fundamental role in supporting children's health and growth. During the initial developmental stages of a child, a strong connection with nature, and exposure to the natural environment, not only supports children's well-being [1, 2] but in a wider sense lays the groundwork of a sustainable future for society [3, 4]. Research evidence on the importance of nature in children's environments reveals an imperative to maintain and strengthen the child's natural connections within educational contexts where children spend more time than any other place (with the exception of their home). However, children are currently confronted with the challenges of limited access to nature in these contexts. Increasing rates of population growth and urbanisation in many parts of the world, have resulted in reduced opportunities for exposure to the natural environment and have exacerbated a disconnection between children and nature. In 2018, 23% of the world population lived in cities of at least 1 million inhabitants, and the United Nations' 'World Urbanisation Prospects' indicate that rate of growth has increased in both size and number of cities, particularly in the less developed regions [5]. Green infrastructures surrounding school environments, are therefore being negatively impacted both in terms of size and in the prevalent diversity of natural features. These changes cause differences in neighbouring school sites within urban configurations, for example, in cities, in the countryside, in high-density areas, or in wilderness areas. Such changes result in substantial differences in the physical-natural environments which alter the relationship between children and nature. They cause pervasive environmental problems (such as air pollution, contamination of water and soil). A lack of green areas or nature reserves makes it more difficult for children to affiliate, or identify, with degraded natural environments. Furthermore, an increasing amount of time spent indoors, an expanding interest in technical gadgetry, and growing parental concerns about children's safety present complex social factors that affect children's outdoor time [8, 9]. Such social trends diminish children's natural experiences and have a negative impact on their affinity to nature [8]. This involves a psychological phenomenon recognised by Kahn Jr [9, p. 113], as "environmental generational amnesia" where "with each ensuing generation, the amount of environmental degradation increases, but each generation in its youth takes that degraded condition as the non-degraded condition as the normal experience". This highlights the importance of providing opportunities for enhanced experiences of nature in early childhood as a wider strategy for promoting more sustainable futures.

Recognising this importance, new approaches to the design of educational buildings and related landscapes have been suggested in order to enhance children's direct contact with the natural world [10]. Among the challenges of contemporary primary school architecture, finding appropriate ways to bring natural environments closer to children within the scope of rapid urbanization, while addressing the problem of a degraded quality in local natural settings has emerged as an important societal responsibility. School environments need to be organized and structured to provide children with opportunities to learn and understand the intrinsic values of nature. Similarly, the decision-making process for the design of new schools, and for the refurbishment of current schools, needs to incorporate methods that enhance pupils' direct exposure to the natural world.

In this study, we have two main objectives: firstly, to compare the contextual variables as the major factor altering the child-nature relationship within school environments. This relationship is intensively influenced not only by the urban fabric but also by other characteristics such as social forces, educational philosophy, and pedagogical approaches that are principal factors in the decision-making of the setting and designing educational environments. Here, we have used multiple case studies to explore significant patterns within and across contextual cases. Beyond the physical features of the primary schools studied, the pupils' distributions, including living environments, types and frequencies of off-school weekend activities, and preferred sources of natural knowledge, were collected through parents' surveys. This is to examine the differences of connectivity with nature between pupils across case studies and to explore the relationship between features of main-users and school contexts. Secondly, we broadly applied the Child-Nature-Distance methodology to demonstrate the connection between naturalness values and spatial environmental qualities with case studies in Glasgow, Scotland [11] into Ho Chi Minh City primary schools and compare the impacts of urban fabrics and spatial settings with different contextual conditions. This provides an in-depth understanding of associations between children's multiple layers of sensory modalities with particular attributes of the spatial environment within schools and determines the level of naturalness that children experience, in both internal and external spaces.

To accomplish these objectives, a summary of how primary school architecture has evolved and has varied across urban-social-educational contexts and physical settings is briefly reviewed to identify factors that influence the child-nature connection. The particular contextual conditions of Glasgow and Ho Chi Minh City are then subsequently examined. Next, the material and method section describes the research design, the criteria of school selection, the data collection process, and the methods of analysis. In the results section, each school context, and the distinctive spatial and natural environments of the school, including location, master planning, classroom and playground settings are discussed to understand how children study, play, and interact with nature within these places. The distinctive features of pupils who are main-users of classrooms and playgrounds investigated are examined to inform the measurement of pupils' visual and non-visual natural experiences within the studied spaces. Lastly, the findings are synthesised, and the implications, potential contributions, and research limitations are discussed.

2 LITERATURE REVIEW

Focusing on architecture research in primary school design, we firstly explore relative factors within primary school environments and their consequences to the connected intensity between children and natural environments. Then, we present the contextual backgrounds of an urban environment, climate, and primary education for an overview of a natural environment that children of two cities experience within their urban environments.

Children's direct natural experiences within primary school environments

a. The school site: location and local feature

The opening consideration is the impacts of urban fabrics on where a school is located. Previous studies have examined the urban contextual conditions in different distance ranges around schools as the key predictors. For example, the greenness within and surrounding school boundaries positively correlated with children's academic performance [12], stress declined caused by having nothing to do [13], mental health improvement [14], and increased empathy and concern for nature [15] which have lasting effects throughout their lives. Having a closer proximity between the school site and the urban green spaces provides more positive benefits that children acquire through daily direct experiences both for educational and physical activities. When a wilderness area appears in the school's spatial environment and daily curriculum, it provides a pivotal opportunity for students to have direct experiences with natural processes, local species, and habitats [16]. Additionally, an extensive level of children's exposure to nature is also related to nature diversity at the local and regional extent. For example, children in regions where nature changes seasonally or has higher nature richness could have more experiences with various natural elements and stimuli in school sites than others [17]. Moreover, the weather variations also impact the duration of children's outdoor activities due to thermal comfort, especially during winter in cold regions [18] and during summer in hot places [19]. The frequency and quality of children's exposure to nature at schools varied across localities and seasons. Understanding these effects, appropriate school spaces need to be questioned to foster children with daily direct experiences with natural environments in correspondence to season and weather variations.

b. Outdoor environments – Playgrounds

A school playground is considered the main space for children's physical, emotional, cognitive, and social development. To them, it is the place for rest, recreation, play, sports, applying knowledge, extending their classroom experiences, and interacting socially. Researchers across a range of disciplines have proven that children who attend schools with naturalized schoolyards enjoy multiple advantages. Specifically, students attending these greener school grounds benefit from a diversity of play opportunities within safer and friendlier outdoor environments and an enhanced physical activity and motor development [20]. Besides affording recreational activities as a common conception, nature lends itself to many of the same activities that mostly take place in classrooms. The direct contacts with outdoor natural objects and stimuli evoke students' attraction and attention; following this, they could observe, have sensory stimulation, evolve emotional affective and behaviours within the classroom environments [21]. The naturalized school environments, in a broadened aspect, contribute to the re-establishment of natural habitats that existed prior to barren and artificial surfacing schoolyards. Despite the potential importance of nature in school grounds that have been pointed out, many current school

grounds are in conditions of barren, hard, unimaginative and natural shortage. Restoration approaches of school playground naturalizing, therefore, should be practically developed by improving the overall structure and function of total landscapes for natural (re)connection targets.

c. Indoor environments – Classrooms

Classrooms play a role in influencing students' learning and academic performance. Evidence from previous studies has indicated that contact with nature within built environments, even if only visually, is beneficial for humans. Having visual access to nature is known to be beneficial to people across a wide range of healthcare and physical well-being contexts. In educational environments, window views with green landscapes and indoor natural features are subjectively important to students [22]. However, there is a lack of explorations of non-visual connections with nature, such as hearing, smelling, touching, and tasting stimulation in classroom environments. Future studies should also include children's experiences with outdoor nature, instead of being limited to views of trees only, through both visual and non-visual senses within classrooms. Moreover, research to date has targeted high school and university students rather than primary school children who are the main target group for environmental education and classroom interventions with rich and sensorial experiences with nature.

Studies reviewed here have addressed the contributions of nearby natural environments and within school sites, and how these aspects impact students' achievement, behaviours, and well-being. For this reason, the structure of school environments needs to provide children opportunities to be in nature, to learn and understand the intrinsic values of nature. There is a need for more evidence for understanding the effectiveness and impact of spatial and non-spatial features [23] on the relationship between children and nature to successfully foster children's sensorial experience of nature at schools. These are insightful advances to promote approaches of sustainable designs for education architecture.

The context of Glasgow City, Scotland, UK

a. Urban environmental contexts

Glasgow City is the largest city in Scotland, UK, with a population of approximately 635,000 [24]. The average urban green space area was around 154 sqm/person; among greenspace types, the private garden was the highest proportion for 41% while public parks and natural/semi-natural greenspaces accounted for 13% and 12% of all greenspace, respectively [25]. Due to a high range of natural spaces, around 40% of the population could visit nearby green spaces within 5 minutes, and they also more likely to visit more often than those living further away [26]. Glasgow is famous for having accessible green areas that offer many social and environmental benefits. The quality of these open green spaces, especially for children's outdoor activities, has been an important consideration of the Scottish government who are examining levels of use and the benefits derived.

b. Climate context

Glasgow has a temperate oceanic climate with rain and wind for most of the year. The average maximum temperatures in the warmest months (July and August) are approximately 19°C during the days and 11.4°C at night. Meanwhile, the coldest months last from December to January with daily and nightly temperatures of approximately 6°C and 1°C, respectively. Climate change also affects Glasgow City, and the average temperature could rise at least a couple of degrees by the 2050s [27]. The predicted scenarios are urban heat islands and sub-surface flooding in urban areas as negative outcomes of heatwave events, the current rise in temperature, rainfall, and the rising sea level in Glasgow City. Furthermore, the features of old buildings with the purpose to confront the extreme cold temperatures in winter seasons seem unprepared for the temperature rise in summer months.

c. The context of primary schools

Scottish children usually spend seven stages from Primary 1 (P1) to Primary 7 (P7). Besides public schools of the state-funded system, independent schools (or also called private schools) are operating with their private fund. They also need to register with the Scottish Ministers. According to the statistic report in 2019, the total number of primary schools in Glasgow City was 2,667; among them, there were only 14 independent schools [28]. The Curriculum for Excellence (CfE), introduced by Scottish education in 2010, aims to provide knowledge, essential skills, and characteristics for life in the 21st century for children and young people aged 3-17.

In terms of school architectural setting, the Building Bulletin 103 for mainstream school design specified that the school site area, outdoor playground area, and the classroom size area per student are 33.3-42 sqm, 25-30 sqm, and 1.7 sqm, respectively [29]. Additionally, following the framework of CfE, the school design must respond to innovative approaches which engage effective learning and teaching. Green and outdoor spaces within school sites are important factors for children's outdoor activities, including formal and informal studying and playing as these approaches foster children's health, well-being, motivation, and environmental responsibilities towards communities and nature. To respond effectively to climate change, school planning should be 'greener, more sustainable, and environmentally efficient' as suggested by COSLA and The Scottish Government in 'Building Better Schools: Investing in Scotland's Future' in 2009. These strategies indicated that the planning and design of primary schools were put in an extremely essential position to deliver sustainable education and development for Glaswegian children.

The context of Ho Chi Minh City, Vietnam

a. Urban environmental contexts

Ho Chi Minh City (HCMC) is the largest city in Vietnam. It has developed rapidly over the last few decades and has become the nation's financial capital as it keeps attracting talents from across the country. In 2019, the average population of HCMC reached over 9 million with 79% people living in urban areas, an increase of 2.2% and 1.7% over 2018, respectively [30]. The drastic urbanization of HCMC is an outcome of economic development and rapid population growth. Its population was approximately 8 million and an average population density was 4.292 people per square kilometre in 2019 [31]. Current challenges of urban development of HCMC are urban sprawl and climate change impacts [32], for example, increased urban heat island effect and pollutions of water, air, and the environment. Furthermore, the rapid urbanization process with the growth of both planned and informal expansions has resulted in increasing degradation of natural areas, especially in the central districts where the green space was significantly replaced by urban infrastructures much more than in outer districts [33]. The average urban green space of HCMC per citizen in 2017 was 32.4 sqm [33] and the park area per inhabitant was significantly low with only 0.22 sqm. Additionally, the size and quality of new urban neighbourhood parks are not appropriately assessable for children under 15 years old [34]. These urban issues of HCMC have significantly influenced children's daily lives and the child-nature connection in particular. The increasing temperatures caused by urban heat islands [33] and intensive use of air conditioning [35] are threatening remarks to public health, especially urban children who have been spending less time outdoor than indoor environments. This issue leads to the disconnection between the child and nature outdoors as well as their inclinations for non-natural environments in their daily lives. Along with the urban development progress and climate change, urban schools in HCMC have been negatively affected in both school size, outdoor and indoor environmental quality.

b. Climate context

HCMC belongs to the tropical savanna climate zone, the climate is usually hot all year round due to the considerable effect of solar radiation and also specifies with two distinct seasons. The dry season begins from November to April and the rainy season lasts from May to October when the rainfall accounts for approximately 90% of the total rainfall during the year. The temperatures of the dry season are around 26-28°C in the mornings and 32-34°C in the afternoons, however, the absolute maximum temperatures can rise to 40°C.

The effects of high solar radiation, progressive urban heat islands, and entailed cooling demands are major factors in considerations of designing urban and buildings for human's thermal comfort satisfaction. Orienting buildings according to the main wind direction, providing shading, and controlling openings of buildings are some appropriate design solutions to improve indoor environmental quality with natural ventilation and daylighting, including primary school buildings. For outdoor environments, it is important to consider children's activities and usage of spaces under the impacts of high solar radiation and sun hours during the day. This is because the outdoor temperature exceeds the temperature threshold of human thermal comfort which could cause heat-related illnesses.

c. The context of primary schools

According to the Vietnamese educational system, the public (mainstream) primary school comprises five grades for children from 6 to 11 years old. Besides the progressing toward a complete universal general education that aims to provide education to every primary-school-age child, the Ministry of Education and Training (MoET) of Vietnam enacted a national standard for public and non-public primary schools to build on the quality of teaching and learning activities [36]. MoET regulated that the number of students in each class must be no more than 35 [36]. However, the figures of HCMC schools in 2019 were higher than this standard with an average of 40 pupils per class. This suggests that the current situation in public primary classes in HCMC was overcrowding, and thus, caused negative effects on the quality of indoor environments for children's studying activities. An insufficient space could induce discomfort, limit the types and flexibilities of students' activities within their classrooms.

In terms of primary school architecture, urban school site area and the classroom size area per student have to be no less than 6 sqm and 1.25 sqm, respectively [37]. The recommendation is that indoor environments try to exploit natural ventilation and daylighting for students' studying comforts. However, since the negative effects of urban heat island and requests of high-income parents, air conditioner installations into classrooms have been increasingly adopted in many HCMC primary schools. As a consequence of non-natural dependence, besides the above discussed negative influences on children's health, the gap between children and the natural environment has also been further expanding.

Regarding outdoor environments, the regulation merely covers the ratio of a particular area that combines playground and green areas is not less than 40% in the total school site area. Due to a lack of detailed regulations and urban restraints, most urban primary schools in Vietnam and HCMC had only hard playground areas for multi-purpose. Meanwhile, green spaces or natural environments have been completely overlooking. These practical contexts of HCMC reveal that the scales and quality of schools, including built and natural environments, are diminished, and urban children are losing their connection with nature in all temporal and spatial scales of daily life. Furthermore, children have increasingly depended on non-natural conditions while natural experiences for children within their schools have received scant attention.

The above information system has introduced various issues relating to the connection between children and nature in Glasgow City and HCMC, including the contexts of urban environments, climate, and educational environments of primary schools. To summarize, the key issues which need to be considered in evaluations of child-nature connections are the following:

- Specified by much higher population density ranges both in the inner core and new outer districts than Glasgow City, it appears that children of HCMC intensively lack natural areas and opportunities to visit green spaces within every aspect of their living environments.
- HCMC citizens are more severely affected by urbanization processes and climate changes than Glaswegian citizens. These problems provoke more increasingly disconnections between the children and nature within urban and school environments in HCMC.
- The scales of urban primary school environments in HCMC, both built and natural areas, are diminished in comparison to primary schools in Glasgow. For this reason, in HCMC schools, the settings of classroom are usually tidy and lack flexibility due to size constraints while green spaces or natural environments had been completely overlooked within school playground areas. On the contrary, with more advantages of urban environments, the financial resources, and updated planning and actions for aims of sustainable development, children of Glasgow schools, especially independent schools, have more opportunities to connect with nature in their daily lives.

These distinct features between Glasgow City and HCMC are important factors that influence the naturalness degrees that children are exposed to through an overall assessment. In order to explore the features of children and particular attributes of the spatial environment within schools, varying across school sites and educational approaches, to determine the level of naturalness that children experience, in both internal and external spaces, we used multiple case studies to explore patterns within and across different contextual cases. In the next section, we will describe the rationale for recruiting these schools, how data are collected, and types of methods.

3 MATERIALS AND METHOD

Study design

The study used a quantitative approach and can be characterized as a case study. It examined the physical and natural settings of classrooms and playgrounds in six different schools in Glasgow and HCMC. Besides, questionnaire surveys were distributed to parents of pupils who are users of investigated classrooms to analyze the social impacts on children's degrees of off-school natural connections.

Description of the case study

In both Glasgow and HCMC, we recruited three primary schools in each city to conduct case studies. We aimed to investigate the ranges of children's visual and non-visual experiences of nature within various indoor and outdoor spaces. The main selection criteria were access permission for the researcher and appropriate features for the research questions. The first selection criterion was for best practice case study schools, limiting external variables, as shown in Table 1. The second criterion demonstrated a distinction in recruiting primary schools between Glasgow and HCMC.

Table 1. Criteria for school selection

Status	School case study criteria	
	Glasgow, Scotland, UK	Ho Chi Minh City, Vietnam
1	The school had to be a primary school;	
2	Schools had to share a similar social and educational condition.	Schools had differences in educational philosophy and pedagogy.
3	Schools had distinct locations within urban settings;	
4	Schools offered differences in spatial configurations and architectural features of classrooms and playgrounds;	
5	Head teacher had to be willing for the school to participate.	

Table 2 provides a summary of the final case study primary schools selected to participate in the research. Regarding Glasgow, the research was to investigate the influences of spatial configurations on the natural experiences of children who belonged to a similar socio-cultural-educational context. Three primary schools of the Glasgow Academy (TGA), including TGA_Kelvinbridge, TGA_Milngavie, and TGA_Newlands, satisfied the entire criteria. This is a private school; thus, the majority of TGA pupils are from higher-income families. The descriptions of these schools and explored classrooms and playgrounds were presented in our previous article [11]. Three TGA's schools' curriculums are based on CfE with a wide-reaching range of co-curricular clubs, specialist lessons, and outdoor learning activities. Especially, TGA students also have many opportunities to experience nature through co-curricular activities and regular learning trips.

Table 2. Features of case study primary schools in Glasgow, Scotland, UK and Ho Chi Minh City, Vietnam

City	School ID	School Type	Location	Area (sqm)
Glasgow	TGA_K	Private school*	High density area of city	19,295
	TGA_M	Private school*	Residential area in the suburb	1,411
	TGA_N	Private school*	Residential area in the suburb	1,050
HCMC	HCMC_TQT	Public school	City centre	2,335
	HCMC_TDP	Private school**	Community–educational area of the new developing district	4,586
	HCMC_TXS	Private school***	Residential area of the new developing district	756

* The Glasgow Academy is a private school within the Scottish education system and the majority of its pupils are from higher-income families residing in and around Glasgow.
 ** This is a private school within the Vietnamese education system; it structures its special educational curriculum with three main pillars: (1) Montessori method, (2) physical development which provides sport and adventurous activities to its students, and (3) spiritual development. Participants came from middle to high-income families.
 *** This is a home school belonging to Steiner educational system.

In HCMC, because this stage was linked with broader socio-educational factors, the researcher required a diverse contextual consideration. Thus, information on primary schools that differed in educational settings was collected, including systems of mainstream and private schools. Offering differences in socio-educational contexts, distinction locations in the urban setting of HCMC, and architectural features of schools' sites and buildings, three selected primary schools in HCMC were appropriate to investigate in this study (Figure 1).

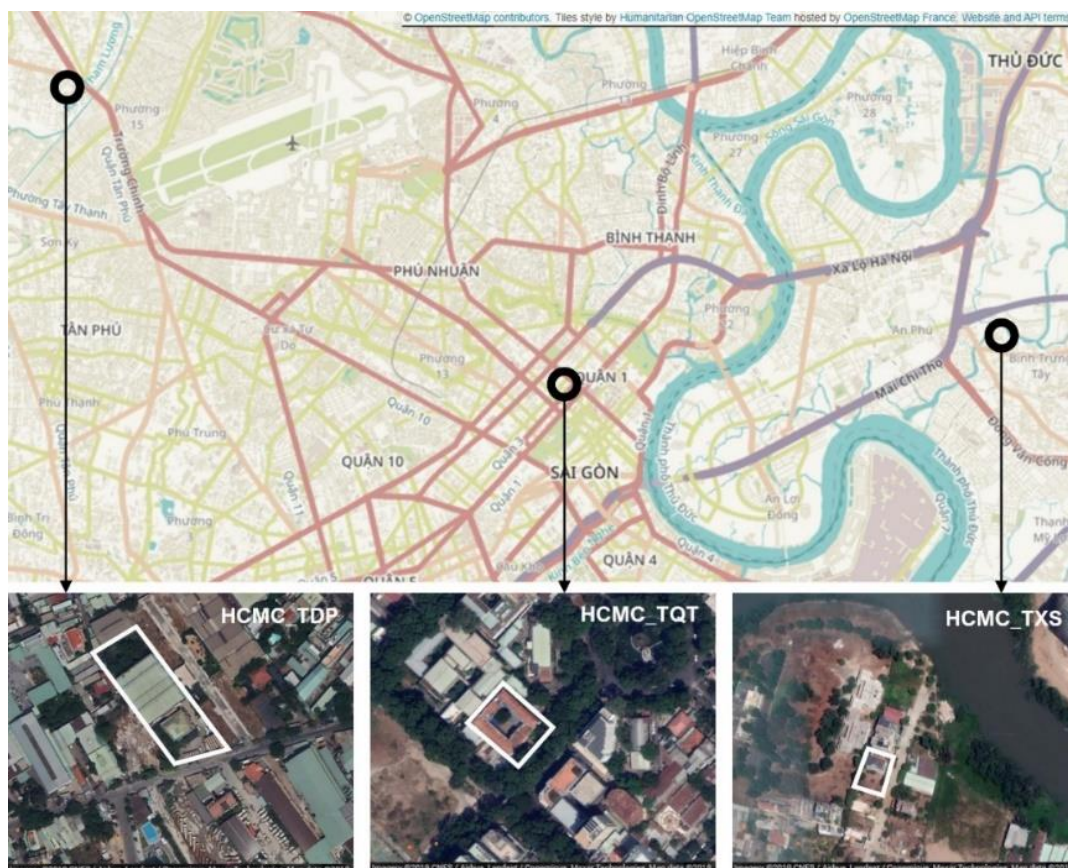


Figure 1. The locations of three primary schools in HCMC. Sources: Source of the left map: ©OpenStreetMap; Source of the right maps: ©Google Maps; Note: white shapes represent the boundaries of school sites

Particularly, the public primary school HCMC_TQT in the city central district is under the management of the People’s Committee of District 3 in HCMC (Figure 2). By satisfying the specific requirements relating to the development and maintenance of education quality and ethical standards, this school received the certification of the National Standard School Level 1 in 2016 by the Ministry of Education and Training. Like the majority of conventional schools in Vietnam, the school’s main building in rectangle shape creates a central playground area for multi-functional outdoor activities. This layout principle is very common in Vietnamese architecture for climate and weather adaptation. In 1997, the school building was built entirely new with 21 classrooms, with approximately 35 pupils per class on average. In this school, the researcher selected the typical classroom (HCMC_TQT_I) which there are two doors along the corridor and two windows opposite each classroom, doors, and windows have simple glazing and steel frame. Through approvals of the headteacher, children of three different grades ranging from 9 to 11 years old were delivered the consent and survey papers.

Tue Duc Pathway is a private school in the community-educational designated area of the developing district - District 12 (Figure 3). This school has a special educational approach built on three main pillars: (1) develops children's intelligence and creativity following the Montessori method, (2) enhances children's physical development and social skills through many sports and adventurous activities, and (3) nurtures children's spiritual development. The school playground and main building were renovation works from an industrial building type; thus, the layout was completely different from principal school design as HCMC_TQT. The number of pupils enrolled per class is smaller than in public schools and varies from one year to another. All pupils always study in air-conditioner and artificial lighting conditions because the layout is not appropriate for natural ventilation and lighting. We selected three classrooms (TDP_P3, _P4, and _P5) and the main playground to measure.

Tre Xanh Steiner school locates in a residential area of District 2, a developing district (Figure 4). This home school belongs to the Steiner educational system, in which Waldorf students, especially from 7 to 14 years old – the period which emphasizes establishing a 'healthy moral foundation', are nurtured to be aware of natural beauty and to be in harmony with nature through nature-based settings in classrooms and outdoor activities. There were only 4 classrooms within the house. Two classrooms of students grade 5 (TXS_P5) and grades 4 and 3 (TXS_P4.3) had the same layout while on different floors. Besides, the significant feature of Waldorf classrooms is the "Nature" table exhibits natural elements that reflect the rhythms of the seasons. The school rented three pieces of vacant land which to create three different playground areas for various kinds of pupils' outdoor activities.



Figure 2. HCMC_TQT studied playground areas and classrooms. Source: Author. (a) Studied classrooms and playground areas; (b) The view of main playground from the first floor; (c) the in-between playground area for multi-functional purposes; (d) the left side of playground area at the entrance gate (visitors parking included); (e) the right side of playground area at the entrance gate (parking included).



Figure 3. HCMC_TDP studied playground areas and classrooms. Source: Author. (a) Studied classrooms and playground areas; (b) the artificial-grassed playground area; (c) and (d) the views of playground area and corridor of school building.



Figure 4. HCMC_TXS studied playground areas and two classrooms. Source: Author. (a) Studied classrooms and playground areas; (b) the area for multi-playing activities; (c) the area for children studies outdoor and play, including (d) a vegetable garden; (e) a vegetable garden at the front gate; (f) the sand playground area

Data collection and methods

The data collection progress of these phases included site studies, archival data analyses, and pupils' parents of selective classes through surveys. Firstly, after selecting classrooms for investigation, the research included questionnaire surveys distributed to students and their parents. Parents provided information regarding biological features (age and gender), living environments (accommodation, garden, and pets), children's off-school activities regarding visiting natural environments, and means of children's studying nature. This data was collected to analyse the degrees of having contacts with nature of pupils to figure out the differences and similarities between various features related to the living, playing, and studying environments.

Following this, an investigation of the influences of urban configurations and spatial settings of schools was conducted through an utilization of the methodology for measuring children's visual and non-visual sensory experiences across varying "Child–Nature–Distance" ranges. It was developed with case studies in Glasgow City and presented in our previous publication [11]. In this paper, we continue to apply this method to HCMC case study to compare and then discuss the findings in a broader consideration of spatial and non-spatial features. Thus, the process of site studies and archival data analyses of HCMC case studies to measure the naturalness values of multi-sensorial experiences with nature are repeatedly conducted.

Recommendations Documents

In order to create the land coverage plan, the researcher initially reviewed the documentation of Glasgow and Ho Chi Minh City as follows:

Glasgow, UK

- NLUD 4.4 Land Cover: The UK National Land Use Database: Land Use and Land Cover Classification - Version 4.4 (LandInform Ltd, For Office of the Deputy Prime Minister, February 2006, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/11493/144275.pdf). The NLUD 4.4 Land Cover provides the land cover nomenclature.
- LCM2015: The Land Cover Map 2015 (Version 1.2, 22nd May 2017) provided a parcel-based land cover map for the UK.
- LCS88: The Land Cover of Scotland 1988 (Final Report), The Macaulay Land Use Research Institute, Craugiebuckler Aberdeen AB92QJ, 1993.

Ho Chi Minh City, Vietnam

- Circular 12/2016/TT-BXD: on proposals and design of regional, urban and special purpose zone construction planning (Ministry of Construction, 2016).
- Ho Chi Minh City Urban Planning Information included the Land use plan scale 1/2000 (developed by Department of Planning and Architecture, <https://thongtinquyhoach.hochiminhcity.gov.vn/en>) that provides land use categorized information of plots in 24 districts of HCMC through an online platform.

Ethics

All students' parents and guardians who participated in this study signed the informed consent. The University of Strathclyde Ethics Committee approved this study and signed on 23rd March 2018.

4 RESULTS

Distributions of pupils of case studies

A total of 57 parents' survey forms was collected from teachers in three TGA schools, resulting in a response rate of 76%. Meanwhile, there were 119 fulfilled forms of parents sent back to the researcher in HCMC schools that accounted for 97.5% in total.

a) Biological distributions

The TGA participants consisted of 57 pupils without special needs (50.9% males, 49.1% females) with all children aged between 7 and 12 years ($M_{age} = 9.18$ years, $SD = 1.48$). In HCMC case studies, there were 119 pupils without special needs (47.1% males, 52.9% females) with their ages ranged from 9 to 13 years old ($M_{age} = 10.13$ years, $SD = 0.93$).

b) Living environments

The distributions of participants' living environmental conditions are in Table 3. Among participants, Glaswegian pupils mostly lived in private housing (86%) with their own gardens (94.7%). This figure could be explained by the fact that the majority of TGA pupils are from higher-income families. Whereas, with case studies including both public and private schools, the figures of accommodation typologies were distributed more diversely. Among them, around half of HCMC

respondents lived in private houses smaller than 100sqm (42%) which is the most common dwelling typology in HCMC urban areas. The ratio of having gardens only accounted for 31% of total HCMC participants. The lacking green spaces in HCMC here are the results of the high population density. Besides, the percentage of owning pets of HCMC children was also much lower with only 20%. These figures could show the difference in which HCMC pupils had fewer natural experiences within their living environments than Glaswegian pupils.

Table 3. Distributions of participants' living environmental conditions

Glasgow city participants			HCMC participants		
Accommodation type	Frequency	Percentage	Accommodation type	Frequency	Percentage
Private house	49	86.0	Private house ≤ 100sqm	50	42.0
High-rise flat	1	1.8	Private house > 100sqm	21	17.6
Tenement flat	6	10.5	Low-rise apartment	18	15.1
Others	1	1.8	High-rise apartment	25	21.0
			Others	5	4.2
<i>Home garden</i>			<i>Home garden</i>		
With garden	54	94.7	With garden	38	31.3
Without garden	2	3.5	Without garden	81	68.0
<i>Owned pets at home</i>			<i>Owned pets at home</i>		
With pets	22	38.6	With pets	24	20.2
Without pets	33	57.9	Without pets	95	79.8
Total responses	57		Total responses	119	

c) Off-school natural experiences

Through parents' surveys, participants in both cities showed they more often stayed home during weekends than in other places as shown in Table 4. Children in Glasgow had more time spending at nearby parks and sport facilities than those who were living in HCMC. Among HCMC participants, the frequencies of children visiting green areas also varied according to the schools. Particularly, children of private schools, especially Waldorf school, visited parks and wilderness areas more frequently than those of public school HCMC_TQT and HCMC_TDP.

Table 4. Means of frequencies participants spend during weekends at various places

School ID	Homesite	Pavements	Nearby parks & playgrounds	Adventure playgrounds	Commercial facilities	Sport facilities	Wild areas
TGA K	4.05	1.56	3.51	2.56	2.12	3.44	2.71
M	4.54	1.92	3.15	2.92	2.46	3.38	3.00
N	4.33	2.67	3.67	3.00	3.00	4.33	3.33
TGA Total	4.18	1.70	3.44	2.67	2.25	3.47	2.81
HCMC TQT	3.00	2.31	2.48	2.57	2.89	2.37	2.00
TDP	3.15	2.65	2.71	2.65	2.79	2.09	1.88
TXS	3.54	2.46	3.43	2.77	1.92	2.38	2.79
HCMC Total	3.11	2.43	2.66	2.62	2.75	2.29	2.06

In regards to studying nature at home Table 5, television and internet gadgets were the most common sources in cases of HCMC as fewer opportunities were available for outdoor activities. On the contrary, children in Glasgow received information from many other different manners beyond technical gadgets (e.g. family members, outdoor trips, and books). Among groups, students of HCMC_TXS also significantly had the highest percentages for learning nature through outdoor trips and less technical gadgets in comparison to others. This difference could be explained by the role of Waldorf educational philosophy which Waldorf parents are encouraged to follow for every aspect of the child's day at home.

Table 5. Distributed percentages of resource categories that children study on Nature at home

School ID	Family	Books	TV. Internet	Outdoor events	Others
TGA K	78.0	63.4	75.6	82.9	2.4
M	60.0	50.0	55.0	40.0	5.0
N	15.4	23.1	15.4	15.4	0.0
TGA Total	62.3	52.0	58.7	58.7	2.7
HCMC TQT	47.1	44.1	82.4	20.6	5.9
TDP	37.8	43.2	64.9	59.5	0.00
TXS	57.1	64.3	7.1	71.4	35.7
HCMC Total	44.3	45.1	66.4	37.7	7.4

These features reflect the current situations of lacking hands-on natural experiences of urban children in HCMC. These considerable shortages could be explained with three reasons: (1) lacking of green spaces surrounding residential areas as well as within inner city due to high dense urbanization, (2) the significant changes in urban lifestyle and nurturing methods of parents who allow children to use and spend more time with technical gadgets, and (3) an increasing focus on off-school advanced courses (for example, learning foreign languages, arts, and advanced skills) that are considered as the further important and necessary aspects for a child's intellectual development. Moreover, the difference in HCMC children's off-school natural experiences are consequences of the educational philosophy that parents selected for children, especially in the case of Waldorf members.

Naturalness values of Visual and Non-Visual Sensorial Experiences of Nature

a) Three case studies of Glasgow, Scotland

The detailed results of case studies in Glasgow were presented and discussed in To and Grierson [11]. In this paper, overall results were shown in Figure 5 and Figure 6 to conveniently compare to case studies of HCMC.

b) Three case studies of HCMC

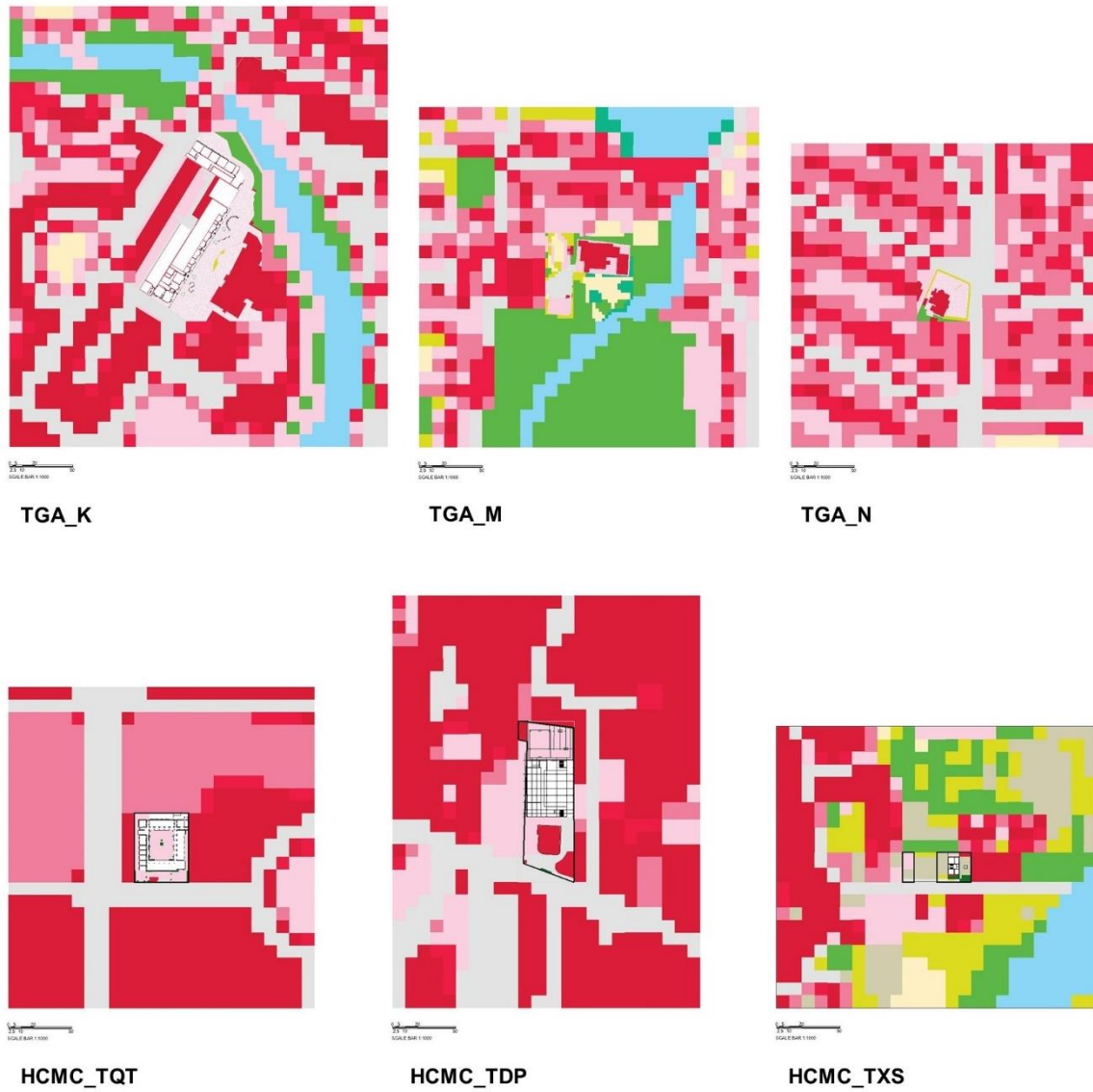
In Figure 5, it is clear that six similar scaled land cover plans show distinct variations in the school areas and the diversity of the schools' surrounding environments. Overall, TGA_Kelvinbridge heads for the largest total covering permeable area while TGA_Newlands and HCMC_TXS do the opposite. However, HCMC_TXS heads for the figures of total natural area coverage and the ratio of the natural environment among HCMC case studies, and thus, its values regarding naturalness of non-visual senses are only slightly lower than those of TGA_Milngavie which have the greatest benefits of the surrounded wilderness area and low-density residential area. Furthermore, these schools also have a significant feature of natural diversity compared to other sites. In contrast, sites of HCMC_TQT and HCMC_TDP have the lowest values both in the permeable natural area and the naturalness of non-visual senses.

Following this, as shown in Figure 6, the greater urban density of HCMC, especially in the city centre and highly developing areas, is reflected by disparities of naturalness values between studied schools in Glasgow and HCMC. Except for the Waldorf school site, which is located in an area where still remains surrounding natural environments due to its undeveloped status, reaches relative naturalness like TGA school sites, children of HCMC_TQT and HCMC_TDP have much fewer natural experiences than Glaswegian pupils in total and particular sensorial experiences (see Figure 6.(a)).

Regarding the external spaces of three HCMC schools, it can be inferred that the three playgrounds of Waldorf school offer the most substantial multi-sensorial natural environment although it has the smallest school site, especially the sand playground area TXS_O.1 where accounts for the highest values of natural vision. Substantially deficient in natural connections appear in both the HCMC_TQT and HCMC_TDP playgrounds. Particularly, the main playground TDP_O.4 has the remarkably higher in the figure of looking produces its increased total values of sensorial-dynamics in comparison with playgrounds of the public school HCMC_TQT where there are slightly higher regarding touch, taste, hear, and smell. These figures demonstrate the naturalness of non-visual senses is significantly dependent on the proportions of nature and visible area scale, whereas the directional factor and surrounded built objects (as visual barriers) play the main role in the naturalness of vision.

In HCMC school sites, except the Waldorf school, which was occupied in the residential building, other schools have in-between spaces that provide sufficient connection between indoors and outdoors. This architectural feature, which is a common style developed to adapt to the tropical climate condition, is also illustrated in the results. They have similar naturalness figures of touch, hear, smell, and taste while have lower regarding looking than outdoor viewpoints. Thus, these spaces even though offer reduced naturalness to children than complete outdoor; their values are much greater than when children are in classrooms.

When considering internal spaces, they have lower values of VN in comparison with TGA studied classrooms because of both lower the natural values of senses and permeability values of visibility (PV). The former reason is related to higher density in HCMC urban environments, and the latter is in connection with insufficient scales of openings. The classrooms of Waldorf school exhibit the highest values of nature for all five sensorial modalities; especially, the grade 5 room accounts for greater values of naturalness of all five senses due to larger permeability areas. Children in classes of HCMC_TQT and HCMC_TDP cases have a less direct connection with nature in terms of visual and non-visual senses. The principal reason for this difference lies in both the greater values of permeability and the naturalness of sense. Although the classroom's windows of TQT are appropriately installed that help to provide greater and slightly equal visual areas of viewpoints as well as a better connection for non-visual senses, their natural values are limited by unfavourable impacts of urban configuration. For the same reason, much fewer natural connection also occurs in both three classrooms of TDP. Especially, the TDP_3, children disconnected completely from nature due to unfavourable location and openings were closed during the observation period as their normal operation. In contrast, although TDP_4 and TDP_5 classrooms have windows, the size and positions of windows decrease the naturalness of visual connection. Thus, these results reflect the influences of architectural features of opening installations as well as the built-natural environment of an urban context.



Figures of the naturalness of non-visual senses

	Total Permeable Area (sqm)	Built environments		Natural environments		Naturalness
		Total area (sqm)	Noto/ Noh/ Nota/ Nosm	Total area (sqm)	Noto/ Noh/ Nota/ Nosm	
High intensity						
Medium intensity						
Low intensity						
Open space						
Permanent made surfaces						
Barren						
Grass						
Woodland						
Shrub						
Heathland and bog						
Water						
School ID						
TGA_K	103195.8	84548.9	0.125	18647.0	0.099	0.224
TGA_M	72198.9	41671.2	0.113	30527.8	0.234	0.348
TGA_N	58379.9	57576.7	0.182	803.2	0.007	0.189
HCMC_TQT	61914.4	61914.4	0.086	0.0	0.000	0.086
HCMC_TDP	78258.5	78203.0	0.068	55.5	0.001	0.069
HCMC_TXS	56587.6	24247.4	0.052	32340.1	0.257	0.309

Figure 5. The land coverage plans and figures of Naturalness of non-visual senses of studied schools.



Figure 6. The naturalness value of visual and non-visual senses within the playground areas (a) and the classrooms (b) of three TGA and three HCMC primary schools

5 FINDINGS AND IMPLICATIONS

Firstly, regarding social impacts on the child-nature connections between two different cities, with all issues presented above, there are important concerns according to participants' living environments and off-school activities relating to the levels of children's experiences of nature. The primary issue is the negative impacts of lower green space ratios and constrained urban primary school environments, participants of HCMC case studies had fewer opportunities to be in contact with nature in both living and studying environments than those of Glaswegian studied schools. Secondly, although the Glaswegian students had a higher frequency of visiting natural environments than those of HCMC cases, the results of parents' surveys in two cities illustrated that students more often stayed home whereas visiting outdoor green spaces and/or wilderness areas had received little concerns during off-school times. Children of both cities were also spending more time indoors with higher utilisation of technical gadgets to get knowledge of nature rather than obtaining hands-on experiences with the diverse natural environments. Thus, the global trend regarding a declination of natural experiences appears to be currently underway within different social contexts. For these reasons, offering an experience of nature within educational environments where children spend more time than any other place (except for their homes) has emerged as an important societal responsibility.

Moving to the investigations of physical and natural settings of case studies through measurements of visual and non-visual natural experiences, generally, the results have revealed the features of urban configuration significantly influence the Child-Nature-Distance and attributes of natural environments while features of architecture govern the permeability values of built envelopes that directly act on the relationship between the child and nature within a space. Particularly, features of urban configurations influence the quantitative and quality degrees of children's sensorial experiences of nature within educational environments. For example, the high-density urban environments of HCMC_TQT and HCMC_TDP school sites where natural environments are impoverished lead to lower-level of naturalness and natural diversity for children experience at their schools. Conversely, a wilderness area of TGA_Milngavie, the surrounded green and water landscapes of TGA_Kelvinbridge, and an undeveloped urban area of the Waldorf school in HCMC remarkably provide children richness natural values for visual connections. In these schools, the results also reflect the favourable conditions of nearby nature urban on the non-visual connections within classrooms of TGA_Kelvinbridge_P3 and HCMC_TXS while other classrooms have unfavourable impacts of built urban environments. Specifically, openings at the side confronting with urban traffic or other building tend to be closed to reduce noise and children's distraction for their study whereas classrooms that are located at the natural side could both enhance natural view-fields and non-visual experiences with surrounding nature.

Additionally, the results obtained also suggest that the values of multi-sensorial experience of nature, as they relate to space, significantly depend on particular design characteristics within urban settings, and are impacted by planning decisions on the built environment, and by a variety of architectural elements and interior features. In particular, all sensorial modalities are significantly associated with attributes of nearby natural environments, and both in terms of scale and quality are dependent on the distance ranges of the child's sensorial experience. While the sense of vision is affected by the visibility of envelopes and the observer's positions within the spatial environment, the direct natural connections via the senses of hearing, touching, tasting, and smelling are associated with the connectivity level of envelope features.

Through our findings, including features of urban configuration, school settings, and architectural features, corresponding proposals are developed and shown in Table 6. Improvements in primary school architectural environments can be achieved through a consideration of the distance ranges of a child's sensorial experience and designing with children's visual and nonvisual experiences of nature in mind. The visual connectivity of a classroom can be improved by analysing visible areas of identified view-points, selecting appropriate seating arrangements, identifying specific areas for the teacher, and selecting classroom furniture. In the case of a classroom that lacks direct natural connections due to its location and nearby urban environment, its primary function could be designated to other activities or features, and openings could be renovated. In terms of outdoor spaces for children's restorative experiences, under the impact of distance, landscape reconstructions can be designed to increase the naturalness values within the school's boundary, and areas with the greatest potential for multi-sensorial exposure natural environment can be identified for the pupils' daily activities, such as outdoor classes or interval sections. These spatial decisions at a micro level can directly transform opportunities for children's experience of the natural environment around them with meaningful outcomes.

Table 6. Findings and implications of primary school architecture for visual and non-visual experiences with nature

Findings	Proposals
Features of urban configuration: Child–nature–distance and attributes of natural environments	
<p><i>Visual and non-visual connections are influenced by:</i></p> <ul style="list-style-type: none"> • the built-natural distributions of urban configuration, • the distances of natural sources that verify degrees of natural exposure. 	<p><i>Decision-making process to select appropriate locations for future schools should take these priorities:</i></p> <ul style="list-style-type: none"> • the prosperous natural environments of potential urban areas to offer the richness of natural types and stimuli. • the closest distances of nature and the richness of nature at the doorstep exist nearby and within school sites, the strongest connection with nature children could exposure and experience.

Features of school settings - Outdoor environments

Visual and non-visual connections are influenced by:

- the master planning of the school site and buildings to enhance linkages and minimize visual barriers to natural areas,
- the richness of naturalness of senses.

Decision-making process and design approaches of school architecture should offer:

- an appropriate master plan of the school site and buildings for children's daily activities within the spaces without visual barriers or accessible preventions that decrease naturalness values of vision and other senses.
- the large scale of abundant natural environments within school site to offer children the strongest daily hands-on natural experiences of nature through vision and non-visual senses.

Features of Architecture – Classroom environments

Visual connection is related to:

- the layout of classrooms within the school building and school site in considerations of nearby urban environments,
- features of opening systems, including installed position, size, height, and materials,
- children's seating arrangements or functional areas for children's activities.

Non-visual connections are influenced by:

- the layout of a classroom within the school building and school site in considerations of nearby urban environments,
- features of opening systems, including installed position, size, height, material and "opened-closed" status.

Decision-making process and design approaches of school architecture should consider:

- an appropriate layout within buildings in considerations of nearby urban environments to avoid negative impacts of urban activities (e.g., greater views to built environments, noise, and distractions) and to increase the connections with higher naturalness environments through (that means windows are possibly opened more frequently),
- a priority of natural connections for spaces of children's daily activities. Functional replace for other activities that children do not study and play frequently, or for specific requirements of noise insulations and disconnect with outdoor environments,
- a suitable installation and renovation of opening systems (position, size, height, and materials) to enhance the permeability values and view areas toward natural environments,
- the interior set up of children's study desks and furniture to ensure every child could have views of nature.

6 CONCLUSION

This study, deals with children's experiences of nature in six primary schools under the impacts of physical features and diversified environments in a cross-societal, cultural, and educational context, and confirms the influential agents within the child-nature relationship. The naturalness values of children using their bodies and senses experience within school and off-school environments are the consequence of physical and natural settings that are determined by conditions of urban configurations, societal differences, and philosophies for educating children. In order to develop children's connected with nature, Environmental Education (EE) programmes have set out three main components: education "in", "about", and "for" the environment [38, p. 12] to be implemented in formal education since the 1970s. However, the natural environment is merely referred to as location in the conventional pedagogical principles for the "in" component in real-world conditions that many children from urban areas and low-income classes do not have the opportunities to have complete environmental educational systems. With the aim of fostering pupils' sensorial experiences of nature at schools, this study highlights factors and consequences of different spatial scales and features. Through findings of the repeated using the Child-Nature-Distance methodology, we proposed implications to (re)connect children and nature at their school environments; these urban and architectural approaches offers a contribution for setting out education "in" the environment – nature would be a relational context and a daily resource of children's environmental education [39]. In a broaden prospect in which the child-nature relationship would be increasingly reconnected and schools' naturalness values would be prosperously enhanced, these implications could offer benefits to the sustainable development orientation of society and the quality of urban environments.

In addition, the research provides some directions for future studies. Comparisons of children's experiences of nature within primary school environments in different contextual environments offers a fruitful area for further work. One of our current challenges is to make the Child-Nature-Distance methodology more accessible for practical implications in the decision-making for refurbishing schools and planning for new schools. Particularly, the layers of natural environments are currently measured according to classifications of land coverages with a quantitative aspect only. The issue that was not addressed in this methodology was how different natural types and stimuli contribute to the degrees of children's natural exposure and experiences within a space. Moreover, further experimental investigations are needed to determine if the ranges of naturalness values for particular sensorial connections provide appropriate limits for children. This direction will be an important step in updating school design principles and regulations, and to bridge the gap between research theory and application.

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