University of Strathclyde, Glasgow

Department of Architecture

Children's Experiences of Nature in Primary School Architecture

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

By

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This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Abstract

Nature plays a vital role in the development of children, and direct encounters with nature, experienced through all of a child's senses, form the foundation for their connectedness to nature. While the existing broad body of research into children's connections with nature identifies a societal responsibility to offer experiences of nature within educational environments, in order to further enhance children's sensorial experience of nature at schools, there is a need to provide clear evidence on the effectiveness and impact of related spatial and non-spatial features within these specific environments.

This study focuses on measuring and observing children's visual and non-visual sensorial experiences of nature within primary school spaces in Glasgow, Scotland, and Ho Chi Minh City, Vietnam with the child-centred methodological approaches combining both qualitative and quantitative investigations. The educational environments studied are located within specific urban environmental contexts and climatic conditions, and are aligned with particular educational philosophies. The core purpose of this study is to provide evidence-based arguments that advance the children and nature movement, and address a widening disconnect with nature that has been observed across the world.

The thesis indicates the importance of early natural experiences and argues that to achieve desired improvements in primary school architectural environments, a child-centred holistic approach to design proposals that promote children's multisensorial experiences of nature is needed. The findings of this study confirm that built and natural environments influence children's senses, and their connections with nature in schools. The more wilderness at school children are exposed to, the more intensively their connectedness to nature are formed, the more their affinity toward nature are promoted.

The outcomes of the work support primary school design decision-making through the enhancement of children's positive experiences of nature, and aim to promote improvements in their health and wellbeing through the enrichment of the child-nature connection.

Preface

Chapter 5 and Chapter 9 are partially adaptations from "An application of measuring visual and non-visual sensorial experiences of nature for children within primary school spaces: Child–nature–distance case studies in Glasgow, Scotland" (To & Grierson, 2019).

Chapter 4 and Chapter 5 are partially adaptations from the ESCI-2022 conference paper entitled "Children's Experiences of Nature in Primary School Environments: Contextual Influences and Child-Nature-Distance Ranges - Case Studies in Glasgow, Scotland, UK and Ho Chi Minh City, Vietnam" (To & Grierson, 2022).

I am the primary author of these publications.

I confirm that:

(a) the works in the incorporated publications are my own, and

(b) my co-author gives permission for the articles to be included in the thesis.

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Chapter 1 Introduction

"We want politicians and other public policy-makers (local and national) to change government guidance to schools to include a minimum of one hour per school day to be spent outdoors in wild play and learning."

— The Wildlife Trusts's call on actions (**UCL Institute of Education**, 2019)

This thesis is about architectural research in primary school contexts as a mean to enhance the opportunities for children to have multi-sensorial experiences of nature in studying and leisure spaces at schools. The thesis, therefore, explores and analyses how school environments are designated and then influence the thresholds of children's accessibility and engagement with nature through their sensorial modalities. The main aim is to propose approaches to (re-)connect children with nature by solving two questions: *How to bring nature closer to children* and *How to encourage children to explore nature* within their school environments in daily life.

1.1. Children's Experiences of Nature: Towards Children's Nature Connection in Primary School Environments

At schools, every child should have the opportunity to have daily and meaningful contacts with the natural world. The evidence of wide-ranging research reveals that playing and learning within the natural environment are fundamental parts of childhood, and these activities help children grow up healthy. During the initial developmental stages of a child, a strong connection with nature and frequent exposure to the natural environment support children's well-being, as seen in the systematic literature reviews of Chawla (2015) and McCormick (2017), and in a wider sense, lays the groundwork of a sustainable future for human society (Collado & Evans, 2019; Duron-Ramos et al., 2020; Gill, 2014). Among children at different ages, Jean Piaget (1964) and Rudolf Steiner (1996, p. 11) highlighted the children group from 7 to 12 years old and categorized this group as "*the concrete operation stage*" for their greater environmental experience range, compared to the under 6-year-old and over 12-year-old stages (Heerwagen & Orians, 2002). This group is considered along with a significant intellectual development with surrounding creatures and natural settings (S. R. Kellert, 2002; Miller & Kuhaneck, 2008), and a higher connection to nature than teenagers (Hughes et al., 2019). According to this, children at this stage are encouraged to have daily and meaningful interactions, which means they could explore and interact with pristine nature using all five senses instead of vicarious or symbolic experiences with the natural world.

However, many contemporary influences of the human-built development have diminished and imperilled the harmonious relationship between children and nature today. Children are spending less time outdoors to interact with nature and to have nature-based activities than ever before . The outcomes of an increased disconnection with nature, which was presented in the review by Stephen Moss's 2012 publication Natural Childhood produced for the UK National Trust, could include physical health problems, mental health illness, and a lack of ability to access risk (Moss, 2012). Advocating and providing for children's access and recurrent connections with nature have become an essential priority to respond to the psychological problems of an increased separation and even alienation from the natural world of future generations (Kahn Jr., 2002). Consequently, there have been many calls to promote plans to (re-)connect children with the natural world. According to the framework of 'The UN Convention on the Rights of the Child' (Unicef, 1989), "*the education of the child shall be directed to the development of respect for the natural environment*" was mentioned in Article 29. Professor Robin Moore, an international author on the design of children's playing and learning environments, also emphasized that urban children need to have the right of having safe daily hands-on interactions with the natural settings in their living environment (1997). Recently, the National Trust, in 2020, studied 1,051 children aged between 8 and 15 in Great Britain to explore the child-nature relationship. The results showed that this group never or rarely participated in the 'noticing nature' activities (e.g., birdwatching, watching sunrise or clouds, smelling wildflowers, or noticing butterflies and/or bees) in the past year of this survey (in 2019). Following this, an action plan for "*Unlocking the power of simple, everyday experiences in* *nature*" to improve children's wellbeing, and to save nature and the environment, especially in the educational environments were proposed. The significant finding is that participated children expressed that their schools could do more to help and protect nature in the UK (National Trust, 2020). Understanding the importance of reconnecting children with nature, many researchers also suggested approaches to educational building and landscape designs that could enhance children's direct and indirect contact with the natural world. For example, the most famous researcher in biophilia and biophilic design, Professor Stephen Kellert pointed out that we need to transform children's playing and studying environments at schools to nurture their affinities for the natural world (S. Kellert, 2015). Richard Louv, the author of the famous book 'Last child in the woods', supported the environmental-based education or environmental-based schools by utilizing the surrounding nature as children's classrooms to find the beauty of nature as well as to solve the child's nature-deficit disorder phenomena (2006, pp. 186, 204, 215). The successive benefits include the understandings and appreciation of nature that nurture their care, protection, and love for the natural world.

This profound evidence on the importance of nature in children's environments reveals that it is crucial to maintain and strengthen the children's nature connections in the educational contexts where children spend more time than any other place (except for their homes). Challenges of the contemporary primary school architecture are finding the appropriate approaches to bring the more wilderness natural environments closer to children in the limited conditions of rapid urbanization as well as the degraded quality of the local nature. This has emerged as an essential societal responsibility. School environments then 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 the refurbishment of current schools need to incorporate methods to enhance pupils' direct exposure to the natural world.

Along with that, the current lacking in studying the school design is an exploration of the relationship between natural-physical settings and the children's nature connection of direct natural experiences, although, in recent years, design and development approaches have focused on re-establishing connections between children and nature in schools. For example, several studies show that children attending primary schools ranked as sustainable buildings according to criteria-based building assessment systems had significantly more pro-environmental attitudes and behaviours than conventional schools (Tascı, 2015; Tucker & Izadpanahi, 2017a). Studies about forest schools, a growing movement offering children the richness of naturalness through forest-based settings and activities, also revealed their significant contributions to these educational environments (Harris, 2021; Sharma-Brymer et al., 2018). Even though these results have shown the remarkable benefits of potential design strategies, the findings were observed through the filters of children's environmental perceptions only while there was limited demonstration and exploration of spatial features. This presents the need for further studies in the architectural research context. Therefore, the crucial question about designing schools emerges: *How do school environments modify the threshold of direct natural experience children are daily exposed to, along with the nature connection in children through the way their emotions, interactions, and environmental preferences whilst at school?* This direction could eliminate the limit of previous interventions to increase nature connection in children in educational contexts; particularly, a new approach is to research schools' environments focusing on spatial configurations influencing the child-nature relationship (Barrable & Booth, 2020). By exploring architectural features and school settings along with children's direct natural experiences, the anticipation that outcomes would support future decision-making and significant resource for the design of primary school environments, which can foster the outcomes of reconnection between children and nature in the future.

1.2. Research Statement

The purpose of this research is to explore the child-nature connections which principally undertake multi-sensorial natural experiences within studying and playing environments of different primary school contexts. The findings are constructive for understanding school environmental settings that are designated according to different urban-, social-, cultural-, and pedagogical- contexts, and then influence the extent of children's connectedness with nature. Then, potential approaches of primary school design would be investigated and suggested to '*bring nature closer to children*' and '*encourage children to explore nature*' – within school environments.

1.3. Conceptual Framework: Spatial Configuration and the Child-Nature Connection

Initially, this study develops a research framework that integrates the conceptualisation of children's experiences with nature and elements of schools' spatial configurations. The model of children's experiencing in nature was synthesized by Linzmayer et al.(2014) from literature reviews on human development, regulation, and neurobiology aspects. Based on this original model, Figure 1-1 shows the advanced conceptualisation of children's direct experiences of nature within school environments for this study. According to Stephen Kellert (2002), the child-nature connection composes three levels of interaction (i.e. direct, indirect, and vicarious or symbolics). For him, a direct nature means "*involves actual physical contact with natural settings and nonhuman species (e.g. creatures and environments occurring largely outside and independent of the human-built environment*", an indirect nature is a nature that "*involves actual physical contact but in far more restricted, programmed, and managed contexts … nature in these situations is usually the product of deliberate and extensive human mastery and manipulation*", and a symbolic nature is "*in the absence of actual physical contact with the natural world*" (S. R. Kellert, 2002). The principal difference between physical and non-physical contacts is the state of '*feeling*' through sensorial modals when the child's physical body is exposed to and affected by the '*real*' nature, and then evokes an appraisal of core effects (including awareness, affective feelings, and judging). Various natural elements and stimuli arouse diverse effective dimensions through each sense in the child's internal biological structure. Cognitive and affective components of this process are the premises of shaping the child's attitudes and behaviours toward '*perceived*' nature. Along with ways that children define the meaning and values of nature, future prospects of the natural world would be transformed by their constructed environmental perceptions in childhood.

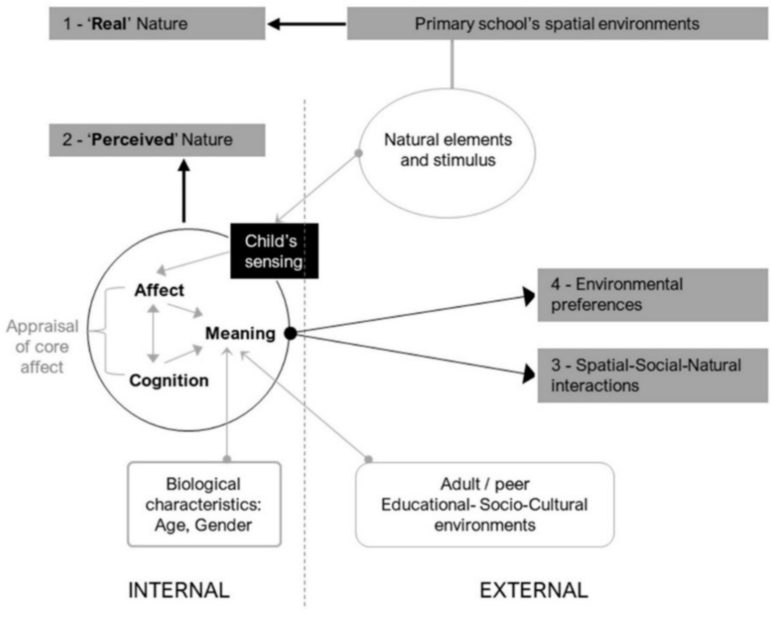


Figure 1-1. Conceptualisation of children's experiencing nature within school environments, based on the model of Linzmayer et (2014)

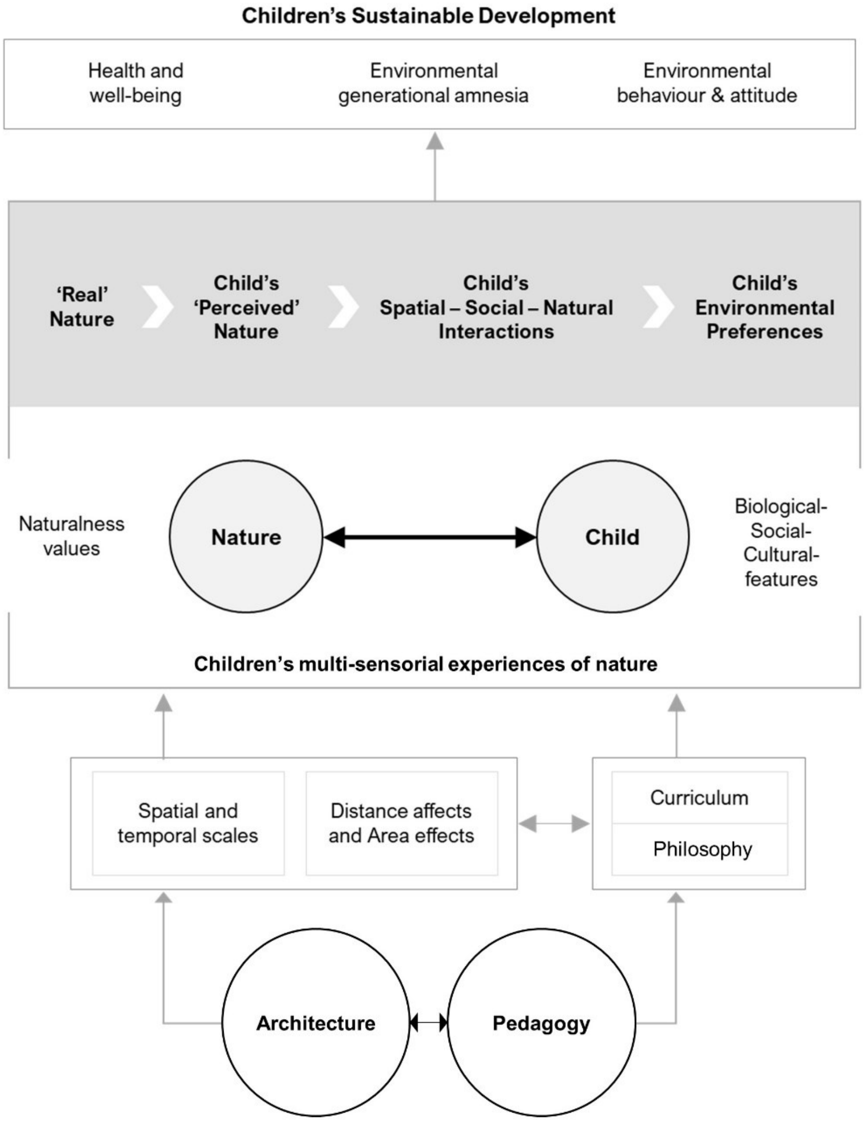


Figure 1-2. Conceptual framework of this study

In the architectural research context, this advanced conceptualisation highlights the need for clarifying spatial features influencing the naturalness values of the '*real*' nature and the child's '*perceived*' nature, through their explorations, feelings, and interactions with nature. In this study, it is argued that children have physical contacts with nature through multi-senses and the '*real*' nature is defined as natural settings and species that range from independent of the human-built environments (as a wilderness) to human-designed and constructed landscapes and creatures according to Kellert's descriptions of children's physical natural experiences. The natural attributes of these experiences, which are synthesized from facets of the environmental education, landscape design, and biophilic design, include: air, astro-sky, minerals, water, weather, wind, light, fauna species, and flora species within children's indoor and outdoor environments at their schools. This investigation would help us acquire the extent of child-nature connection within different contexts of school settings and typologies to bring nature closer to them.

In another aspect, it is also important to understand the relationship between children's perspectives and physical-natural features to encourage children to explore nature, which means children positively engage with nature. This requires explorations of *where* – children's environmental favourite places, *why* and *what for* - children's needs in the natural and built environments. With vital strategies for children's sustainable development and a focus on the space-children-nature relationship, the integrated research conceptual framework of this study is presented in Figure 1-2. It combines four main research objectives, namely: naturalness values of child's visual and non-visual experiences of nature, child's perceived nature, child's spatial-social-natural interactions, and child's environmental preferences at schools are presented.

This thesis thus attempts to bring spatial, psychological, and behavioural dimensions into the methodological framework.

1.4. Research Aims and Research Questions

Based on the established conceptual framework, the aims of this study are as follows:

- To explore how architectural features of school environments within various urban-, socio-, cultural-, and pedagogical- contexts construct the threshold of naturalness values children could directly expose to, perceive, feel and interact with through visual and non-visual senses;

- To investigate perspectives of children, architects, and educators on environmental settings at schools that would efficiently offer children rich opportunities and build up their positive engagement to interact with nature during daily studying and playing activities;
- Finally and synthetically, to inform design approaches and future decision-making in primary school architecture through outcomes mentioned above to increase the child's connection to the natural world.

Thus, to advance and enrich the existing research in relation to nature connection in young people of educational contexts, the management question of this research is:

How does primary school architecture contribute to the children's direct experiences of nature to connect them to the natural world?

According to the conceptualisation of children's experiences of nature, this framed sub-research questions that were as follows:

> **RQ1 –** How much Nature exists in the limited distances of a child's visual and non-visual experience in both internal and external spaces with particular spatial attributes of the education? - This question relates to the values of '*real*' nature impacting the child's body and senses. With this research question, it is necessary to develop a methodology for measuring children's visual and non-visual sensory experiences to evaluate the connection between naturalness values and spatial environmental qualities across varying child-nature-distance ranges.
>
> **RQ2 -** What are the differences in the children's experiences of nature through visual- and non-visual senses, including their discovery of nature – feelings towards nature and environmental preferences according to various spatial features, educational, and social contexts?
>
> **RQ3 -** How do children experience nature through visual- and non-visual senses when comprehensively considering spatial- social- natural interactions?
>
> **RQ4 -** How are children's perspectives about ideal nature-built environments for their daily school activities?
>
> **RQm.** The synthesised research question – What are appropriate design approaches for primary school architecture to enrich children's direct experiences with nature?

With these research questions, classrooms and playgrounds are selected as study environments since these places are accessed daily for pupils' learning and recreational activities.

1.5. Structure of the thesis

Following is the chapter plan of the thesis.

Chapter 2: Children's Experiences of Nature: Potential Approaches to Primary School Architecture For Children's Connection o Nature

Following Chapter 1, Chapter 2 will provide the background segment of the thesis, laying the theoretical and practical foundations that appear to be significant in support of its arguments. In particular, to set the context for the research, this chapter reviews the current extent of the research field, initially by providing evidence to offer the child's multi-sensorial connection with nature within educational environments. Then a summary of how primary school architecture has evolved and varied across social-cultural-educational contexts and physical settings is analysed for important factors that influence the child-nature connection. Next, Biophilic design and architectural studies, with a specific focus on children's direct experience of nature, are also investigated to explore limitations and to suggest transformative potentials of school design. Toward the children's nature connection as the far-reaching direction, current investigations and further directions are discussed in consideration of particular facets of the architectural research. The chapter concludes with a summary of findings and an identification of the necessity for research to enhance students' natural experiences in primary school architectural design.

Chapter 3: Methodology

This chapter will set out the methodology approaches taken to investigate the research questions posed. Firstly, an analytical framework will be presented to help us to understand the system of data. Then, how data are collected is considered, and the types of analysis that will be conducted. Detail descriptions of each method employed are as follows.

Chapter 4: Case Studies in Glasgow, Scotland, UK and Ho Chi Minh City, Vietnam

This chapter focuses on studying primary schools as case studies in Glasgow and Ho Chi Minh City, providing context for the research. It will begin by introducing the rationale for recruiting these schools according to research objectives. The description of each school context will be presented in an overview and then, distinct features between case studies regarding and influencing the relationship between children and nature. The considerations and investigations into urban-, social-, cultural-, and pedagogical- contexts demonstrate distinctive spatial- and natural- environments of classrooms and playgrounds to understand how children study and play and interact with nature within these places. Beyond the physical features of primary school environments, distributions of participants of case studies are presented to understand how living environments and off-school activities relate to the levels of children's experiences of nature. The discussion of the similarity and dissimilarity between studied schools in two cities would become a key driver in the evaluation of the naturalness levels children get exposed to, how they feel about nature, and which and why they favour a natural element and a particular space within their schools in following chapters.

Chapter 5: Naturalness values of Visual and Non-Visual Sensorial Experiences of Nature

This chapter will describe the development of measuring naturalness values of the visual and non-visual experiences of nature children have within the defined environment (the '*real*' nature). It begins by exploring the contextual justification for the necessity of this methodology. Then, it describes how this method is developed through an investigation of human (children) sensory modality and the relevant spatial configurations of school environments. Finally, the obtained results of six primary schools, both in Glasgow and Ho Chi Minh City, will be used to discuss: - the factors relating to the urban configurations, built environmental master planning, architectural features, and interior design on children's connectivity to nature, and – practical implications and values of the developed method.

Chapter 6: Children's Direct Experiences with Nature

This chapter presents the results obtained from applying the analytical approach, including main sub-sections: (1) Children's discovery of nature, (2) Children's feelings and favours to natural classifications, (3) Children's environmental preferences at school contexts, and (4) Children's spatial-social-natural interactions when exploring nature within school environments. The discussion of these thematic findings will concern the relationships between spatial configuration and children's experiences of nature and the existing literature. Besides, it will draw together the influences of social-, cultural-, and pedagogical- contexts that can affect how children discover, feel, interact and favour nature within the school environments.

Chapter 7: Bridging Children – Architects and Educators on Primary School Architecture for Children's Natural Experiences

This chapter further explores the discussion related to the characteristics of classroom and playground environments focusing on the differences in perspectives between children and adults in the particular condition of HCMC. The focuses are: (1) What children need, want, and desire for them in learning and playing, and (2) What architects and educational professionals think and consider in making spaces providing natural experiences for children. They will be discussed through obtained results from in-depth interviews, concluding with a summary of findings. This chapter is intended to be a reference in the discussion of research findings and to highlight the importance of promoting appropriate approaches, not only to ensure children's activities occur reasonably but also to enrich children's positive engagement with nature.

Chapter 8: Towards Design Approaches for Children's Experiences of Nature within Primary School Architecture

This chapter will provide a synthesis drawing together the key themes from the main findings of previous chapters, including (1) the schemas of children's experiences of nature relying on a spectrum of built and natural environment, (2) how natural attributes are experienced and considered by children, and (3) how spatial features affect the extent of connectivity between children and nature. Following this, a holistic approach to the planning and design of primary schools is generalised and promoted. In particular, primary school environments, through suggested innovative proposed architecture implications for enriching children's experiences of nature, and child-centred proposals and guidelines in every step from decision-making process to conduct pedagogical curricular, would contribute to the greenery urban environments, the practice of environmental education, and enrichment of the Child-Nature Connection.

Chapter 9: Conclusions and Considerations

This chapter responds to the posed research questions, explains how the thesis contributes to knowledge, and suggests directions for future research on school design for children's connection to nature more broadly.

Chapter 2 Children's Experiences of Nature

Prospective Approaches to Primary School Architecture for Fostering Children-Nature Connection

"The research has been done and it is true that it's good for the human mind to be able to live and experience in really natural situations."

— Edward O. Wilson

To set the context for the research, this chapter addresses the overarching question.

Question 1. Why is it a must to offer direct experiences of nature to primary school children in their educational environments?

In doing, this chapter firstly reviews the current extent of research, initially by providing a summary of how nature contributes to the development of a child from 6 to 12 years old and the prospect of increasingly detaching generation-by-generation from nature. Responding to this, it emphasizes why the contexts of primary schools hold an important topic for this research (presented in 2.1).

Question 2. How do primary school environments construct the connection to nature in children? and **What kind of existing school design and architectural research has evolved into the children's direct experience to nature?**

These questions explore how current school environments have been conceptually and practically framing the relationship between children and nature. The environmental regulations and organisation of schools have shifted significantly over time and continued to change according to the urban fabrics, influences of progressive educational theory, and practices on school designs. Firstly, an appraisal regarding influences of urban contexts and school settings in indoor and outdoor spaces on the degrees of children's nature connection is presented in 2.2. Studies that have addressed relative factors in children's perceptions and preferences of nature in the 6-12 age group are reviewed in (2.3) to identify issues that have been raised and needed further investigations in the aspects of architectural research. Responding to a must of offering the child multi-sensorial experiences of the healthy natural process and diversity, it is important to understand existing frustrations of primary school environments apropos of the Biophilia hypothesis and is more likely to suggest a transformative potential way forward (presented in 2.4).

Question 3. How are aspects of methods and approaches used to measure the child's connection with nature, focusing on children's multi-sensorial experiences of nature within a particular place?

This question constitutes the specific focus of the research presented herein. Established methods available for evaluating the connection of nature in children are also reviewed with a particular focus on direct experiences, to discuss the potential aspects of methods and approaches from the architectural perspectives (presented in 2.5). These would help to set out the methodological approaches in Chapter 3 and Chapter 5. Then, the chapter concludes with a summary of findings and identifies the necessity of research to enhance children's natural experiences in the decision-making progress and design of primary school architecture (presented in 2.6).

2.1. Children's experiences of nature: The need for (re-)connection children and nature

> *"Experience depends on sensory equipment. A child is finely equipped: his senses are sharp, undulled by age. But the ability to make use of his sense is limited."*
>
> **— Yi-Fu Tuan (1977)**

As scientists have proven, the natural environment, a significant space that children engage and explore, positively contributes to the development of children. Comprehensive child-focused systematic reviews and quality assessments offer evidence to support these benefits (Chawla, 2015; Gill, 2014; Tillmann et al., 2018), which could be summarized as follows: physical health, psychological well-being (e.g. mental and emotional health, self-control, self-awareness, and self-confidence), cognitive development, affiliation and imaginative play with social skills, and environmental attitudes and behaviours (for example, affiliation with other species and the natural world, and concern for the environment, connected to nature). The relationship between a child and nature is termed '*connectedness to nature*'; it describes the child's enjoyment of nature, empathy towards nature and living beings, responsibility toward nature, and awareness of nature. Previous studies confirm the magnitude of direct encounters with nature, with all the child's senses, as the foundation for the child's connection with nature (Kals et al., 1999). These regular advantageous interactions within nature allow children to feel comfortable in it, develop empathy with it, gain knowledge about it, and grow to love it – these are fundamental features of children's affinity toward nature.

However, children are currently confronted with the challenges of limited access to nature. With the on-going rate of population growth and urbanity, the process of environmental degradation of contemporary life arises and leads to the disconnection between children and nature. In 2018, 23% of the world population lived in a city with at least 1 million inhabitants, and it is estimated that urbanisation has been increasing in both size and number of cities, especially in the less developed regions (Nations United, 2018). The green infrastructure surrounding school environments, therefore, will be altered, mostly in imperfect tendencies, both in size and diversity of natural features. These degraded environmental changes shape substantial differences in the relationship between children and nature. In particular, pervasive environmental problems (such as air pollution, contamination of water and soil), lack of green areas or nature reserves create more difficulties for children to affiliate or identify with degraded natural environments. Furthermore, increasing time spent indoors, expanding interests in technical gadgetry, and growing parental concerns about children safety are complex social factors that affect children's outdoor time (Alexander et al., 2015; Strife & Downey, 2009). One problematic outcome regarding this trend of diminished natural experience is discussed by several authors who used different terms to describe the same psychological phenomenon. Particularly, Daniel Pauly first introduced the term '*the shifting baseline syndrome*' in a fisheries context to describe the gradual acceptance of the loss of fish species. Then, it was conceptually broadened to demonstrate "*a gradual change in the accepted norms for the condition of the natural environment due to a lack of experience, memory, and/or knowledge of its past condition*" (Soga & Gaston, 2018). Another term, '*the extinction of experience*', is constructed by Robert Michael Pyle as "*an inexorable cycle of disconnection, apathy, and* *progressive depletion due to the loss of contact and subsequent alienation*" (Pyle, 2003). Direct and intimate interactions with nature, especially local natural environments, are considered as the most important factor to nurture their biophilia (i.e. positive feelings and enjoyment of nature) and to diminish their biophobia (i.e. negative feelings that could range from discomfort and fear to avoid nature). And lastly, the most well-known term, '*environmental generational amnesia*', is defined as "*with each ensuing generation, the amount of environmental degradation increases, but each generation in its youth takes that degraded condition as the nondegraded condition as the normal experience*" by Kahn Jr. (2002, p. 113). As also described by Kahn (2007), the child's attitude toward a polluted environment has a similar trend as when that polluted condition becomes the norm. He showed the negotiation between him and land developers and owners as a current war between the remaining natural environment and the necessary progress of replacing nature with built environments for human needs. Kahn's objections that to keep nature for future generations are not about restricting human's developing progress but about "*freedom and human flourishing*" - as he argues. This kind of battle happens everywhere and has become more intensive due to overpopulation, urbanization progress, and overconsumption of human's desires. If this conflict is not solved, children's affinity to nature will not have the vital opportunities to be nurtured and flourished during their childhood. Consequently, biophobia responses, an aversion to natural stimuli or configurations, may develop (Ulrich, 1993). The peril of cultural perspective on biophobia is when children display contempt for everything natural-based and affiliate with technology and human artefacts (Orr, 1993) along with an increase of people with disaffection towards nature in the next generation (Soga & Gaston, 2016). For example, Bixler & Floyd (1997) found that adolescents who reported negative perceptions of wilderness also tended to prefer social indoor recreational activities and future job selections. W. Zhang et al.(2014) studied how contact with nature influenced biophilia and biophobia in children aged 9-10 in two Chinese metropolitan cities; the obtained results reveal that direct and concrete experiences with nature can change initial biophobia attitudes towards animals. In either case, the results of Soga et al. (2020) also found that the frequency of direct experiences with nature negatively associated with their levels of dislike, disgust, fears, and perceived dangers towards invertebrates. These pieces of evidence highlight the importance of early natural experiences in the generational institution of sustainable futures.

Accordingly, advocating and providing for children's access and (re-)connection with nature in the places where children live, play, and learn have become essential priorities to respond to by designers. It requires a mosaic of green spaces at multiple scales, beginning with nature at the front steps and back doors, and extending to systems of connected parks and greenways.

These everyday experiences, which provoke sensory-rich opportunities from engaging with the diverse and untrammelled nature, play an important role to overcome the biodiversity declining and close the widened gap between people and nature. Responding to this imperative, 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.

2.2. Children's direct natural experiences within primary school environments

Focusing on architectural research in primary school design, we firstly explore relative factors and their consequences to the connected intensity between pupils and nature within school environments. The opening consideration is the impacts of urban fabrics on where a school locates. Particularly, differences in contextual contexts could alter children's exposure to urban green spaces, as well as the values of naturalness they could interact. Along with external conditions of nearby urban configurations, architectural features of playgrounds and classrooms, where students have daily access for learning and recreational activities, also significantly vary the child-nature relationship.

2.2.1 The school site: location and local features

According to Benito (2003), the ecology of nearby urban areas plays a significant role in shaping the course of school design and school culture. The natural-built settings of school sites and buildings are engaged with the specific features of the local environmental conditions to ensure all activities of children and teachers occur efficiently. Some studies have examined the urban contexts in different distance ranges around school sites as the key predictors. Within 0-2000m buffer distance around school sites, the greenness within and surrounding school boundaries positively correlates with children's academic performance (Wu et al., 2014), stress declines caused by having nothing to do (Corraliza et al., 2011), mental health improvement (Dadvand, Nieuwenhuijsen, et al., 2015), higher frequent interaction with natural elements (Liu & Chen, 2021), and increased empathy and concern for nature (Giusti et al., 2014) which have lasting effects through their lives. On the other hand, children who studied in schools with lower presences of natural experiences in urban areas had fewer natural experiences as well as obtained lower emotional affinity with the biosphere than children with nature-rich routines (Giusti et al., 2014). When the investigated distance is expanded to 5000-meter radius circular buffer surrounding school sites, Huynh et al. (2013) did not find the relationship between the public natural space and Canadian students' emotional well-being. Therefore, it could be argued that the positive impacts of natural experiences decrease as the child's natural exposure distance increases.

Additionally, the closer proximity the school site and the urban green spaces are in, the more positive benefits children could acquire through daily direct experiences and for various demands, both educational and physical activities. For example, Fischer et al. (2019) conducted a study of biodiverse edible schools in Berlin. In particular, the neighbouring vacant wild sites were planned, managed, and occupied to enhance students' gardening and recreational activities and food experiences. These broader school surroundings could serve as an advantageous factor to raise awareness of the food and biodiversity in children through hands-on experiences. When the wilderness area is a part of 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. However, the accelerating expansion of urban space has strongly reduced the green areas in school sites, as well as in the ratio of area per student at schools. Many unconventional issues arise when a school locates near highly urbanized areas, such as air and noise pollutions, degraded landscapes, and compromised safety. The consequence here is the disconnection between the school and community as well as urban green spaces. This is why each school's design process must stand on its own approaches to create accessibly manners for natural appearance within both the external and internal environments besides utilizing advantages of nearby green spaces.

The extensive level of children's exposure to natural environments also has a relation with the nature diversity at the local and regional extent and is influenced by other contextual factors, such as species-area relations (Rosenzweig & Ziv, 1999), altitude and climate variations (Pyšek et al., 2002; Rahbek, 1995). Some regions may have higher species richness for children to explore or higher appropriate and comforting conditions that enable children to spend more outdoor time than others. For example, children in regions where nature changes seasonally or have higher natural richness could have more experiences with various natural elements and stimulus in school sites than others (Paddle & Gilliland, 2016). Moreover, the weather variations also impact the durations of children's outdoor activities due to thermal comfort, especially during winter in cold regions (Rasi et al., 2017) and during summer in hot places (Vanos et al., 2017). 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 nature in correspondence to seasonal and weather variations.

2.2.2 Outdoor environments – Playgrounds

Within school environments, 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, recreational activities, sports, applying knowledge, extending their classroom experiences, and interacting socially. Researchers across a range of disciplines have proven that children who join 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 (J. Evans, 2001; Jansson et al., 2014; Larsson, 2013; van Dijk-Wesselius et al., 2018), and an enhanced physical activity and motor development (Fjørtoft, 2004). The nature-based design of playgrounds also significantly constitutes the children's peer relationships that play an important role in supporting their education and well-being. While the hard-artificial surface of the playground was considered as entirely unsuited for children and not based on their needs, natural-based settings were found to facilitate children's engagement in spontaneous plays of their choices and socializing with peers. For example, large asphalted playgrounds, after the reduction of school gardening movement of Swedish post-war schools before the late 1960s, were the best environments for bullying and unequal distributions of playing activities and socializing with peers (Larsson, 2013). Similarly, Ndhlovu & Varea (2018) found differences in children's playing activities and social interactions between hard and grassy surfacing playgrounds of rural primary schools in New South Wales, Australia. In addition, the greening school playgrounds also enhance children's positive moods (Chawla et al., 2014), increase learning opportunities, improve academic performance (Blair, 2009; Dadvand, Nieuwenhuijsen, et al., 2015; Lieberman & Hoody, 1998), and heighten environmental stewardship (Jansson et al., 2014; Sobel, 1990). For instance, Jansson et al. (2014) conducted a case study in Sweden where a school's asphalt and grass playgrounds were remodelled as a hilly landscape with diverse flora species and winding paths. This greening approach within one and a half year with children's involvement established their positive and caring relationships with the designed vegetation area.

Besides affording recreational activities as a common conception, nature lends itself to many of the same activities that mostly take place in classrooms (Jacobi-Vessels, 2013). The direct contacts with outdoor natural objects and stimuli evoke students' attraction and attention; following this, they could observe, have sensory stimulation, and evolve emotional affective and behaviours within the studying environments (Duerden & Witt, 2010; S. R. Kellert, 2002; O'Brien & Murray, 2007). Kellert argued that the information-rich and fascinating natural environments are "*a rich direct for cognitive development*" (2002, p. 125). 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 that has been pointed out, many current school grounds are in conditions of barren, hard and 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.

2.2.3 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 indoor 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. For instance, Küller & Lindsten (1992) investigated a study in a school to assess the differences in children's health and behaviour between classrooms with and without windows. They concluded that studying in windowless environments negatively influences pupils' abilities to concentrate and their annual body growth. Li & Sullivan (2016) also found that classroom views to green landscapes positively influenced high school students' performance on tests of attention and recovery from stressful experiences. However, there is a lack of exploring non-visual connections with nature, such as hearing, smelling, touching, and tasting in classroom environments.

Besides improving air quality within built environments (Han & Ruan, 2020), previous studies also have empirically examined the benefits of indoor nature in classrooms for students. Han (2009) found that high school students enjoyed more positive emotions, behaviours, and health when there were real natural elements of a specified amount of living plants in the classroom. Across three experiments conducted at a university and two secondary schools in real-life classroom settings, van den Bogerd et al. (2020) discovered that students preferred classrooms with indoor plants as they reported higher satisfaction with their study environments and a lower level of stress, fatigue, and health issues. However, there is limited evidence regarding the primary school context, except one study of 170 Dutch students from 7 to 10 years old to evaluate the restorative impacts of green walls (A. E. van den Berg et al., 2017). They found that children in classrooms with a green wall scored better on the selective attention task and rated their classroom more attractive compared to children in classrooms without a green wall. However, the duration of installing a green wall for this study was short and for decorative intervention only; thus, this may have limited children's emotional responses to indoor plants. Putting together, these studies have shown that the reintroduction of nature can enhance the quality of learning environments by improving health, wellbeing and productivity. Despite that, the indoor natural setting in classrooms is limited to plants only; the effect of other natural elements has not been analysed. 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.

Given the growing evidence for the benefits of natural experiences, combined with the considerable amount of time students spend at primary school, it is important to explore feasible nature contact interventions at the school from the architectural aspect and landscape design to provide natural sensorial exposure. This raises the question of how educational architecture - including the urban fabric, the school greenness boundaries and settings, the external shell of buildings and their internal spaces, and the use of natural-based forms and materials – construct the children's exposure to naturalness within their sensorial distances and – to then, to build up an intimate bond between children and nature in their life-course.

2.3. Primary-school children's perceptions and preferences on natural environments

Following the children's exposure to natural stimulus and elements, cognitive-, affective-, and interactive- components are important aspects to consider the psychological aspects of children within a place. Previous approaches to the study of children between the ages of 5 and 12 concerning their perception and environmental preferences have explored several related different factors, including distinctions of the human ontogenetic development, social-cultural contexts, and the educational philosophy. These are considerable variations that are the root of forming the cognition, attitudes and behaviours during the middle childhood stage. Each of these factors is reviewed in turn.

2.3.1 The evolutionary contexts of natural experience

Research into the relationship between children and nature has examined a general concern for substance characteristics of the ontogenetic development of humans. According to the scientist Gordon Orians in the Biophilia by Wilson (1984a), three elements of the ancestral natural environments that are closely connected with humans are as follows: the *savanna*, *topographic relief*, and *water features* (e.g. lakes and rivers). It is well established from a variety of perceptual approaches to natural landscape assessment that the younger children have a similar sense for these categories.

Concerning the savanna hypothesis, Wilson (1984a) recommended the '*biophilia*' and '*biophilic*' notions, which argued that humans are likely to blend in other forms of the life course. For instance, people with free-choice conditions would gravitate towards savanna-like environments due to their rooted genetic inheritances. This argument appeared first in a study by Balling & Falk (1982) which surveyed a very diverse population residing in two American cities. The results showed that the youngest age group from 8 to 11 had the highest preferences for savanna scenes comparing to open forest, jungle, and desert. Later research by Kaplan & Kaplan (1989), Ulrich (1993), and Falk & Balling (2010) also showed similar results. Referring to the topographic relief, children concentrated more on functional values of topographic features for various playing forms rather than thinking about the landform or what complexity the area looks like (Zube et al., 1983). Other studies argued that the level of vegetation in natural landscapes is a supportive factor for the richness of children's outdoor playing (Fjørtoft & Sageie, 2000; Taylor et al., 1998). These findings have been associated with ecological psychological theories of affordances of Gibson (1979). In this case, the functional properties of natural environments afford individuals for their activities. Lastly, water landscape is the most significant element in the majority of studies with children aged 5-12 years; it is defined as a desired feature according to Francis (1988) and a valid attribute that could enhance scenic values for natural landscape preferences (Zube et al., 1983). Yamashita (2002) reported that water features strongly attracted child residents from 10 to 12 years old in rural areas of Japan. Malaysian children in the same age group also relished the dynamic and visual effect of water features in the park in the study by Mahidin & Maulan (2012).

These studies showed that people, including children in both Western and non-Western cross-cultural studies, have an innate love for nature and most prefer those ancestral landscapes during the evolutionary contexts. Although some aspects of natural preferences could have been determined and considered seriously, they need further analysis from the angles of cultural bias, temporal and spatial changes in children's lives. Additionally, an architectural concern in school settings that compound these kinds of natural landscapes raises the question of how to integrate these outcomes of environmental psychology studies into practical situations: How could these structural landscape features be meaningfully applied to the architectural settings? On both counts, theoretical and applied, these future studies have important and exciting contributions to make.

2.3.2 Socio-cultural contexts

With the argument disputes studies that hold on to the difference in preference of natural landscapes, the cross-cultural variations are considered as the important factor altering children's consciousness of nature. For instance, studies by Kaplan & Herbert (1987), that compared Western Australian and American students, illustrated the effect of cultural and even sub-cultural differences in perceptions and preferences for natural environments; besides, the different ways of seeing and defining the environment is more significant than preference. Younger children under 15 years old, in the Canary Islands study by Bernaldez et al. (1987) disliked or less be interested in landscape photographs that relate to the mystery, strong risky, and insecure feelings. On contrary, Scottish children preferred natural landscapes with more risky, and more vivid features (Hayball et al., 2018). These pieces of evidence lead to insights into cross-cultural and sub-cultural differences. How nature and wilderness are defined and valued by an individual are considered as the consequences of the distinct historical development, and the interactions with physical and natural environments (Hartig, 1993). Thus, design approaches for children's natural experiences cannot be homogeneously applied without cultural considerations.

Along with culture, the relationship between a child and nature is also formed within a developmental context of the social forces. A survey in how children engage with natural environments in the UK highlights the greater disconnection from nature of urban children and children from lower socio-economic classes than rural children and children from higher socio-economic classes, respectively (Hunt et al., 2015). Linzmayer & Halpenny (2014) also found differences between rural and urban children when asking them how they defined nature and what they favoured in natural landscapes. Supporting this perceptual approach, some studies, for instance, Talen & Coffindaffer (1999) and Miller & Kuhaneck (2008), reported that rural children like to play on the waterside while urban children prefer grassland areas which they believed to be the most natural environment based on their experiences and knowledge. Children living in urban areas also tended to prefer outdoor environments with attributes relating to social interactions rather than nature-based features; the possible explanation is their limits of having sensorial experiences with nature (Talen & Coffindaffer, 1999). With differences in environmental preferences, the pro-environmental beliefs and behaviours also differ from one culture to another (Schultz & Zelezny, 1999; Vikan et al., 2007). To illustrate, this could be seen in the study about the 'New Ecological Paradigm' scale for younger children by Van Petegem & Blieck (2006), they found that Zimbabwean respondents feel dominant over nature while Belgian ones did not share this human dominance perspective. The results of environmental and self-reported behaviours of children aged 6-8 from America, Mexico, Spain, and Austria indicated that American children have fewer pro-environmental attitudes in comparison to other countries' participants (G. W. Evans et al., 2007).

Understanding the meaning of the cross-cultural and social differences in children's views on nature would improve the practical applicability of future approaches. Therefore, ongoing sociocultural-based research in educational environments is necessary to promote the positive capability to enhance children's perceptions and preferences towards nature at schools.

2.3.3 Educational approaches relating to nature

An educational philosophy closely related to the design of educational environments can satisfy children's activities following the school style proper occurring. Besides conventional pedagogies that mainly focus on children's intellectual development, there are some best-known alternative educational approaches for primary schools that the connections between children and nature have been much more deeply concerned in curriculums.

In developed countries, people regard the Waldorf, Montessori, and Reggio Emilia approaches as significant educational alternatives to traditional education. These approaches share a similar educational philosophy which is putting the child at the centred in order to develop each individual with thorough potential for intelligence and creativity (G. W. Evans et al., 2007). Waldorf schools were established by Austrian Dr Rudolf Steiner (1861-1925) with the core curriculum of his philosophy is to educate the thinking, feeling and willing capacities of the child as a whole (Edmunds, 2004). 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, such as gardening and farming (Easton, 1997; Schmitt-Stegmann, 1997). Montessori schools were originally established by the Italian physician Maria Montessori (1870-1952). The educational philosophy emphasized the Montessori prepared environment in which children have the exercises of practical life outdoors, have multi-sensorial engagement with nature, and utilize the nature-based materials for studying mathematics and languages (Vaz, 2013). Reggio Emilia, a region in northern Italy, has developed a unique educational system for young children known as the Reggio Emilia approach. The educators of this approach believed that children have more rights than simple needs (Hewett, 2001). By considering the educational environment as a 'third educator', Reggio principles offer active learning manners that could evoke children's curiosity about the natural world, force their imagination to create their own spaces as well as build their environmental mindset (Strong-Wilson & Ellis, 2007; Vandermaas-Peeler et al., 2017). Besides the above-mentioned educational methods where natural environments are part of school sites, the model of forest school runs into a particular approach in which woodland is made into an entire school site. Forest school models developed in Scandinavia and UK could be seen as a typical representative of the education for sustainable development. This model uses forests as resources and affiliated contexts to encourage and promote eco-sensitive attitudes (Grimm et al., 2011). The entire wilderness here offers children the highest levels of natural diversity to learn about and to connect with; they could overcome initial fears to have pleasant feelings, connect with nature through perceived nature and places, and then develop affinities for the school woodland (Harris, 2017, 2021).

These models of nature-based or nature education are the commonest forward approaches to make intentional use of natural outdoor spaces for children's play and learning activities. This is argued to be the predominant difference between natural and conventional pedagogical principles. The natural environment is merely referred to as a location in the latter approaches, whereas former ones rather consider it as a relational context and a resource (Warden, 2019). However, in real-world conditions, many children from urban areas and low-income classes do not have the opportunities to attend these educational systems. Thus, to develop children's connectedness with nature, Environmental Education (EE) programmes have set out three main components: education '*in*', '*about*' and '*for*' the environment (J. Palmer, 2002, p. 12) to be implemented in formal education since the 1970s. Integrating nature-like forest gardens as broader environmental fieldwork into the curriculum have been considered as potential and adaptable approaches to increase natural knowledge for urban schools rather than significant impact on children's environmental preferences (Askerlund & Almers, 2016; Blair, 2009; Leuven et al., 2018). Here, the major restriction of these pedagogical models is that children could not have daily access and have freedom within these places. Furthermore, the diversity of natural gardens is also a restraint for teaching and learning targets along with the dominant distribution of flora species that could satisfy solely small groups of children. Besides direct and indirect manners, pedagogical approaches that apply vicarious nature experiences (i.e. nature experiences without any physical contact with natural settings) delivered through books or technical gadgets at schools. These educational approaches are ranged according to the decrease of connection with nature, from direct experiences with diverse nature in wilderness areas to indirect and then vicarious or symbolic manners. This trend is accompanied by the corresponding decrease in emotions of children with nature although their environmental knowledge could be increased. Interacting with technological nature could provide some advantages but could not replace all the benefits of having direct experiences with actual natural environments (Kahn Jr et al., 2009). In the long run, this issue could gradually destroy the deep connection with nature or love of nature which is built through sensorial emotions; and following this, the expanded gap between the child and nature possibly increases along with the 'environmental generational amnesia' problem. For these reasons, the importance of architectural interventions fostering children's sensorial experiences of nature, especially in urban contexts, should be researched further to promote highly promising educational approaches forwarding more children's engagement and connection rather than targeting increased environmental knowledge (Harris, 2017; Otto & Pensini, 2017).

To summarise, these studies provide important insights into the concept of this study. They indicate that the relationship between young children and nature within school environments are influenced by many factors. Particularly, the degree of naturalness and sensorial natural experiences children have at their schools are intensively influenced by characteristics of the ontogenetic development of humans, socio-cultural contexts, educational philosophy, and pedagogical approaches. Among these, nature as a daily space, a resource and relational context for various types of children's activities is considered as the most suitable educational environment for children's sustainable development.

2.4. Biophilic Design in educational architecture

Biophilic design is defined as "*the deliberate attempt to translate an understanding of the inherent human affinity to affiliate with natural systems and processes into the design of the built environment*" (S. R. Kellert, 2008, p. 3). The philosophy of this novel design emphasizes the integration of natural elements and processes in buildings and places that can help in rebounding the divergence between ancestral and current habitats (Joye, 2007; S. R. Kellert, 2008). The Biophilia hypothesis - defined as "*the innate tendency to focus on life and lifelike process*" (Wilson, 1984a, p. 1), supports this approach. Due to several consequences of societal trends, the social process has been changing through the shifting from the wilderness to cities (Williams, 1985) where nature is being vanished or converted into planned landscapes while humans are losing their individuation in the experience of nature (Emerson, 1967). Focusing on the humanity-nature relations and the need for sustainable development, the concept of '*biophilia*' has gained popularity in environmental scholarships. The book 'Biophilia' by E.O. Wilson (1984a) mentioned that from the starting – humans have little unknown about the natural world, then our knowledge grows and becomes more narrowly intellectual, while broadly interacted distances, it is time to retrace human steps to natural conservation ethic for affiliating with the true human nature. The theory of Biophilia suggests the essential need for children to engage with the natural features and settings repeatedly for their physical and mental maturation (Kahn Jr., 2002). Biophilic design and architecture then suggest frameworks that integrations of natural contents (i.e. natural elements, natural materials, or natural forms) in buildings and urban spaces are restorative environments. Regarding the framework of Kellert, three fundamental ways that people experience nature in Biophilic design are the direct experience of nature, the indirect experience of nature, and the experience of space and place – through a variety of senses (i.e., sight, sound, touch, smell, taste, time, and movement) within a space (S. Kellert & Calabrese, 2015; S. R. Kellert, 2018). Browning et al. (2014b) outlined three classifications related to design with 14 design patterns: 1) Nature in the Space – the direct and physical presence of nature in a space; 2) Natural Analogues – organic, non-living and indirect evocations of nature; and 3) Nature of the Space – spatial configurations in nature. While these frameworks mainly concentrated on biophilic design in the context of architectural and interior design, Clancy & Ryan (2015) suggested that a retrofitting of small biophilic spaces with increasing levels of biodiversity varying throughout the year is the key strategy for implementing biophilic patterns in urban landscape architecture. And green schools are considered a potential part of the biophilic urban route that could contribute to human health and wellbeing goals; the natural grounds project of Merrylee Primary School in central Glasgow is an example. At building- and site- scales, notable biophilic design features (e.g. natural lighting, wetlands, swales, courtyards, interior connections to the outside environment, shapes and forms inspired by nature, and natural-rich materials) could both upgrade the environmental qualities for all children's activities as well as enrich the connection to nature while still guarantee safety and security for them (S. R. Kellert, 2018). Naturalized outdoor spaces for various children's activities and good indoor environmental conditions of natural lighting and ventilation are important biophilic features for sustainable school environments in both UK and HCMC according to Creating Excellent Primary Schools (CABE, 2010) and Vietnamese National Standard of Primary School (MoC and MoST, 2011), respectively. There are also ongoing global projects with respect to the innovation of biophilic school design models, such as the GCRF Networking Grant projects – Healing by Nature and Implementation of Biophilic Design Model for the post-pandemic school design in 2021. Among these projects, Ghaziani et al. (2021) conducted case studies of primary schools in many countries to explore the evidence of 10 patterns of 'Nature in the Space' and 'Natural Analogues'. Besides the contributions of natural-based settings as biophilic features of school playgrounds and classrooms that were previously presented in section 2.2, green rooftops or rooftop gardens that are becoming a mainstream concept in biophilic city design are also innovation examples in the school contexts investigated by Ghaziani et al. (2021). The rooftop gardens of Vo Trong Nghia's Farming Kindergarten in HCMC and the Sharrow School in the

UK are practical examples of greening and wilderness approaches. Therefore, it could be argued in a comprehensive context, especially in high-rise schools in density areas, that biophilic design principles should primarily intensify sensorial experiences with green elements in both horizontal and vertical plans in a natural style and diversity as much as possible to connect school children to nature (Wright, 2020). This knowledge promoted the importance of biophilic patterns and principles of landscape and architectural design for sustainable school environments where children have greater opportunities to experience nature. However, the mentioned evidence of educational environments is limited to introductions and brief descriptions of elements related to biophilic design through some practical examples. There is still a lack of evidence base in the research area, especially for multi-sensorial natural experiences. In another aspect, with a holistic synthesis, Watchman et al. (2020, 2021) provided a vocabulary of biophilic design strategies and schemas in relation to school architecture in cold climate conditions; they emphasized the importance of a climate-based approach to biophilic architecture and suggested further studies in different climatic and cultural environments. Thus, it requires a need to expand understanding of how particular biophilic attributes deliver impacts and benefit children and their activities in school environments in different contexts of climatic and cultural conditions. Additionally, existing policies and frameworks in both the UK (e.g. Area guidelines for mainstream schools: Building Bulletin 103 (Department for Education, 2014), Building Better Schools: Investing in Scotland's Future (COSLA and The Scottish Government, 2009), and Creating Excellent Primary Schools (CABE, 2010)) and in Vietnam (e.g. National standard of Primary school (MoC and MoST, 2011)) regarding wilderness school environments are suggestive rather than explicit in the way designers practice. These are several remaining aspects that need to be investigated further.

In a broaden aspect related to Biophilic design, the Restorative Environmental Design (RED) named the Biophilic design as 'Positive Environmental Impact' when combining it with the low environmental impact design strategies. Besides avoiding and minimizing harm to the biological environment, RED contributes as the appropriate approach to re-establish positive connections between nature and humans in modern primary schools. It does so by increasing children's daily activities which are necessary for their proper and meaningful development, as well as for essential environmental needs of sustainability (Derr & Kellert, 2013; S. R. Kellert, 2006; McGee & Marshall-Baker, 2015) rather than only forward to sustainable building labels. Several studies have shown that children attending primary schools with sustainable buildings according to criteria-based building assessment systems had significantly more pro-environmental attitudes and behaviours than conventional schools (Tascı, 2015; Tucker &

Izadpanahi, 2017b). Even though these results have shown remarkable benefits of potential design strategies through studying considerable particular buildings, the researchers placed a much greater emphasis on the children's environmental behaviours and attitudes. They also focus on the children's positive feelings for schools through the filters of their environmental perceptions which are integrated into the educational methods regarding nature and environmental technological features. Combining effective environmental education curricula and advanced high-tech methods in primary schools, which are assigned to the non-physical and vicarious/symbolic manners of children's experiences with nature, primary-school children's cognitive skills, behaviours and attitudes toward environmental issues are increasing significantly. These findings linked to the "*children's know-it-all state of mind*", which is the phenomenon of a young generation growing up in a world beyond their senses as Richard Louv discussed the nature-deficit disorder (Louv, 2006, p. 34) and the advantages of environmental educational approaches. To manage this challenge, he proposed environmental-based education approach that uses the surrounding natural environments as classrooms for children to develop their multi-sensorial experiences and find beauty in the natural world (Louv, 2006, pp. 186, 204–215). Forwarding this matter to the perspectives of Biophilic design philosophy and RED, the physical design of a new primary school, or the retrofitting of an old school, needs to put the direct experiencing with the pristine nature as the top priority of the design principle. They emphasize how to reconnect children with nature within a space to foster integral and beneficial goals of children's development rather than bringing natural elements into a place (Bolten & Barbiero, 2020; Browning et al., 2014b) and introducing environmental knowledge without hands-on experiences. Hence, most previous studies exclusively measured children's intellectual or emotional concepts, which depend on educational methods rather than understanding their perceptions, emotions, and interaction with natural features at their school sites. Promoting efficient measurement tools for when children directly expose themselves to natural elements and stimulus is a potential direction to increase understanding about the child-nature relationship.

In addition, while sustainable design aims at experiences of nature through multisensory, the vast amount of research presents a gap in the non-visual aspects of nature. Much of the literature found that the restorative potential depended on the visual senses of nature and are dominated by greenery within built environments. At the same time, characters of non-visual sensorial connections with other natural elements and stimuli are in call for further study to have a complete picture of how nature benefits through the full ranges of human senses (Conniff & Craig, 2016; Franco et al., 2017; Schebella et al., 2020). A holistic understanding of multi-sensorial experiences of natural elements and stimuli can successfully deliver natural benefits for children because not all exposure to nature is pleasant (Ratcliffe, 2021) to children and their specific activities. Following, there is also a need to explore features of individuals and various combinations of natural attributes of Biophilic design when perceived by both children's visual and non-visual senses. This is one of the central issues of environmental psychology, how different architectural and natural attributes within a spatial environment provoke different affective states and interactions in various types of individuals, such as reactions of liking or disliking, engaging or averse, exciting or boring.

Similarly, there is not enough attention on children's perception of the ideal environmental school according to their needs. More recently, studies started using children's drawings, accompanied by their written and oral explanations, to explore the kinds of space and relative features within these drawings that attract children to engage with to propose child-friendly environments. These child-centred methods provide opportunities for children to express their perspectives and interests in increasing their subjective well-being (Mustapa et al., 2015). Loureiro et al. (2020) analyzed Luxembourgish primary school children's drawings, and the results indicated that schools are not only for learning but much more for recreational activities, including socializing, playing, and relaxation. Although less frequently mentioned, being closed to nature and greening school grounds with trees, water, and animals are popular features in their concepts of an ideal school. Similarly, Gal & Gan (2021) revealed that nature at school could be the foundation of EE programs with the declination of fear tactics. These studies show the discrepancy between adults' and children's perceptions about a beneficial school environment for children. This gap surfaces clearly in the construction of primary schools at present. Wilson suggested that we apply the first law of human altruism of Garrett Hardin, which stated "*never ask people to do anything they consider contrary to their own best interests*" (Wilson, 1984a), for a profound and eloquent observation of the interconnectedness of nature. Therefore, it is important to keep in mind the distinctions between children's preferences and adults' perspectives when designating policies and practices, planning and designing approaches that not only enhancing children's attraction and desire for nature but also raising their interests in environmental concerns. Towards this, sustainable approaches to children's meaningful relations with the natural world must deliberately deliver to the distinctions of biological characteristics (for example, age range, gender, and special needs of potential populations) and the context of specific social–cultural factors. Collectively, these are compulsory facets that need further exploration to develop the conception and principles of sustainable designs for educational architecture.

2.5. Study of children's nature connection: integrated approaches of spatial configuration to children's nature connection

The Human-Nature Connection (HNC), described as the relationship between humans and nature, has accumulated more interest in the research world. Many researchers have introduced different instruments to measure this relationship. For example, Kals et al. (1999) developed the Emotional Affinity toward Nature scale (EATN) to explain nature-protective behaviours. To analyze people's sense of connection to nature, Schultz (2002) introduced the Inclusion of Nature in Self (INS) scale. As an extension of Schultz's, Mayer & Frantz (2004) invented the Connection to Nature Scale (CNS) to investigate and predict ecological behaviours. With more cognitive measures than CNS and INS, Love and Care for Nature scale (LCN) served as a predictor of willingness to make personal sacrifices to protect the environment (Perkins, 2010). Clayton (2003) proposed the Environmental Identity scale (EID) as a sense of connection to nonhuman natural environments to predict behaviours according to individual differences of self-concepts. Another broader method is the Natural Relatedness (NR), which accesses the affective, cognitive and physical relationships of individuals with the natural world (Nisbet et al., 2009). Later studies consistently preferred NR, Nisbet et al. (2011) established linkages between NR and various indicators of psychological health and motivational force toward environmental behaviours. Also emphasizing three key dimensions of cognition, affect, and behaviour, Connectedness with Nature (CWN) is considered a reliable predictor of motivation for environmentally responsible behaviours (Zylstra et al., 2014). These instruments share similarities in revealing a broadly comprehensive construct for HNC, with a divergence between various methodologies due to differences when focusing on cognitive, emotional or multidimensional concepts.

According to these instruments, three principal components constructing natural connectedness are *cognitive* (how an individual states their relationship with nature), *affective* (how an individual judges the natural conservation), and *behaviour* (how an individual will himself/herself protect nature). Based on the descriptions of the three components, they are considered the outcomes of various forms of natural experiences. These components of adult measures also have been applied in the assessment of children by modified models, such as CNS, INS, and CNI (see reviews of Barrable & Booth (2020) and Chawla (2020)). While this literature is rich and vast, besides important features of socio-cultural contexts, there is still a lack of understanding about the relationship between connection indicators of experimental dimensions in relation to particular forms of activities in different spatial environments. The majority of studies in children mostly explore the interventions of Environmental Education

(EE) programs (Barrable & Booth, 2020) while different nature interventions could cause significant consequences for children's nature connection.

The children's HNC progression includes three phases: being *in* nature, being *with* nature, and being *for* nature. The three phases reflect how a child develops connectedness components (i.e. cognitive, affective, and behaviour) with nature, and this progress is characterized dynamically through diverse nature routines (Giusti et al., 2018). Ives et al. (2018) pointed out five types of connection to nature: material, experiential, cognitive, emotional, and philosophical, ranging from shallow to deep connection levels. Therefore, studies focusing solely on the EE programs could only partly reflect the features of the 'being *for* nature' phase while the way a child connects with nature through beauty, emotion, compassion, and sustained interactions is much more necessary than knowledge to conserve nature (Lumber et al., 2017). Previous studies also emphasized the importance of direct experiences as the foundation for children's HNC. Following these pieces of evidence and suggestions, the questions left are *where* and *how* one has interactions with nature to gain the feeling of being connected to nature or *why* this spatial environment could raise the feeling of being connected to nature while others could not. The investigations of place-based components, i.e. geographic locations, material forms, cultural and subjective meanings, and influences on people's perceptions and behaviours, may help explore more potential interventions for sustainability transformation (Beery & Wolf-Watz, 2014).

Another aspect that needs more emphasis here is the child's nature connection within a spatial environment as a combination of three kinds of interactions: with *nature*, with *space*, and with *other people*, which forms the *natural- spatial- social* interactions. For example, the physical and natural settings of a place could encourage children to engage more with nature (Vickers & Matthews, 2002), or a child could invite a peer or an adult to come into contact with natural objects and vice versa (Skar et al., 2016). Thus, the degree of children's HNC should have an additional affiliation to spatial and social components rather than only features of individuals with nature to provide thorough insights into the understanding of how different connectedness degrees varies between different contexts and scales (Klaniecki et al., 2018). Furthermore, there are limitations in the research methodology of HNC studies that need reconsideration. The exploration of children's nature connection through individual psychology substance enforcing behaviours mostly used quantitative research methods. The specific people-place relationship and the distinctive people's experiences of nature within particular local areas were in the single form of quantitative questionnaires and observation of people's experiences with nature, respectively, to study emotional connection to specific natural spaces (Ives et al., 2017). The declination of studied methods here could only explain partially components or phases or a particular interactional form of children's HNC. Therefore, future research in children-nature connection needs to look at mixed approaches or combine qualitative and quantitative methods to help advance children's explanations of their perceptions and emotions toward nature, or how they perceive and evaluate nature. These approaches, thus, help to determine related factors and consequences of experiences associated with connectedness levels. For urban and architectural research facets, Klaniecki, Leventon, & Abson (2018) and Ives et al. (2017, 2018) shared similar suggestions for further studies: to utilize empirical explorations, investigate in different spatial scales, and consider cultural and subjective meanings to understand the interactions and linkages between these factors. In summary, it is essential to follow these directions to provide practical implications for future sustainability science and architectural research.

2.6. Summary and conclusion

This chapter reviewed research on the relationship between and among relative facets of the child-nature connection within educational environments. Considering the broad body of research into children's nature connection, education, and school environments, it highlighted that offering an experience of nature within education environments has emerged as a societal responsibility. Studies reviewed here have addressed the contributions of natural environments nearby 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 with opportunities to be in nature, to learn and understand the intrinsic values of nature. Similarly, the decision-making process of schools' new designs and/or refurbishment needs to incorporate methods that enhance students' direct exposure to the natural world. The summary of references for each area being investigated, the gaps that need to be further investigated, and cross-reference to this thesis as relevant are shown in Table 2-1.

Considering the impact of spatial features of primary schools on the degree of child-nature relationship, including geographic locations, urban configurations, and architectural and landscape settings, it highlights the need for clarifying how these spatial factors influence the way children perceive, favour, and interact within outdoor and indoor environments. Various non-spatial factors also governed the architectural interventions, for example, socio-cultural differences, pedagogical approaches, and the dominance of adults' perspectives on school settings. There is a need for more evidence for understanding the effectiveness and impact of spatial and non-spatial features 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.

Table 2-1. Specific themes, key references, gaps in investigated areas, and relevant parts of this study and thesis

Themes	**Investigations in previous studies**	**Key references**	**Need for further investigation**	**Relevant consideration / chapter of this thesis**
The need for (re-) connection children and nature	The importance of offering children daily multi-sensorial experiences with the diverse nature	(Chawla, 2015; Gill, 2014; Kahn Jr., 2002; Soga et al., 2020; Soga & Gaston, 2018; Tillmann et al., 2018; W. Zhang et al., 2014)		
Influential features of primary-school contexts in relation to children's direct natural experiences				
Location and local features of school sites	The positive impacts of natural experiences decrease as the child's natural exposure distance increases	(Corraliza et al., 2011; Dadvand, Rivas, et al., 2015; Giusti et al., 2014; Huynh et al., 2013; Liu & Chen, 2021; Wu et al., 2014)		These are important factors for: - an adaptation of the comparative study between Glasgow, UK and Ho Chi Minh City, Vietnam to investigate the influences of contextual contexts, and - selections of schools that differ from urban contexts (presented in Chapter 4).
	The influences of the nearby urban areas and specific features of localities and seasons on the extensive level of children's exposure to natural environments	(Fischer et al., 2019; Paddle & Gilliland, 2016; Rasi et al., 2017; Vanos et al., 2017)		
School's playgrounds	Multiple advantages of naturalized schoolyards	(Blair, 2009; Chawla et al., 2014; Dadvand, Nieuwenhuijsen, et al., 2015; Duerden & Witt, 2010; J. Evans, 2001; Fjørtoft, 2004; Jacobi-Vessels, 2013; Jansson et al., 2014; S. R. Kellert, 2002; Larsson, 2013; Lieberman & Hoody, 1998; O'Brien & Murray, 2007; Sobel, 1990; van Dijk-Wesselius et al., 2018)	- A lack of exploring non-visual connections with natural elements and stimuli within schoolyards and classrooms - A lack of study in effects of other natural elements and stimuli, except for plants only. - Limited evidence regarding indoor natural settings of primary school contexts	- Chapter 3 presents the overall and detailed research methods to explore children's visual and non-visual experiences of nature within outdoor and indoor environments of primary schools. - The results are then presented and discussed in Chapters 5 and 6.
School's classrooms	Beneficial impacts of classrooms with visual access to nature	(Küller & Lindsten, 1992; Li & Sullivan, 2016)		
	Beneficial impacts of indoor natural settings	(Han, 2009; Han & Ruan, 2020; A. E. van den Berg et al., 2017)		

Themes	Investigations in previous studies	Key references	Need for further investigation	Relevant consideration / chapter of this thesis
Primary-school children's perceptions and preferences on natural environments				
The evolutionary contexts	Children's innate love for nature and inclinations for natural landscapes	(Balling & Falk, 1982; Falk & Balling, 2010; Francis, 1988; Kaplan & Kaplan, 1989; Mahidin & Maulan, 2012; Ulrich, 1993; Wilson, 1984a; Yamashita, 2002; Zube et al., 1983)	A need for further analysis from aspects of cultural bias, temporal and spatial changes	- This study selected various children's groups from case studies between Glasgow and HCMC to explore differences and similarities in children's perceptions and preferences on natural environments. - The differences and similarities in perceptions and preferences for natural environments between children and adults, including architects and educators, are also conducted and presented in Chapter 7.
Socio-cultural contexts	The effects of cultural-, sub-cultural-, and social- differences in children's perceptions, preferences for natural environments, and pro-environmental beliefs and behaviours	(G. W. Evans et al., 2007; Hartig, 1993; Hunt et al., 2015; Kaplan & Herbert, 1987; Linzmayer & Halpenny, 2014; Miller & Kuhaneck, 2008; Schultz & Zelezny, 1999; Talen & Coffindaffer, 1999; Van Petegem & Blieck, 2006; Vikan et al., 2007)		These studies provide insights into the concept of this study with: - an adopting the comparative study between Glasgow, UK and Ho Chi Minh City, Vietnam to investigate the influences of contextual contexts, and - selections of schools that differ from socio-cultural contexts (presented in Chapter 4).
Educational approaches	Approaches of school architecture forwarding more children's multi-sensorial engagements with nature	(Harris, 2017; Otto & Pensini, 2017; J. Palmer, 2002; Warden, 2019)		These studies provide insights into the concept of this study's case studies which differ from educational philosophy and pedagogical approaches that are presented in Chapter 4.

Themes	Investigations in previous studies	Key references	Need for further investigation	Relevant consideration / chapter of this thesis
Primary school architecture				
Biophilic Design	Appropriate wilderness approaches in architecture and landscape design to re-establish the positive connections between nature and children in modern primary schools	(CABE, 2010; Clancy & Ryan, 2015; Derr & Kellert, 2013; Ghaziani et al., 2021; Joye, 2007; S. R. Kellert, 2006, 2008; McGee & Marshall-Baker, 2015; Ryan et al., 2014; Watchman et al., 2021, 2020; Wright, 2020)	- A need for a more detailed description of biophilic design features of educational environments - A need to promote efficient measurement tools rather than an exclusive focus on children's intellectual or emotional concepts - A need to explore features of individuals and various combinations of natural attributes of children's exposure, explore, and feel about nature through multiple senses - A need to understand children's perception of the ideal environmental school according to their needs and desires.	- The design approaches with associated purposes and biophilic design patterns are presented in Chapter 8 - This study provides a combination of different methods to bring spatial, psychological, and behavioural dimensions of children's experiencing nature through visual and non-visual senses within school environments. The description of research methods is presented in Chapter 3. The results are shown in Chapters 5 and 6. - The desirable characteristics of studying and playing environments are addressed in Chapters 6 and 7.
Child-centred school architecture	The discrepancy between adults' and children's perceptions about a beneficial school environment for children through child-centred methods	(Gal & Gan, 2021; Loureiro et al., 2020; Mustapa et al., 2015)		

Themes	Investigations in previous studies	Key references	Need for further investigation	Relevant consideration / chapter of this thesis
Study of children's nature connection (or children's HNC)				
Children's HCN	The diverse nature routines, especially direct natural experiences, as the foundation for shaping children's connectedness development.	(Chawla, 2020; Giusti et al., 2014)	- A lack of the understanding the relationship between connection indicators – forms of activities – features of spatial environments - A need to look at mixed approaches to help advance children's explanations of their perceptions and emotions toward nature, and how they perceive and evaluate nature within different contexts and spatial scales	This study provides a combination of different methods and mixed approaches to bring spatial, psychological, and behavioural dimensions of children's experiencing nature through visual and non-visual senses within school environments. In particular, - Descriptions of research methods are presented in Chapter 3 - The relationship between natural connection and features of spatial environments are investigated and presented in Chapter 5 - Children's natural connections that include their discovery of nature, environmental preferences, and spatial-social-natural interactions when exploring nature within different settings and scales of classrooms and playgrounds are presented in Chapter 6.
	The children's natural connection within a spatial environment is a combination of the natural-spatial-social interactions.	(Klaniecki et al., 2018; Skar et al., 2016; Vickers & Matthews, 2002)		
Research methodology of children's HCN studies	The dominant distribution of the EE programs' interventions which partly reflect features of the 'being *for* nature' phase	(Barrable & Booth, 2020; Lumber et al., 2017)		
	The dominant distribution of quantitative research methods	(Ives et al., 2017)		

All theories and evidence reviewed in this chapter help integrate related agendas, by incorporating the spatial configurations and their role into the children's nature connection research. However, research gaps remain in some specific areas of methodology and an integrative research framework. While most studies focus on children's task-working through examining memory, attention, self-individual emotional descriptions on scales, or performance on academic subjects, a detailed investigation of how children directly perceive and respond to various natural elements other than plants within their school sites is limited. Accordingly, there is a lack of research into evaluating methods that specifically focused on comprehensive measures of natural environment characteristics. These characteristics can directly connect to a child's sensorial modalities. Following this, an association between school settings, which are made up of the physical features and natural landscape, and the children's perceived multi-sensorial direct exposure to nature requires investigations. This responds to the need to understand how children define, feel, and interact with natural and non-natural objectives to enhance their sensorial experiences of nature when composed of various natural types within different kinds of school settings and typologies with socio-cultural-pedagogical contextual differences. These directions require further studies looking at empirical explorations and mixed methodology adaptions in architectural research related to children's nature connection. Therefore, this research aims to address these gaps and explore how new primary school design approaches might impact children's multi-sensorial experiences of nature in these spatial settings.

Chapter 3 Methodology

"Future research needs to link children's relations with the natural world to theory grounded in basic processes of child development, and weave back and forth between qualitative and quantitative methods."

— Louise Chawla (2020)

This chapter provides the overall approach to this research and a description of the methods employed. In the previous chapter, I concluded that studying children's experiences with nature in the primary-school-architectural field should combine the following factors: features of spatial environments and socio-cultural-pedagogical contexts. I also pointed out research gaps in the studies of children-nature connection. First, most research depended majorly on vision when measuring the degree of multi-sensorial experiences with nature within a defined space to understand how children perceive, feel, and interact with nature and non-nature objects. Second, to positively enhance children's perception and preferences toward nature in school environments, the child-centred approach combining both qualitative and quantitative investigations is a potential research direction. As this approach can increase the understanding about children's perceptions and desires on nature and places, it has the potential of enhancing their connectedness with nature within studying and playing environments at schools. This thesis attempts to bring all these areas together.

3.1. Analytical framework

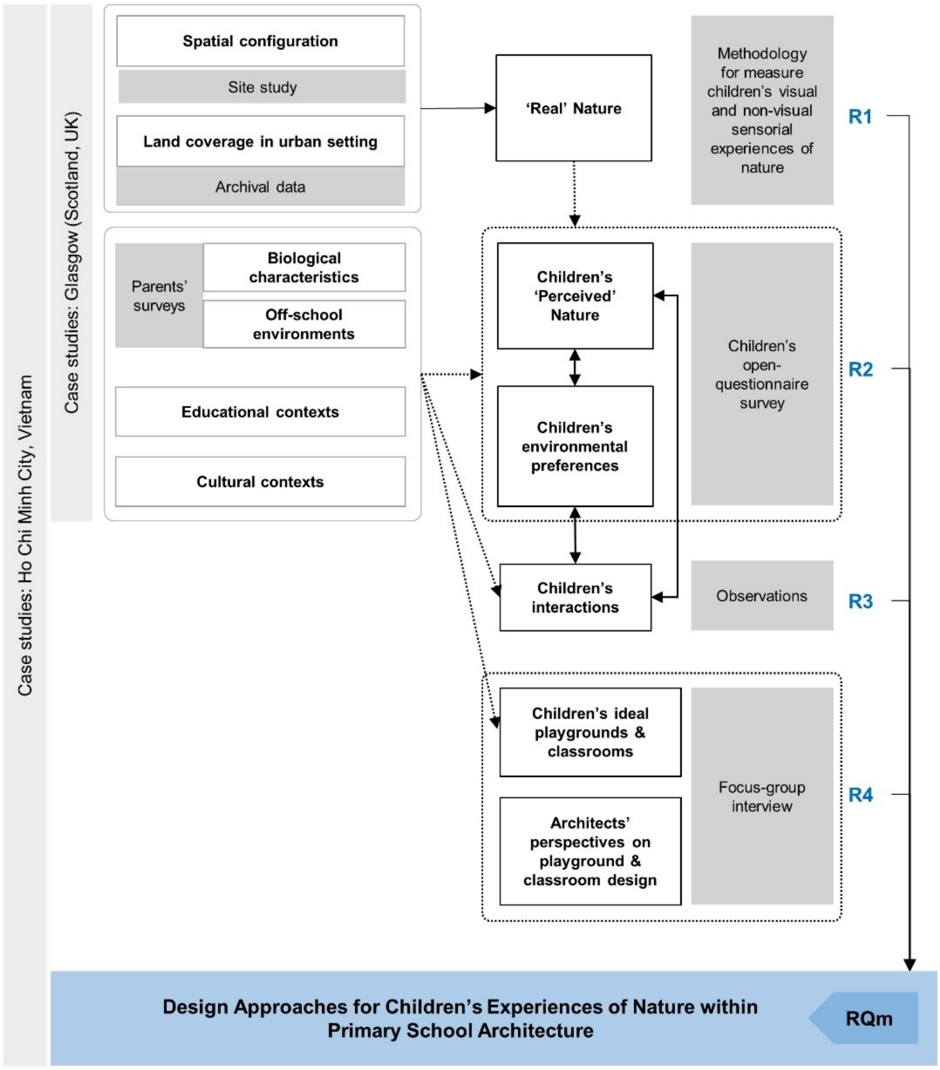


Figure 3-1. Methodology research, data analysis plan, and drawing conclusions

This research employed a four-phase multi-method research design, the data analysis plan, and drawing conclusions as shown in Figure 3-1. The overall research design was organized through case studies to investigate the differences of children's experiences of nature within school environments between various schools in Glasgow, Scotland, UK and Ho Chi Minh City (HCMC), Vietnam. Here, multiple case studies were used to explore patterns within and across different contextual cases (Groat & Wang, 2013). The first and second phases were conducted at selected primary schools in both Glasgow and HCMC to investigate the different facets of the '*real*' nature and children's '*perceived*' nature under the impacts of urban settings, architectural features, and socio-cultural-pedagogical contexts. The data collection progress of these phases included site studies, archival data analyses, and working with children and their parents through surveys. The University of Strathclyde Ethics Committee approved this study and signed on 23rd March 2018. The researcher delivered the research information sheets (see Appendix A_ 1 and Appendix A_ 2) and secured approvals from school boards and heads of six schools. Following, I fully presented what was involved in the research and the procedure of working with pupils to teachers whose classrooms were selected to be investigated. Through teachers, I sent a package, including a letter of research information, a parental consent form, and a survey paper to each child to parents. All students' parents and guardians who participated in this study signed the informed consent. The pilot study initially applied to Glasgow schools was designed to examine the research methodology before applying to HCMC case studies. In addition, this phase, which combined quantitative and qualitative analysis of the data obtained by parents' surveys and children's open-questionnaires, proved to be a key point within the research as it also examined the differences and similarities of the independent and dependent variables influencing children's perceptions and preferences on nature.

Then, the third and fourth phases focused solely on the HCMC primary schools for a comprehensive understanding of children's interactional behaviours and the gap between children and adults in considerations of ideal classrooms and playgrounds to promote contextual-based design approaches rather than a cross-cultural comparative study. Quantitative and qualitative data analysis through observation, open-questionnaire surveys, and in-depth interviews with children and professionals evaluated and discussed the whole picture of suitable design approaches that could bring nature closer to children and bridge the gap between the perspectives of schools' main users and the decision-makers. This could positively move children to vivid natural classrooms for the multi-sensory nature-rich experiences in the primary school environments.

3.2. A methodology for measuring children's visual and non-visual experiences of nature

The first phase is to evaluate the naturalness values of classrooms and playgrounds of primary schools to answer the first research question. The case studies in Glasgow and HCMC offered significant differences in spatial environment attributes to explore factors that impact the Naturalness value (NV) measurement of the children's multi-sensorial experiences of nature. The thesis contends that a comprehensive examination of natural environment characteristics that can directly connect to a child's sensorial modalities can in part address challenges in primary school architectural design and decision-making process when considering the child-nature (re-)connection. This also helps in re-thinking, re-forming, and re-designing proposals for children's learning and leisure places. Previous tools for examining the natural environment, ranging from the nearby to urban green spaces, to wilderness areas, have focused on typology (based on land use database or classification of land cover data) and/or the quality of the natural environment (have also varied between disciplines regarding the human's perceived environmental ranges and how the natural environment contributes to human's physical, psychological, and interactional aspects) (Arriaza et al., 2004; C. Gidlow et al., 2018; C. J. Gidlow et al., 2012; J. F. Palmer, 2004; Pálsdóttir et al., 2018; M. van Den Berg et al., 2017; van Dillen et al., 2012; Wheeler et al., 2015). However, less attention has been given to the relevant literature on the existent value of naturalness (VN) which directly impacts the human body via sensory modalities. This can be interpreted as the value of external *cause* while methods that obtain data from responses of populations bring *perceived* value due to the internal "*appraisal of core effect*" according to the model of human's experiencing nature (Linzmayer et al., 2014). Although the recent Space/Nature Syntax method developed by Munro & Grierson (2016) introduces this aspect, the method limits investigations to the visual connection of the human-nature relationship within the context of social distance. Thus, this study recognizes the need to expand this investigation by exploring the qualification of naturalness in a particular place to a more holistic visual and non-visual sensorial experience. Furthermore, it acknowledges that the varying value of nature concerning distance features has not yet been sufficiently investigated. In particular, it attempts to support a proximity hypothesis – that closer connections bring greater benefits to children; and that the proximity of nature at distances where a child has direct and meaningful sensory exposure is a vital requirement for the primary-school children group selected. For these reasons, a methodology was developed to measure children's visual and non-visual sensorial experiences by connecting NV with spatial environmental qualities across varying Child-Nature-Distance (C-N-D) ranges. Through particular contexts of case studies, this method was applied to evaluate the qualities of naturalness that children are exposed to under the impacts of various urban configurations and architectural features.

About the data collection progress, firstly, the plans and sections of appointed classrooms and playgrounds were defined to calculate the permeable areas and then to explore the permeability values of the relative architectural features through site studies and architectural drawings. Next, to investigate the influences of urban configurations of schools, the initial step was creating the land coverage plan through archival data. Chapter 5 will demonstrate the methodological approach, including an overview of specific features of our sensory modality systems, the results of the defined application, and how this method possibly contributes to decision making at micro and macro levels.

3.3. Children's 'Perceived' Nature and Environmental Preferences

The second phase is to identify the matrix of natural elements and stimuli that children perceive within their classrooms and playgrounds, the descriptor terms for sensory notations based on their feelings, and natural and non-natural features of their favour to spaces. Figure 3-2 presented the data collection and analysis structure of the second.

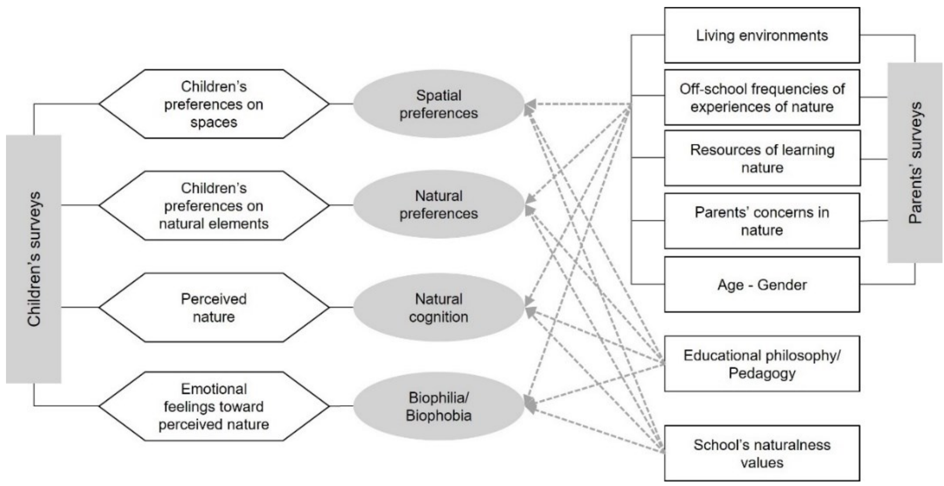


Figure 3-2. Data collection and analysis structure of the second phase

3.3.1 Adopting methods

Specifically, 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, means of children's studying nature, and parents' concerns about children spending time in nature. This data was collected to analyse the social impacts on the research objectives (see Appendix B_ 1 and Appendix B_ 2 for parent's survey forms of Glasgow and HCMC case studies, respectively).

Children had two working papers: the classroom and playground tasks. The open-ended questions and matrix diagram are considered as child-friendly approaches that encouraged participants to work on tasks and express their views without pressure and offered sufficient information and in-depth details for analysis (Grant, 2017; Punch, 2002). Children could both write and draw to illustrate the perceived natural elements. Drawings have mostly been for younger children with linguistic difficulties in writing due to lack of vocabulary whilst other children prefer writing because the drawing's abilities and enjoyment levels are significantly different between children groups (Literat, 2013). Thus, allowing the participants to decide whether in writing or drawing on the natural elements or stimuli, they could figure out via particular senses could provide rich information of the natural environment. The child-friendly format questionnaire was revised by educational experts, working as managers and teachers in investigated schools in Glasgow and Ho Chi Minh City, to ensure appropriate, clear, and consistent communication with the children.

3.3.2 Activities of data collection

Following the developed methods in considerations of age differences and locations of classrooms within school buildings and school sites, discussions were held with the deputy headteacher to select appropriate participants. Next, with the support of teachers, short meetings with students were held before conducting surveys within the studied contexts. Advantages of these contacts included: the researcher had first-hand experiences with potential participants, briefly delivered the purpose and process of the study as well as parental consent forms, collected spatial information, and developed a familiarity with the contexts. The researcher obtained schools' approval, parental consents, and student assent forms before the surveys to identify the number of participants and prepare materials (i.e. working papers, (coloured) pencils, and clipboards) for the students' tasks within classrooms and playgrounds. Work with each participant group occurred within a period of 50 and 60 minutes, including 10 minutes for the introduction and guidelines, 15 minutes for children working in the classrooms, then 5-10 minutes moving from the classrooms to playgrounds, and lastly, between 20 and 25 minutes for the outdoor tasks and collections. In classrooms, children positioned themselves as their regular daily activities. During working time, the researcher interacted and discussed with children whilst teachers only viewed from a distance.

3.3.3 Pilot study and Implementation

The pilot study of this phase was conducted in three private primary schools of The Glasgow Academy in Scotland between April and May 2008, springtime in Scotland, UK. The main aims of the pilot study were to test out research methods and build an understanding of variables influencing children's perceptions and preferences on nature in across-country research. The following sections provide a summary of each method trailed in order to justify the adopted methods.

a) Summary of issues and considerations raised from **children's open-ended questionnaires**:

- The matrix diagram method of the task (Figure 3-3) is difficult for children from 6 to 8 years old. Although the researcher explained how to work by giving step-by-step examples, children were confused and disorientated at the beginning of the classroom activity. Then, the researcher guided children in smaller groups again. After working in classrooms, they did the tasks smoothly in the playground areas.

- Some students forgot to respond to the question regarding their feelings toward nature. Younger students also had difficulties in writing about features of nature and their feelings. When they asked for help, the researcher had short conversations with them following the structure of the survey to avoid them having biased opinions under the influence of the researcher. These conversations started with the researcher repeating the question and asking the child what nature he/she wrote down. Then, the researcher asked questions about how a particular natural element looked like, and how he/she felt about it. When the child responded with words describing a characteristic of a natural element or stating their feelings, the researcher repeated and guided him/her to write down.

- At playground areas, some children were excited about running and playing with other friends rather than writing answers onto papers. They also tended to be discussing together when someone explored a natural element rather than working individually or communicating with friends sitting next to them solely in the classroom.

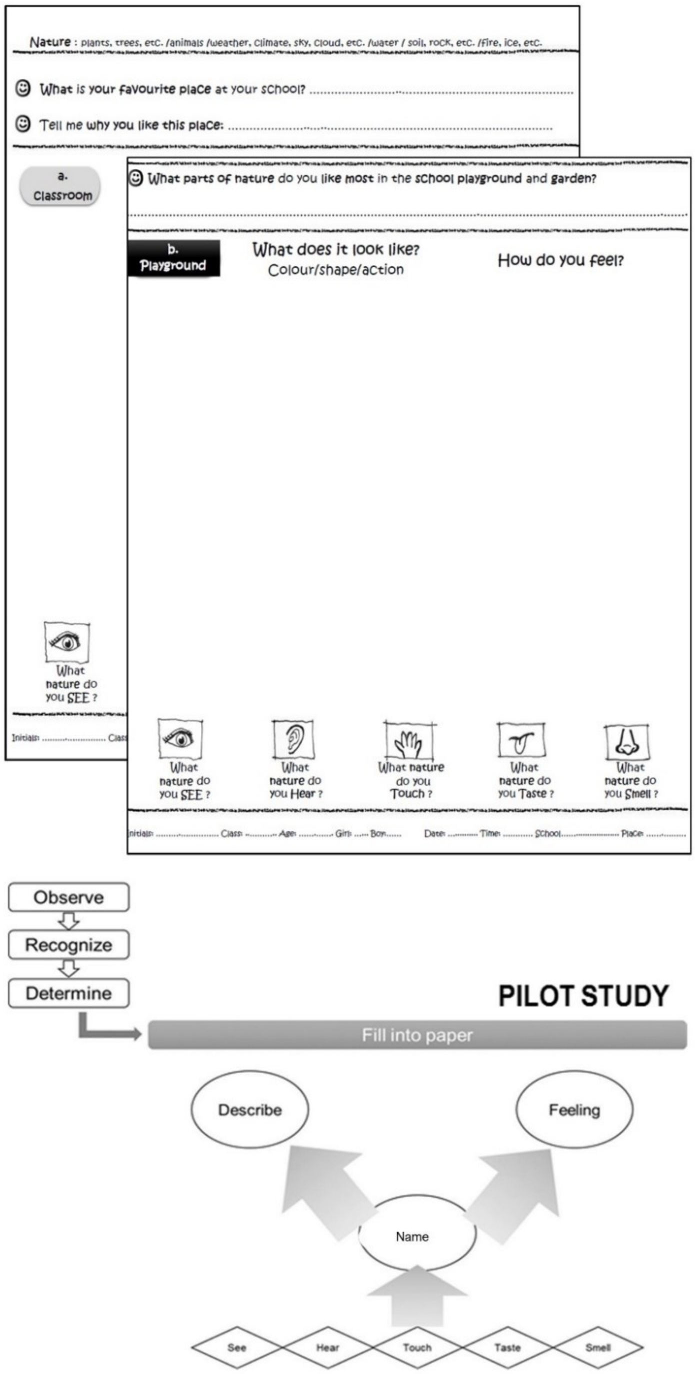


Figure 3-3. Open-ended questionnaire papers in classrooms and playgrounds for Glasgow case studies

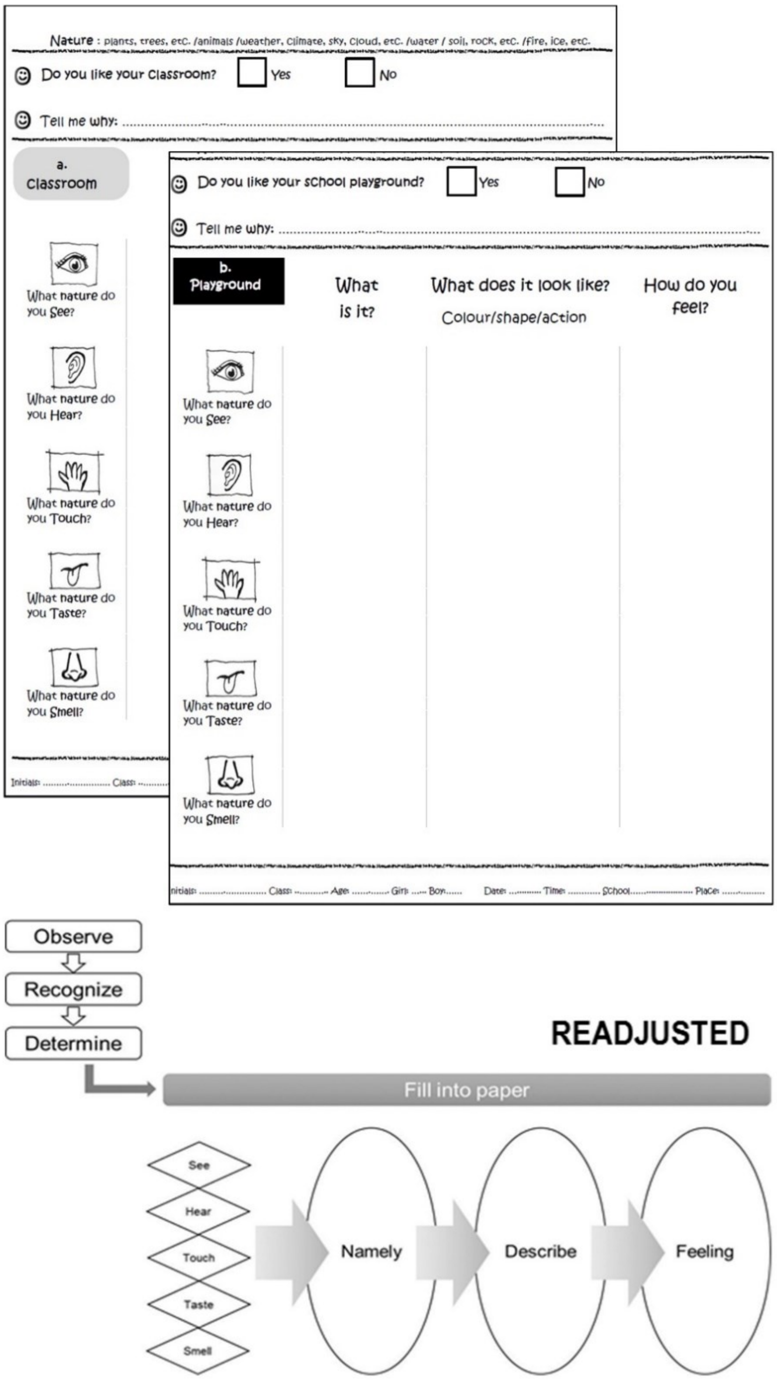


Figure 3-4. Readjusted working papers in classrooms and playgrounds of HCMC case studies

To summarise, consideration is needed for the following key points when designing the research methods:

- **Participant selection:** This method is appropriate for participants older than 8 years old with reasonably intellectual capacity and prior experiences in solving diagram tasks with given examples rather than younger groups who may find it difficult to communicate in writing and fill in diagram tasks (Fargas-Malet et al., 2010).

- **Specificity:** The format of survey papers needs to have distinct steps to help younger children understand and do the task smoothly. Figure 3-3 and Figure 3-4 show the structure of children's tasks of the pilot study and the readjusted version, respectively. With clear directions of given tasks, the refined structure would help children follow their flows of observing, recognizing, and determining the name of perceived nature, then describing features and their emotions. This orientated structure also reduces the number of questions being forgotten during the surveys.

- **Multi-method approaches:**

  In order to deepen the understanding of why children like or dislike a natural element, or why they prefer a place, we need to have a thorough approach to investigate children's discussions and explain their perceptions and experiences concerning nature and place. For this direction, children focus-group interview method is appropriate for generating qualitative data and assessing children's perspectives (Darbyshire et al., 2005; Horowitz et al., 2003). This study employed this approach to gain a precise understanding of children's interest in nature and places, for example, which natural and spatial features are in the favour of children, types of activity and/or individual/social interactions within their desirable spaces. With this supplement, there are changes related to open-ended questions for children in the readjusted version. Particularly, children in the HCMC case studies firstly answered the Yes/No questions: "*Do you like your classroom/school's playground*?", and then explained their opinion to the next question "*Tell me why you like it*?". Their responses would clarify which factors, including spatial–social–natural features, influenced their perception and feelings focusing on studied spaces. Based on children's responses, the focus-group interview approach furthered the investigation with detailed explanations about features of favoured nature and place of children.

  Observing children's activities during the surveys, it is necessary to ensure that the investigation of children's interactions when exploring nature within a space is important to understand how children experience nature. Some of them explored nature to work on the task while others explored nature by their body and movement. Some of them preferred to work individually whilst others gathered to work in groups. These differences varied the numbers of perceived nature elements and types and the emotional feelings children mentioned in papers.

b) Summary of issues and considerations raised from the **Parent's survey form**:

- Due to differences in housing typologies between case studies in Glasgow and HCMC, the options of questions related to types of accommodation vary according to specific conditions.

- There was some confusion between the classification related to occasional ranges of children visiting various places on weekdays and weekends. That gave parents some difficulties in defining the most appropriate options. Thus, the readjusted form (see Appendix B_ 2 for the parent's survey form of HCMC case studies) only creates a temporal scale regarding children's frequencies of visiting different places.

3.3.4 Data analytic strategy

According to the applied methods and structure of children's open-ended questionnaires and matrix of natural exploration, the data analytical process included two main sections. The first one was the diversity and features of natural elements and stimuli that children could explore and gain emotional feelings within their classrooms and playgrounds via multi-senses. The second one was related to their preferences in natural and spatial environments.

Firstly, children responded to the questions: "*What Nature do you see/ hear/ touch/ taste/ smell in your classroom/playground?*", and "*What does it look like (colour/ shape/ action)?*" They were asked to observe and identify names of natural objects corresponding with each sense, and then briefly describe their feelings. The matrix of children's multi-sensorial experiences with nature and the descriptor terms for emotional notations were explored through their reports within classrooms and playgrounds. The natural elements children reported in words or images were arranged into natural classifications according to a synthesis of natural science, environmental education, biophilia and biophilic design facets. Incompatible responses were excluded from the data analysis. Next, the question "*How do you feel about it?*" was posed to understand their emotional feelings toward recognized natural elements. Children's responses were synthesized and categorized into different themes. In particular, features of pleasant, unpleasant, and arousing ranging from low to high levels, were based on the concept of the circumplex model of affective appraisals (Russell, 1980).

The next data analysis focused on students' favourite natural elements and places at their schools according to questions of each case study as follows:

Glasgow case studies:

"What parts of nature do you like most in the school playground and garden?"

"What is your favourite place at your school?", and *"Tell me why you like this place?"*

HCMC case studies:

"Do you like your classroom/school's playground?", and "*Tell me why you like it*?"

Responses related to natural elements were collated into natural classifications and the emotional feeling themes. Favourite places that children identified were grouped according to physical features of places and the naturalness ranges. Reasons for place preferences were analysed through significant words and phrases and then combined for likeness.

Data management and the quantitative-qualitative analysis of data collected from children and their parents were performed using SPSS 26 and NViVo 11 programs.

3.4. Children's natural – spatial – social interactions

Interaction observations were carried out at HCMC studied primary schools when children did the task within the classrooms and playgrounds to establish how children interacted with the spaces, natural landscapes, and other people. Behaviour mapping was considered as a valuable approach for capturing people's behavioural patterns, social and environmental contexts within real spatial settings (Cox et al., 2018; Marušić & Marušić, 2012). The methodology for the observation was developed by a review of environmental-behaviour studies conducting observation techniques (Bozkurt & Woolley, 2017; Cox et al., 2018; Munro & Grierson, 2018). The core components of the behaviour mapping protocol are as follows: 1) a plan of the observation place; 2) a data collection tool; 3) a systematic coding; 4) and a strategy for data analysis. The core components are described in detail below.

3.4.1 A plan of the observation place

Initially, the researcher prepared the plans of classrooms and playgrounds with natural and spatial information. For classrooms, each plan illustrated the locations of openings (i.e., doors and windows), and participants' seats according to their anonymous codes. Because the sizes of classrooms are quite small, there is only one zone for observation. For outdoor areas, each plan showed the location within a school site, scale and layout of natural landscapes (for example, flowers, bushes, shaded trees, vertical plant walls, grass areas, sand areas, vegetable gardens) and physical settings, such as bench and play structures. To capture the entire number of participants, the researcher divided the maps into observation zones in large site conditions and each observer conducted a smaller zone.

3.4.2 A data collection tool

This study applied direct observation with camera recording for collecting data both in classrooms and playgrounds. When in classrooms, an unmanned camera was placed at the teacher's table or at a high position to capture all the children. The researcher noted the positions of children to explore the correlation between their behaviour and how they explored nature in the classroom. At playgrounds, observers took cameras to the field and stood in the pre-designated positions at observation zones. The number of observers with cameras correspondingly engaged in data collection at the playground areas was based on the size and form of the site. The standing positions were designated after the researcher processed the site study. By systematically rotating, observers could manage their time across every area within each zone and ensure that all areas were scanned for a 15-20 second interval to define children's utilizing each area actively or passively, and how children interact with peers. This digital approach helped to minimize missed information of children's interactions because children's states and speed of movements changed quickly, especially when there were a large number of participants. Four observers, including two architects and two undergraduate students, had proper explanation and training before official data collection commences.

Each participant group was recorded for 10-15 minutes in both the classroom and in the school's playground. Although the specified time of the outdoor task was between 20 to 25 minutes, however, the temporal durations of observations in the actual situations were shorter than the expectations because participants initiatively submitted their papers earlier. Furthermore, the time spent in each place varied due to the time each participant group completed the tasks. Important information of each participant group was recorded in the report form (see Appendix C_ 1. Report form of data collection progress). The detail of the data collection setting and procedure of each studied space will be presented in the following chapter.

3.4.3 A set of observable variables to be coded

The first step to analyze data was defining the attributes of observable variables and the terminology related to children's interactions. As presented in the literature review regarding the conceptual and analytical frameworks, three categories of children's interactions while exploring nature within a place are the following: spatial, social, and natural interactions. Because the features of organization of the survey and observable attributes are different, the sets of coding in the classroom and playground areas were designed to differentiate accordingly. The terminology and definitions of children's interactions in classrooms and playground areas were finalised as below.

a) Children's interactions in classrooms

For classroom observable coding, two categories: natural and social interactions of children were coded because the children's positions were unchanged during the period of working on the task.

Social Interaction

'Social Interaction' in the classroom referred to how a child interacts with his/her classmates. There are three coded categories: solitary behaviour, conversation with others, and on looking behaviour. 'Solitary behaviour' presented the children who did not communicate through verbal and non-verbal manners (meaning when a child solely listened without body and facial expression to respond to others). In contrast, 'Conversation with others' represented participants who spoke or listened to other children in pairs or in a group while they were or were not working on the tasks. Lastly, 'On looking behaviour' referred to those who actively observed other people but did not engage in a conversation with them.

Natural Interaction

For how they interacted with nature, 2 categories were set up to describe how a child displayed behaviours. Firstly, 'Natural Exploration' referred to a child who actively explored his/her environment. The behaviours were observing the surrounding of the classroom, looking out of windows, doors or any openings, looking to areas where there was sunlight, pointing out features of the natural landscape to other people, closing eyes and concentrating to explore through non-visual senses, expressing through body and facial languages (for example, when he/she breathes deeply or smells), or touching objects with hands. For non-natural interaction, 'Working on paper' were those who focused on the survey papers only.

b) Children's interactions in playground areas

For playground observation, through video recordings, interactions were marked onto a prepared plan of the investigated space using keys, with 3 categories of interactions, postural and sex identifier notations, being coded.

Spatial Interaction

'Spatial Interaction' referred solely to the interaction between a child and a space where he/she presented and occupied. When the child remained more than 30 seconds in a position, the code "Active Interaction" was applied. Conversely, when the child moved through a space and lasted less than 30 seconds, he/she was coded as 'Passive Interaction' because the main reason for being in an area was to move to another destination instead of using the space actively.

Social Interaction

'Social Interaction' meant a child interacted with other people while working on the given tasks. Children's social interactions were coded into 4 classifications according to the human distances of Hall (1963), they are Intimate (interaction of the child with others which occurs between 0 – 0.5m), Personal (between 0.5 – 1.2m), Social (between 1.2 – 4.0m), and Public (between 4.0 – 12.0m).

Natural Interaction

'Natural Interaction' referred to how a child interacted with natural elements and natural landscapes. When the child involved with the task, gave his or her attention toward natural elements or landscapes, for example, observing surroundings, looking to or going to flowers or plants, touching and feeling with hands, smelling flowers, and looking to the sky. In particular, the code 'involved' represented a child who worked on the task, and 'non-involved' represented a child with off-task behaviours, for example, ran and caught other people or submitted his/her papers back to the researcher.

These interactions were coded in combinations with their postural (whether the child is sitting, standing, lying on the ground, climbing, or walking) and sex identifier notations. The set for codes of children's spatial-social-natural interactions within the playground areas when exploring nature is in Figure 3-5.

Space:			Children's Interactional Observation		
Time: Date:			**Interaction keys**		**Symbols**
Weather:			**Interaction with Nature**		
Temperature:			Involved		
Humidity:			Non-involved		
Observed participants			**Social interactions**		
Female			0 – 0.5m	Intimate	
Male			0.5 – 1.2m	Personal	
Non-participated people			1.2 – 4.0m	Social	
Notes: Time in classroom: Other activities within studied areas during observational period:			4.0 – 12.0m	Public	
			Interactions within Space		
			≥ 30 seconds	Active	
			< 30 seconds	Passive	

F	M	Descriptions of symbols	F	M	Descriptions of symbols
		standing, **active** spatial interaction, **involved** natural interaction			standing, **active** spatial interaction, **non-involved** natural interaction
		sitting on the ground or bench, **active** spatial interaction, **involved** natural interaction			sitting on the ground or bench, **active** spatial interaction, **non-involved** natural interaction
		climb and sitting above others, **active** spatial interaction, **involved** natural interaction			climbed and sitting above others, **active** spatial interaction, **non-involved** natural interaction
		walking slowly, **active** spatial interaction, **involved** natural interaction			walking slowly, **active** spatial interaction, **non-involved** natural interaction
		lying on the ground with head facing down, **active** spatial interaction, **involved** natural interaction			lying on the ground with head facing down, **active** spatial interaction, **non-involved** natural interaction
		lying on the ground with head facing up, **active** spatial interaction, **involved** natural interaction			lying on the ground with head facing up, **active** spatial interaction, **non-involved** natural interaction
		standing, **passive** spatial interaction, **involved** natural interaction			standing, **passive** spatial interaction, **non-involved** natural interaction

Figure 3-5. Interaction keys and symbols of Children's interactions within a playground area

3.4.4 Strategies for analysing data from Behaviour mapping

Following the observational methods for indoor and outdoor interactions of children's experiences of nature, different strategies to analyse collected data are below.

a) Children's interactions in classrooms

Through data from video recordings, the researcher measured the duration of each activity the child spent during the task. The temporal proportion of each kind of interaction represented the tendency of children in exploring nature. Statistical analysis was used to explore the associations between their interactional patterns and the numbers of natural elements they could perceive. These associations were collected and analyzed in the second phase. Furthermore, the proportions of behavioural patterns were used to discuss the influence of spatial features and seating arrangements of the classroom on how a child interacts with others and experiences nature.

b) Children's interactions in playground areas

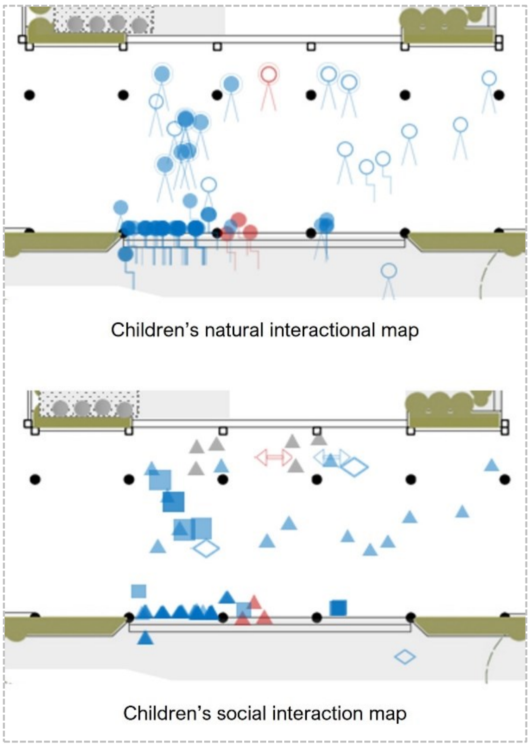


Figure 3-6. An example of how the children's social-natural interaction maps were illustrated

Also from video recordings, the mapping for the whole observation period of a site included 10 to 15 layers. Each layer was within a 1-minute interval for tracing the children's interactional patterns; within each interval, a child who remained in the space more than 30 seconds in a position was coded as 'Active Interaction'. The layer transparency represents the frequencies of children remain or appear in a position. Therefore, the more darkening colour the dots illustrated at a position, the longer time and higher occupying degree children remained and appeared within an area (see Figure 3-6 for an example of the children's social and natural interaction maps). Maps of all observations illustrated which areas were the most popular in the play space, the social patterns of children and the differences in relation to age and gender in experiences of nature. These evaluations could help to confirm the environmental features in studied areas and support opportunities for more connection with nature through different school playground settings.

3.5. Children's focus-group interviewing

After finishing the tasks in classrooms and schools' playgrounds, the researcher scheduled short and structured interviews with the participants to investigate further their activities, thinking and desires for ideal classrooms and playgrounds at schools.

The initial step was selecting participants. The researcher evaluated the children's responses according to two aspects. Firstly, the total numbers of natural elements and types being recognized through children's visual and non-visual senses. Results of children's natural exploration were arranged into three ranges: the lowest score group – the medium score group – the highest score group. In each group, the researchers selected two or three students randomly to join in the interview section with the equal distribution of gender carefully considered. Each child has unique needs and values that could possibly lead to differences in his/her environmental preferences. What appears important to one child may not bear the same values to another. Therefore, an interview offered an opportunity for elaboration. The next reason of interviewee selection was the significant, impressive or unexpected responses which required further explanation. Totally, from 10 to 12 children of each class took part in the interviewing section. When a group had less than 12 participants, the whole group participated in the interview after they finished working on the task. The format papers of students' interview are presented in Appendix D_ 1 and Appendix D_ 2.

Designated participant groups attended the interview in other familiar and flexible places (for example, their library room, a reading area in their schools, or a corridor area nearby their classrooms) without distraction from non-participants. When a child had an interview with the researcher, other children could select their activities flexibly around the area, however, without making noises and interrupting the speakers as suggested by the researcher and agreed by all children. Some children sat around and listened while others read books and waited for their turns. This child-friendly environment as in an extracurricular activity could help the child feel more comfortable when answering instead of being nervous with the one-by-one situation within a space (Clark & Statham, 2005).

Each participant has 3 to 5 minutes to give opinions about the following questions:

- "*Which place do you like most at school? and "Why*?"
- "*Which activities would you like doing in your free time at school?*"
- "*Which natural elements do you like most among your perceived natural types?*" (The research repeated all names of natural elements the child wrote down in his/her papers).

The format of interviewing was opened-ended questions instead of Yes/No questions. The researcher also informed the children at the beginning of the interview that there were no right or wrong answers. These directions could help children feel more comfortable in demonstrating their own thoughts and enriching explanations, as similarly suggested by Fleer & Li (2016) and Ponizovsky-Bergelson et al. (2019).

The following methodological approach in interviewing focus-group children was to investigate between-subject variations in preferences. The researcher minimized the variation between classroom and playground settings by selecting slides that varied on landscape and architectural components. The researcher sought explanations from focus-group children and professionals in architecture and primary education to identify differences in spatial and natural perceptions between the main users' views and the specified decision makers' views. The participants picked up the classroom and playground they liked most among given options and explained why they chose them. There were 4 classroom options and 6 playground options to give to them (Table 3-1). These photos are legally used in this research with the respective authors' approvals. Particularly,

Figures of four classroom options were designated according to specific features as follows:

- Architectural features of indoor-outdoor boundaries that influence the connectivity between studying space with the outdoor natural environment,

- Functional layout of furniture in the classrooms, and
- Characteristics of interior surfaces and facilities (shape, colour, and material).

Six schools' playground options were selected in considerations of the below features:

- The coverage ratio of natural and built environments,
- The levels of high trees providing shadow,
- The diversity of playing activities and facilities,
- The diversity of natural categories that children could experience with, and
- The appearance of humans in the landscape.

Table 3-1. Figures and specific features of classroom and playground options

Classroom options	Specific features
 Classroom I-1 (Source: Carlos Rabinovich)	• Natural connectivity with large windows and doors with views to outdoor environments; • Classical layout for individual studying; • Bright and simple coloured decoration and furniture; • Natural and artificial lightings.
 Classroom I-2 (Source: Huckabee)	• Flexible semi-open and semi-closed spaces that could connect directly to the outdoor environment; • Highly flexible studying layout; • High level of mixing natural and artificial materials which represent nature.

Classroom I-3 (Source: White Design Associates)

- Connect solely with the outdoor environment via skylight for natural lighting;
- Group-studying layout;
- Lively and impressive coloured decoration;
- Use natural materials and a curse-shaped structure.

Classroom I-4 (Source: Dirk (Beeki®) Schumacher on Pixabay)

- Wild area – totally connect with the natural environment and highly diverse natural elements via multi-senses;
- Natural materials and facilities.

Playground options	Specific features

Playground O-1
(Source: Warner Larson Landscape Architects)

- The coverage ratio of the hard surface is much higher than natural-based ground;
- Simple playground setting;
- Lack of playing facilities for young children;
- Lack of high trees and structures providing shadow;
- Not included human.

Playground O-2
(Source: Thuy Nguyen Thanh)

- The coverage ratio of the hard surface is much higher than natural-based ground;
- Diverse functional areas with a variety of facilities for children’s playing activities;
- Colourful decoration;
- Lack of shadowed trees;
- Included human.

Playground O-3
(Source: Sherwood Forest Montessori School)

- High coverage ratio of trees and grassed surfaced ground;
- Simple landscape setting to provide an empty space for children's playing, especially for playing football.
- Lots of high trees providing shadow;
- Not included human.

Playground O-4
(Source: Edible Schoolyard NYC, Photo by: Nancy Borowick)

- The coverage ratio of the natural elements is higher than the built environment;
- Garden setting with a variety of plants and flowers;
- Available sitting within a shadowed space by a light and small cover structure;
- Natural material utilization;
- Not included human.

Playground O-5
(Source: Richard Bellemo Landscapes)

- High coverage ratio of natural environment;
- Complex playground landscape setting with uneven terrains, sand areas, rocks, water streams, and small plants;
- Lack of high trees providing shadow;
- Not included human.

Playground O-6
(Source: Knox Forest School)

- Wild forest with stream and a variety of natural elements;
- Included human.

These dominant aspects for selecting these options to interview children and professionals were to explore the difference in preferences and perceptions on studying and playing spatial environments at primary schools. Each child had 5 to 10 minutes for this section. After looking at classroom photos, the interviewer asked the following questions to the child: "*Please pick up the classroom you like most?*". After the child selected one option, the research asked the next question "*Why did you choose it?*". He/she had time to think about this question, the researcher did not rush or push the child to answer quickly to avoid adding stress. When the child kept silent or had nervous facial expressions or looked back at the researcher without answer, the researcher repeated the question with encouragement, such as 'I really want to know what you like in this photo. Can you show me it?' to help the child relax, and thus, the child could elicit the richest data (Ponizovsky-Bergelson et al., 2019). When the interviewing related to the classroom finished, the child continued the similar process for playground options with the following questions: "*Please pick up the playground you like most?*", and "*Why did you choose it?*".

The collected data are both suitable for quantitative and qualitative analyses. The quantitative analysis was to figure out primary school children mostly favoured which spatial settings. Also, it was important to explore if there were any differences and similarities between children's preferences according to their age, gender, educational philosophies, and pedagogical differences. Next, a qualitative analysis of children's perspectives on spaces could explore significant features that impressed children positively or negatively, whether children considered nature in these places, and whether they were eager to study and play in wilderness areas. These expected outcomes could possibly contribute to promoting design approaches to not only satisfy children's needs and desires but also offer them higher opportunities to interact with nature at schools.

3.6. Interviewing Architectural Professionals and Educators

Age, gender, and occupation were the criteria used in choosing the participants for the interviewing. Two targeted groups of professionals priorly defined were architects and educational experts (i.e., primary-school teachers and school administrators). Unfortunately, the number of educational experts who agreed to participate in the study, especially from the public schools, was limited to three participants only. Thus, the main subjects were architects ranging from 20 to 50 years old. Because of that, the occupation factor is not explored in this study.

Each participant answered questions following the structure of the form shown in Appendix E_ 1. Two first questions were on selecting preferred and ideal classroom and playground settings. After showing the photos, the researcher asked the participants the following questions:

- "*Which classroom and playground do you like to study and play if you were a child?*"

  This question was to explore favours of spatial and natural environments of an adult without considering his or her responsibility for other people and society.

- Then, the researcher continued with the second question: "*From your viewpoint as an expert in primary-school education/architect, which are classroom and playground considered as the most suitable education environments for children at primary schools?*" and "*Why*?"

  This question was completely different from the first one because the subject, then, became self-conscious about the duty to deal with appropriate environments for children. The decision-making process of a professional is principally dependent on this state, and following this, thoroughly shapes the developmental environments of children. Thus, an investigation of these experts' various states of perspectives on environmental preferences for the primary-school period may help to explore changes during the life cycle, and important factors that influence the child-nature connection in primary school architecture.

- The final broad questions are: "*From your viewpoint as an expert in primary-school education/architect, what are the most important factors that need to be considered in setting up classroom and playground environments of primary school architecture?*"

  Responses of subjects to this question were categorised into various attributes to evaluate the importance of children's multi-sensorial experiences with nature from the professionals' perspectives, among other factors which are also significant.

To summarize, all children and professionals viewed the same photos, and the responses of groups with different age and role attributes were compared. This step cautioned the fact that what matters to children may differ from what adults with and without responsibility consider significant. Through these differences and similarities, we can figure out whether architects need to bridge the gaps between children's needs and their current perspectives.

Finally, to answer the management question: *Which are the appropriate approaches to offer children's direct experiences with a richness of natural diversity within primary schools?* - the findings of previous phases were synthesized to suggest implications for the particular condition of HCMC primary school architecture.

3.7. A summary of chapter

In summary, this research has proposed a methodological framework that collaborates spatial, psychological, and behavioural dimensions with a mix of quantitative and qualitative investigations as shown in Table 3-2.

Table 3-2. The summary table of the key influences for the various aspects of the research design

Research aims	Data sources	Method	Data analysis	Reviewed references
Measuring children's visual and non-visual experiences of nature	Land use database and Land use plans; Architectural drawings of plans and sections of investigated classrooms and playgrounds.	Site study and archival data	Quantitative analysis using Space Syntax and Microsoft Excel	(DepthmapX development team, 2017; Gehl, 2010; Munro & Grierson, 2016)
Children's natural exploration and their feelings toward nature within classrooms and playgrounds	Children's working papers	Open-ended questions and matrix diagrams	Quantitative and qualitative analysis using text and drawing analysis by SPSS 26, NViVo 11, and Microsoft Excel	(Fargas-Malet et al., 2010; Grant, 2017; Literat, 2013; Punch, 2002; Russell, 1980)
Children's environmental preferences at schools	Children's working papers	Open-ended questions	Qualitative analysis using text analysis, and Microsoft Excel	
	Children's descriptions and explanations	Focus-group interviews with structured and open-ended questions	Quantitative and qualitative analysis using discourse, text analysis, and Microsoft Excel	(Clark & Statham, 2005; Darbyshire et al., 2005; Fleer & Li, 2016; Horowitz et al., 2003; Ponizovsky-Bergelson et al., 2019)
Children's natural – spatial – social interactions when exploring nature within classrooms and playgrounds	Children's activities	Observations	Behavioural mappings and statistical analysis by SPSS 26, and Microsoft Excel	(Bozkurt & Woolley, 2017; Cox et al., 2018; Marušić & Marušić, 2012; Munro & Grierson, 2018)
Children's off-school environments and activities	Information of children's parents	Structured questionnaires	Statistical analysis by SPSS 26 and Microsoft Excel	
Perspectives of architects and educators to primary school architecture for children's natural experiences	Descriptions and explanations of architects and educators	Interviews with structured and open-ended questions	Quantitative and qualitative analysis using discourse, text analysis, and Microsoft Excel.	

In particular, it firstly includes an objective methodology for quantifying the naturalness of visual and non-visual sensorial experiences in a space. Following, this research implements the child-centred approaches to explore the factors that influence the children's perception – emotional feelings – environmental preferences, and interactional behaviours across different primary school settings and socio-cultural-educational contexts. Subsequently, the gaps between children's developmental needs and perspectives of decision-makers regarding the importance of nature for children at schools are investigated through depth-interview sections. With this established methodological framework, a synthesis drawing together the themes from main findings is generalized to inform design decisions with designated primary schools in Glasgow and HCMC as case studies.

Chapter 4 Case Studies

Primary schools in Glasgow, UK and Ho Chi Minh City, Vietnam

"Research on social attributions provides some evidence that people across countries, despite many similarities, can express different attribution styles, and these differences are deeply rooted in people's social and cultural background."

— Shiraev & Levy (2020, p. 316)

This chapter introduces contextual conditions of primary schools as case studies in Glasgow and Ho Chi Minh City (HCMC), providing background for the research.

4.1. Selection of primary schools

In both Glasgow and HCMC, three primary schools were recruited in each city to conduct case studies aimed at investigating 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 4-1 for two cities. The second criterion demonstrated a distinction in recruiting primary schools between Glasgow and HCMC.

Table 4-1. 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 playground settings;	
5	School's head teacher had to be willing for the school to participate.	

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. The locations and information of these schools are presented in Figure 4-1 and Table 4-2.

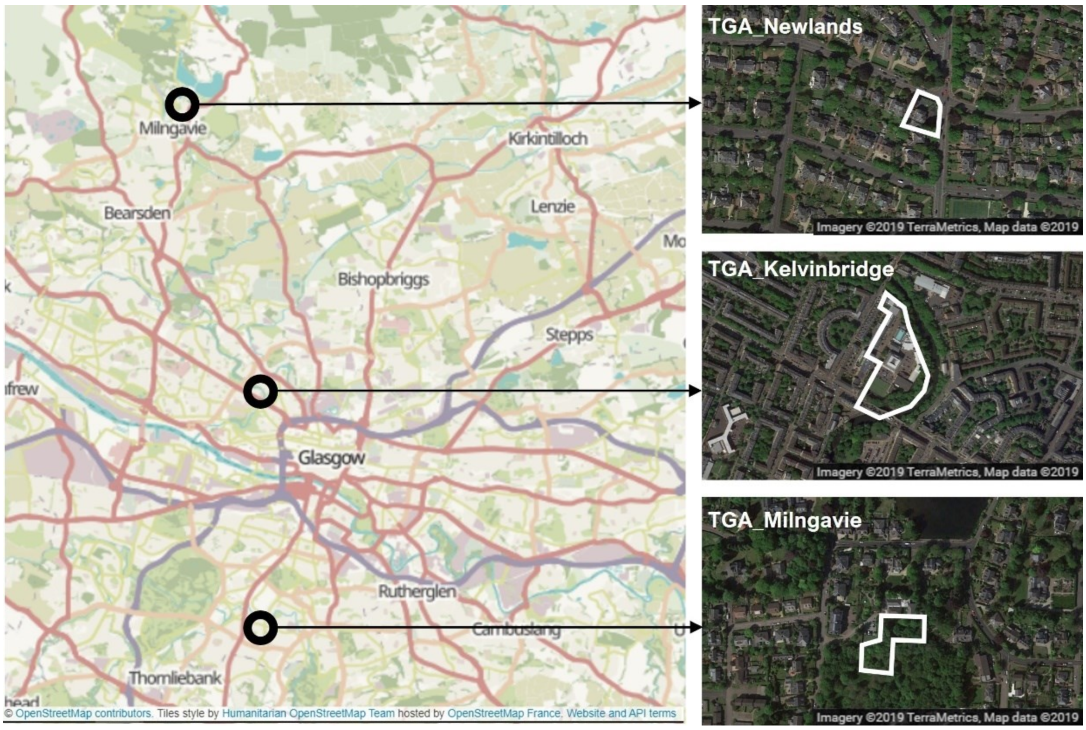


Figure 4-1. The locations of three TGA primary schools in Glasgow. Sources: Source of the left map: ©OpenStreetMap; Source of the right maps: ©Google Maps; Note: white shapes represent the boundaries of school sites.

Firstly, children at these three schools studied with the same educational curriculum. Particularly, TGA is a private school, known as an independent school within the Scottish education system, and so the majority of its pupils are from higher-income families residing in and around Glasgow. Secondly, they offer considerable differences in spatial configurations and architectural features of classrooms and playground settings for primary-school children and distinct locations within an urban setting. Last but not least, headteachers and pupils' parents consented to allow the researcher to conduct the study and work with pupils.

In HCMC, because this stage was linked with broader socio-educational factors, the researcher required a contrasting contextual consideration. Thus, information on primary schools that differed in educational settings was collected, including systems of mainstream and private schools. For the mainstream educational system, through the introduction of the University of Architecture HCMC, the researcher contacted the Department of Education and Training of HCMC in order to establish any connections to viable potential case studies. Then, the case study school Tran Quoc Thao (HCMC_TQT) fulfilled three major requirements: its location in the city centre district, its conventional design of school architecture in Vietnam, and approvals of the headteachers and students' parents. About private schools, a list of all primary schools that were driving as Waldorf Steiner, Montessori, and other alternative approaches was established. There is only one home school driving as the Waldorf Steiner approach, namely Tre Xanh Steiner (HCMC_TXS) or newly changed to Dong Xanh Steiner in 2019, provides curricula for primary-school children in HCMC. Among other private schools, the school Tue Duc Pathway (HCMC_TDP) was the last one to be recruited for its specific features. Firstly, 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. Besides, the school building was renovated from an industrial typology; thus, the setting of classrooms and playground were particularly distinct from the conventional primary school architecture. The similarities of the two private schools were the participants: they were students from middle to high-income families and their headteachers were interested in the research. Offering differences in socio-educational contexts, distinction locations in the urban setting of HCMC, and architectural features of schools' sites and buildings (Figure 4-2 and Table 4-2), three selected primary schools in HCMC were appropriate to investigate in this study. Table 4-2 provides a summary of the final case study primary schools selected to participate in the research. Later sections in this chapter provide a description of each school.

Figure 4-2. The locations of three primary schools in HCMC. Sources: Source of the above map: ©OpenStreetMap; Source of the below maps: ©Google Maps; Note: white shapes represent the boundaries of school sites.

Table 4-2. Features of case study primary schools

City	School ID	School Type	Location	School area (sqm)
	TGA_Kelvinbridge	Private school*	High density area of city	19,295
Glasgow	TGA_Milngavie	Private school*	Residential area in the suburb	1,411
	TGA_Newlands	Private school*	Residential area in the suburb	1,050
	HCMC_TQT	Mainstream school	City centre	2,335
HCMC	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.
** This is a private school within the Vietnamese education system;
*** This is a home school belonging to Steiner educational system.

4.2. Features of classrooms and playgrounds of case studies

Classrooms and playground areas in each school were considered according to their particular settings and how the spaces were used by participants to conduct the indoor and outdoor surveys. Thus, there were differences in the numbers of the selected classrooms, playground areas, and the participants between schools. The particular school settings and contexts investigated in each studied primary school are detailed in the below descriptions.

4.2.1 Three studied primary schools of The Glasgow Academy, Scotland, UK

School Kelvinbridge (TGA_K) context

The school of Kelvinbridge locates in the high-density area of Glasgow city; however, its site is surrounded by a river landscape and diverse green spaces. The features of studied environments are in Figure 4-3. Pupils did the natural exploration tasks within the outdoor environments that stretch from the entrance gate to the trim-trail playground area. The centred areas (Figure 4-3.(e), (f), and (g)) featured a flower-bed, flower-plants pots, and wooden benches while the remaining areas had artificial grass-surfaced ground and higher degrees of greenness.

The researcher investigated three classrooms, in which rooms TGA_K_P3 (on the second floor) and TGA_K_P4 (on the third floor) had similarities of locations within the recent building of the school master planning with modern designs, while TGA_K_P7 located on the ground floor of the older building at the main gate side and faced the road and another high building at the window side. The detailed descriptions of three investigated classrooms are in Table 4-3.

School Milngavie (TGA_M) context

In another condition, the school in Milngavie (Figure 4-4) is within a residential area in the suburb north of Glasgow, and its pupils have three various outdoor playing areas in which a wilderness is part of the school's facility. Three different playground areas were labelled as: TGA_M_O1 (an area at entrance gate), TGA_M_O2 (a soft playground where children spend their break time everyday), and TGA_M_O3 (a wild area where children study outdoor every week). Two outdoor areas selected for children's surveys were O1 and O3 because the O2 were occupied by other student groups' physical classes. The entrance area was decorated with many flower-plants and surrounded by many high trees and bushes while the wilder area was significantly featured with the earthy ground, high trees, bushes, and diverse plants.

Here, there was one classroom (see its description and figures in Table 4-4) where children of grade 3 and 4 participated the study because when TGA_Milngavie students go to the 7th grade, they would move to TGA_Kelvinbridge.

School Newlands (TGA_N) context

TGA_Newlands primary-school placed in the residential area of Mansionhouse Garden estate side is covered by crossroads and private houses. This school is different from Kelvinbridge and Milngavie as it has only one centre playground area. The studied indoor and outdoor environments can be found in Figure 4-5. Within their hard-surfaced playground, each particular functional area was divided by different colours and play facilities settings. The external landscape area was designated with a hedgerow comprised of shrubs and high trees, some flower-plant pots and a flowerbed for decoration.

Similar to Milngavie, Newlands students also move to Kelvinbridge for 7th grade, only one classroom with participants belonged to grade 3 and 4 was studied as described in detail in Table 4-5.

4.2.2 Three studied primary schools in Ho Chi Minh City, Vietnam

School Tran Quoc Thao (HCMC_TQT) context

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. 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.

The layout of school buildings and playground areas are in Figure 4-6. The main building is for teaching, learning and indoor extracurricular activities. 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. There are small flower-plants arranged along the corridor for decoration purposes. Children could also play at the entrance area where parking lots are in two side areas. Connecting these playground areas is an in-between space as the main hall where children could play while under unfavourable weather conditions, have meals, or gather for various 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. As shown in the Figure 4-6, there are two doors along the corridor and two windows opposite each classroom.

Doors and windows have simple glazing and steel frame. In this school, the researcher selected the typical classroom where children of all grades studied English twice a week to conduct the indoor surveys with three groups of pupils in grades 3 to 5 (meaning their age range from 9 to 11). This investigation could study how different age ranges vary in children's multi-sensorial exploring nature within a designated indoor environment. The figures and descriptions of this classroom are in Table 4-6.

School Tue Duc Pathway (HCMC_TDP) context

Tue Duc Pathway is a private school in the community-educational designated area of the developing district - District 12. The school playground and main building is a renovation work from an industrial building type; thus, the layout was completely different from principal school design as HCMC_TQT (as presented in Figure 4-7). The number of pupils enrolled per class is smaller than in public schools and varies from one year to another. In HCMC_TDP, the researcher selected three groups of children, with ages ranging from 9 to 11 years old, to participate. Each group had an indoor survey in their classroom as shown in Table 4-7. All pupils always study in air-conditioner and artificial lighting conditions because the layout is not appropriate for natural ventilation and lighting, such as the classroom of grade 3 (HCMC_TDP_P3_I). Here, the classroom setting during the indoor survey periods remained the same as their daily studying environments for two reasons. The first reason was that the natural settings did not guarantee light quality for students' working on tasks. With these limitations, it would be beneficial to appraise the influences of spatial features on the degree of naturalness children are exposed to and perceived in their real situations.

Outdoor surveys took place at the main playground area where there were two parts with different ground materials (Figure 4-7). One part was artificial grass, and another was hard-surfaced, covered with many play facilities to encourage children physical activities and offer more adventurous challenges. The significant feature of this place was that most of the area was under many shadowed trees and bamboo trees.

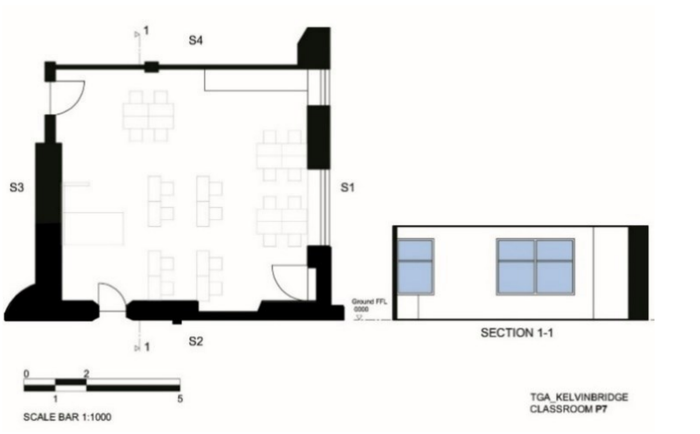
School Tre Xanh Steiner (HCMC_TXS) context

Tre Xanh Steiner school locates in a residential area of District 2, a developing district. This home school belongs to Steiner educational system with only 4 classrooms within the house. Two classrooms of students grade 5 and grade 3&4 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 study table arrangements differ because the number of younger groups is much smaller than older ones; thus, students of grades 3&4 had more flexibility and spacious indoor environments (Table 4-8) with doors and one window for natural ventilation and lighting. Air-conditioners were also in use on hot days. However, during the survey periods, two classrooms remained the same as their normal environments with the air-conditioners turned off.

The school rented three pieces of vacant land which to create three different playground areas (as be seen in Figure 4-8) for various kinds of pupils' outdoor activities. Children from 6 to 8 years old mainly occupy the sandy playground O1 while the O3 area suits the older groups better. The O2 is for outdoor studying activities (for instance, learning carpentry skills, doing handicrafts, and making bonfires) with a vegetable garden. However, these spatial and functional settings do not have clear separation, all children have the freedom to choose the playing area according to their own desires and preferences. Based on suggestions from teachers and school's activities during survey periods, the students of grades 3&4 explored nature in the O3 area while the grade 5 students investigated the O2 area; these were places where each group mostly spent outdoor activities.

Figure 4-3. TGA_Kelvinbridge studied playground areas. Source: Author
(a) Studied classrooms and playground areas; (b) the trim-trail playground area; (c) and (d) river landscape and green spaces surrounding the playground corridor of the newly building; (e) and (f) wooden bench and flower bed; (g) the playground area at the entrance gate.

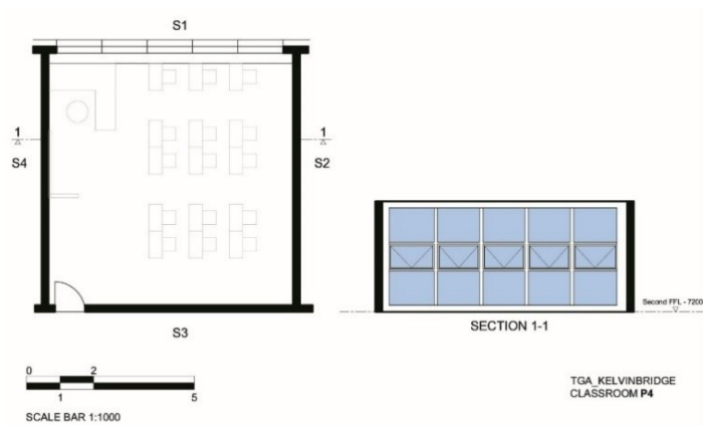
Table 4-3. Three studied classrooms of TGA_Kelvinbridge school



TGA_K_P7_I (Area: 60.5sqm)

- Locates on ground floor;
- Faces the road and a high building from two windows;
- Indoor natural elements: avocado seedling pots (with soil).
- Children sat in pairs and small groups.

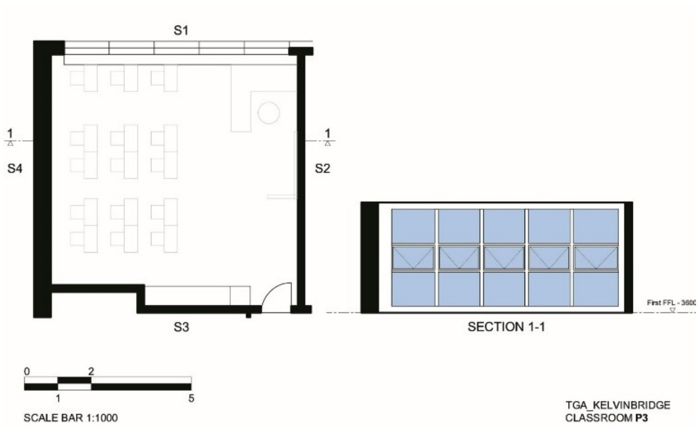
Windows were closed during the survey.



TGA_K_P4_I (Area: 54.8 sqm)

- Locates on the second floor;
- Has large glass windows that provide views to green spaces surrounding school site;
- Children sat in pairs.

Windows were closed during the survey.



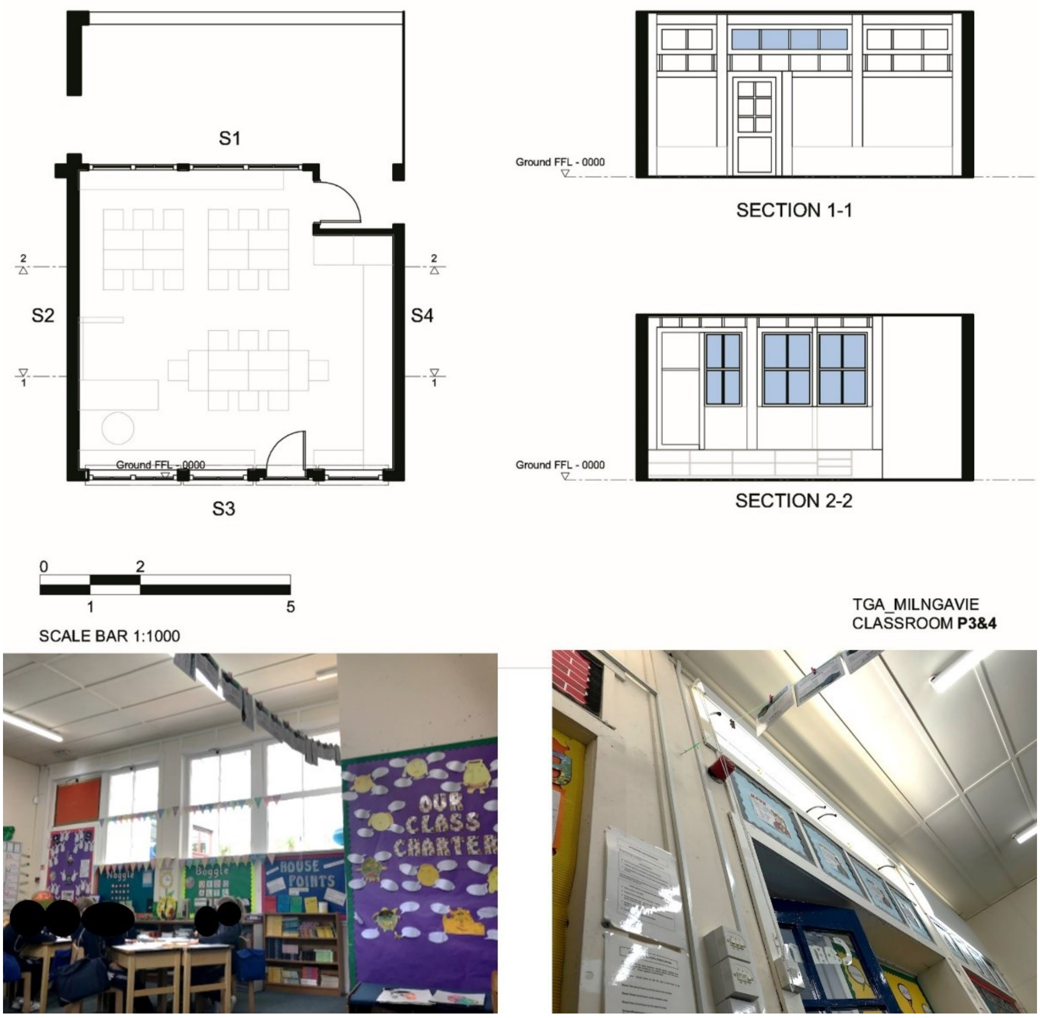
TGA_K_P3_I (Area: 53.8 sqm)

- Locates on the first floor and has large glass windows that provide views to green spaces surrounding school site;
- Indoor natural elements: tadpole pots;
- Children sat in pairs.

Windows were opened during the survey.

Figure 4-4. TGA_Milngavie studied playground areas. Source: Author.
(a) Studied classrooms and playground areas; (b) and (c) the flower-plants at entrance gate; (d) and (e) the wild area for outdoor study that children called as "Moore"; (g) and (f) the soft artificial-grassed playground area where children spend their break time.

Table 4-4. The studied classroom of TGA_Milngavie school



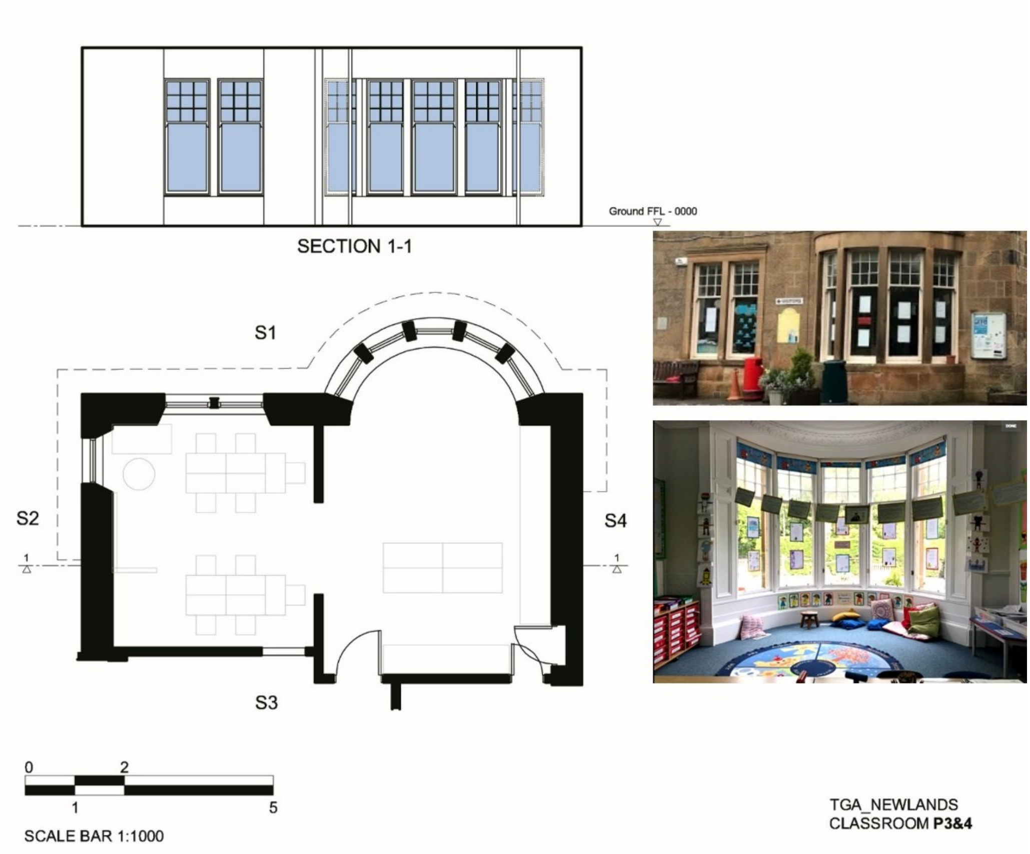
TGA_M_I (Area: 35.7 sqm)

- Has large area of glass-window at the side which is connected via an open-viewed corridor adjacent to an external landscape area – bushes and wooden plants as hedgerow;
- Has glass area above children's sitting and standing eye-heights;
- Indoor natural elements: flower plants for decoration.
- Children sat in small groups.

Windows were closed during the survey.

Figure 4-5. TGA_Newlands studied playground areas. Source: Author.
(a) Studied classrooms and playground areas; (b) and (c) flower-plants and trees in O1 position; (d) and (e) main playground area with wooden facilities; (f) and (g) the area for playing football.

Table 4-5. The studied classroom of TGA_Newlands school



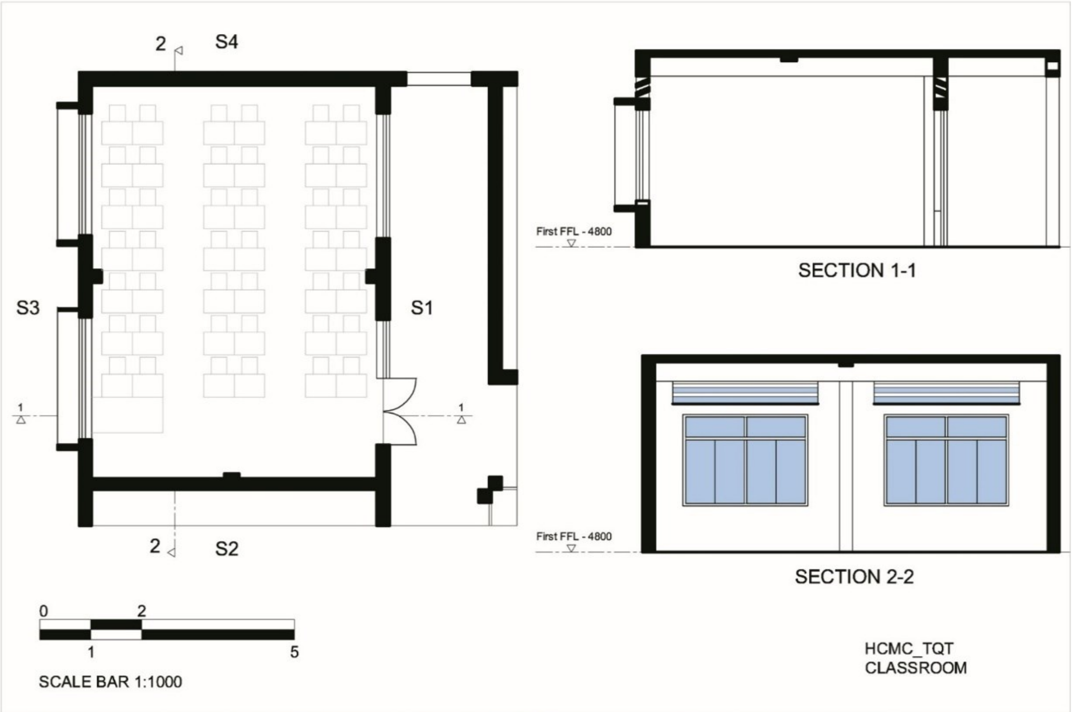
TGA_N_I (Area: 49.1 sqm)

- Has two sides connecting directly to the outdoor environment through glass-window systems at appropriate heights;
- Indoor natural elements: caterpillar boxes
- Children sat in small groups.

Windows were closed during the survey.

Figure 4-6. HCMC_TQT studied playground areas. 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).

Table 4-6. The studied classroom of HCMC_TQT school



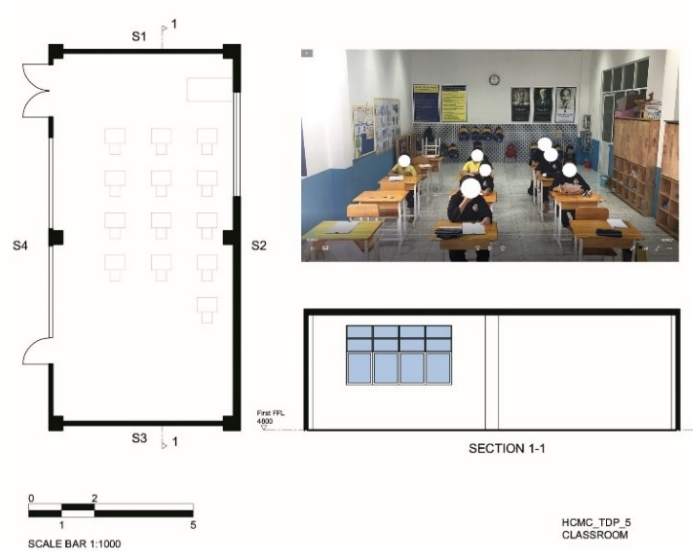
HCMC_TQT_I (Area: 43 sqm)

- Locates on the first floor;
- Has two large windows (with steel frames) directly to the outdoor environment;
- Has a frosted door and a window that was not currently utilized for lighting at the corridor side;
- Indoor natural elements: seedling pots (with soil).
- Children sat in pairs.

Windows were opened during the survey.

Figure 4-7. HCMC_TDP studied playground areas. 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.

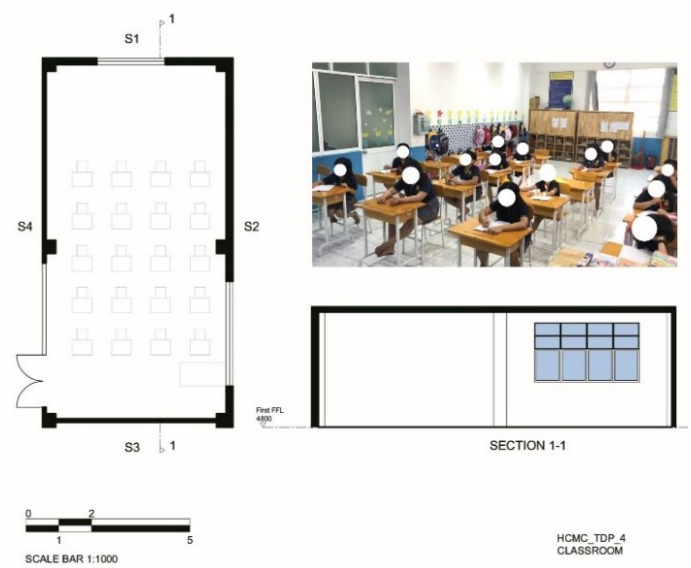
Table 4-7. Three studied classrooms of HCMC_TDP school



HCMC_TDP_P5_I (Area: 62.0 sqm)

- Locates on the first floor;
- Has one window directly to outdoor environment;
- Other doors and frosted glass frame windows at the inner corridor side do not connect with outdoor environment.
- Children worked individually at their study tables and desks.

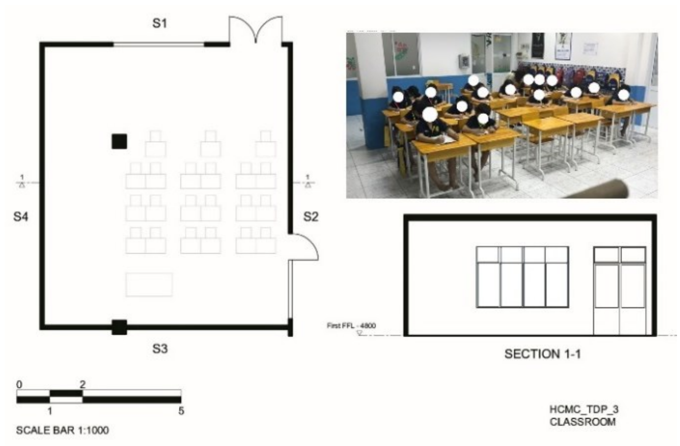
Windows were opened during the survey.



HCMC_TDP_P4_I (Area: 59.0 sqm)

- Locates on the first floor;
- Has two windows directly to outdoor environment;
- Other doors and frosted glass frame window at the inner corridor side do not connect with outdoor environment.
- Children worked individually at their study tables and desks.

Windows were opened during the survey.



HCMC_TDP_P3_I (Area: 63.3 sqm)

- Locates on the first floor;
- Completely disconnect with outdoor environment;
- Children sat in pairs.

Windows were closed during the survey.

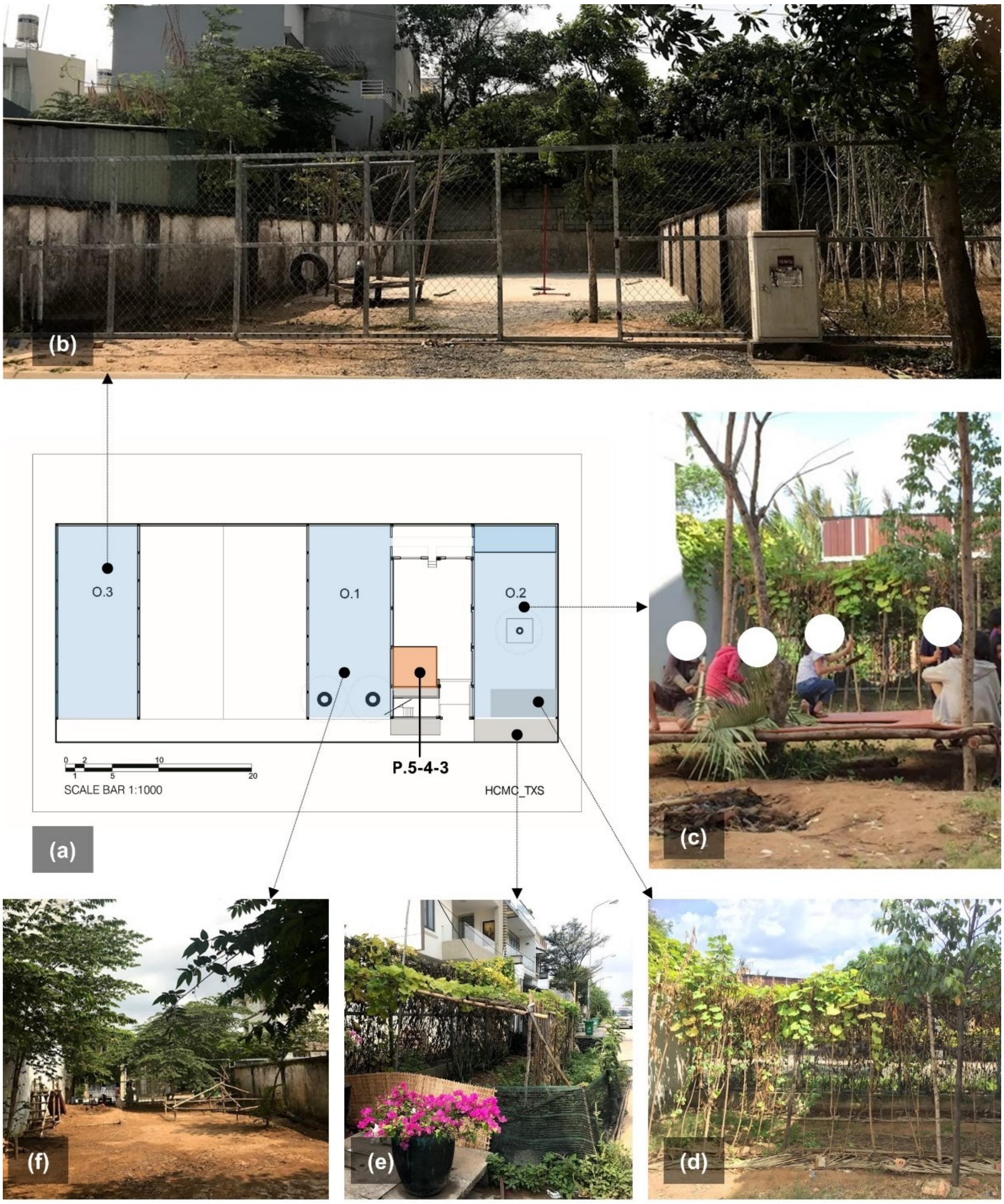
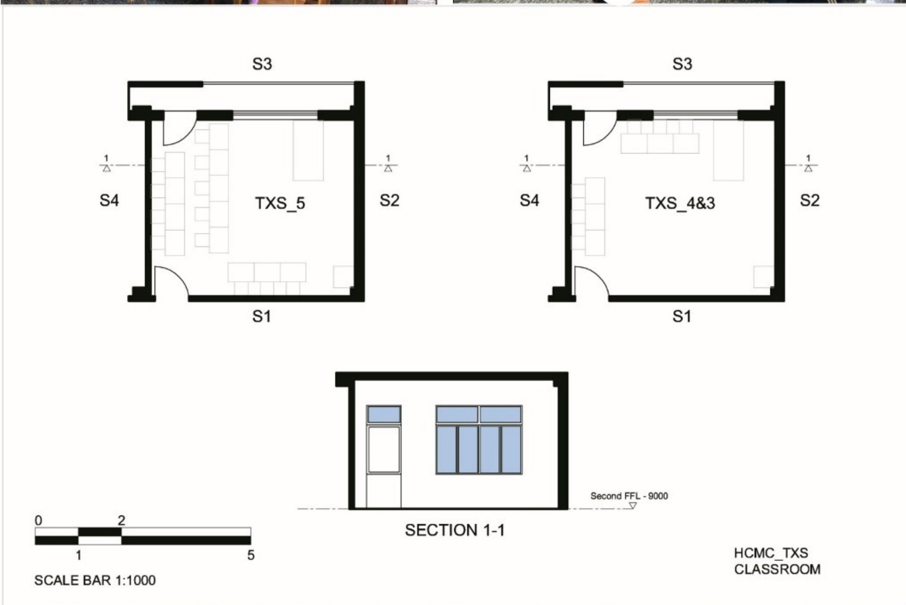


Figure 4-8. HCMC_TXS studied playground areas. Source: Author.
(a) Studied classrooms and playground areas; (b) the area for multi-playing activities; (c) the area for children study outdoor and play, including (d) a vegetable garden; (e) a vegetable garden at the front gate; (f) the sand playground area.

Table 4-8. Two studied classrooms of HCMC_TXS school



HCMC_TXS_P4&P3_I (Area: 19.5 sqm)

- Locates on the second and third floors;
- Has a door and a window directly to outdoor environment;
- Indoor natural elements: "Nature" tables;
- Grade 5 students sat closely along the walls; while children of the grades 3 and 4 sat and lied down on the floor.

During the survey, windows of two rooms were opened, doors of grade 5 room were opened while grade 4 room's doors were closed.

4.3. The significances regarding the child-nature relationship of case studies

This section broadly clarifies important factors affecting the degree of naturalness children experience with and preference for nature between participants from Glasgow and HCMC case studies. Initially, the contextual backgrounds of the urban environment, climate condition, and primary education were evaluated to provide an overview of natural environments that children of two cities experience within their urban living environments. Then, significant features regarding educational contexts of studied primary schools in the facet of the child-nature relationship were discussed.

4.3.1 The context of Glasgow City

a) Urban environmental contexts

Glasgow City is the largest city in Scotland, UK, with a population of approximately 635,000 (Glasgow City Council, 2021). There are many ethnical groups (not include white Scottish) in Glasgow which account for 12% of the total population in 2011; among them, Pakistani, African, and Chinese are the largest groups. This feature leads to a diverse ethnic, religious, and cultural context of Glaswegian citizens in general and school-aged children in particular.

Glasgow has evolved over the last 20 years into a modern service-based economy. In recent years, the economy sector has grown rapidly within digital, science, and technology with three Innovation Districts. With the lowest growth rate among the UK's Core City Regions by 2.7% over the past 5 years, the population density of Glasgow City was 3,618 people per square kilometre in 2019 (Glasgow City Region, 2019).

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 (Glasgow Centre for Population Health, n.d.-b). Due to a high range of natural spaces, the ratio of children under 16-year-old lived within 400m of publicity accessible green space is 80% on average (Glasgow Centre for Population Health, n.d.-a), 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 (Yates, 2021). Even though Glasgow is also famous for its green environments and these accessible greenspaces could offer many social and environmental benefits, however, the quality of open green spaces, especially for children's outdoor activities, has been still an important on-going consideration of the Scottish government for levels of use and the benefit 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^{o}C during the days and 11.4^{o}C at night. Meanwhile, the coldest months last from December to January with daily and nightly temperatures of approximate 6^{o}C and 1^{o}C, respectively. Climate change also affects Glasgow city and the average temperature could rise at least a couple of degrees by the 2050s (Scotland Adaptation, 2017). 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 (Majekodunmi et al., 2020). 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.

In regards to thermal comfort, Krüger et al. (2013) found that 9-18^{o}C degrees were the optimal outdoor thermal comfort conditions for adults in Glasgow. This range is lower than the universal scale of 18-23^{o}C suggested by Matzarakis, Mayer, & Iziomon (1999). For UK children, comfort temperatures are lower than that of adults and vary in different studies due to different seasons. The comfort temperature of 11-16 years old children was 20.8^{o}C in summer (Auliciems, 1973) and 16.5^{o}C in winter (Auliciems, 1969), respectively. Meanwhile, conducted from April to July, Teli et al. (2012) found that the comfort temperature of students in primary school environment was 20.5^{o}C. In this study, the investigated period of data collection was April and May when rain was less frequent, and the temperatures were around 9^{o}C and 15^{o}C. Thus, it is important to explore how they responded to environmental concerns when the weather condition was lower than their thermal comfort range. Furthermore, differences in weather changes during survey time probably influenced how they explored and valued natural elements related to weather, such as wind, sun, and rain, as well as how they selected favourable places under the impact of a colder weather condition.

c) The context of independent 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 (A National Statistics Publication for Scotland, 2019). The majority of private schools are from higher-income families residing in and around Glasgow due to higher tuition fees for greater academics that could help their children achieve higher returns compared to those of state schools.

According to the inspection report by Education Scotland in 2018, the quality of learning and teaching of the three TGA primary schools were highly rated (Urquhart, 2018). The Three TGA schools' curricula are based on Curriculum for Excellence (CfE) with a wide-reaching range of co-curricular clubs, specialist lessons, and outdoor learning activities. The CfE, introduced by Scottish education in 2010, aims to provide knowledge, essential skills and characteristics for life in the 21^{st} century for children and young people aged 3-17. According to the category of Sciences (Experiences and Outcomes) of CfE, children of grade 3 (from 7 years old) have the ability to distinguish living and non-living objects, identify and classify natural elements, day and night, seasonal-weather features and changes. Older children of grades 4 and 5 could develop understandings of species in ecosystems, food chains and webs. Besides, the impacts of humans on nature and how to protect nature (including forest, land, water, and air) also appear in both primary educational curriculums. On top of this framework, TGA students also have many opportunities to experiences nature through co-curricular activities and regular learning trips. For these reasons, TGA students had the appropriate knowledge and capacity to fill out the research surveys.

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 (Department for Education, 2014). The maximum class sizes of P1, P2 or P3, and P4-P7 in mainstream schools are 25, 30, and 33 pupils per class, respectively. Three TGA primary schools in this study had a lower number of students per particular grade classroom than the standardised figures. Students, thus, had appropriate indoor environments for studying. 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 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' (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.

4.3.2 The context of Ho Chi Minh City

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 (Ho Chi Minh City Statistics Office, 2019b). HCMC, as the main economic centre of southern Vietnam, had the highest number of both Vietnamese and foreign immigrants with an increased immigration rate of 12.68% in 2019. 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 (Ho Chi Minh City Statistics Office, 2019c). Particularly, the population density figures of districts in which the primary school HCMC_TQT, HCMC_TDP, and HCMC_TXS locate were approximately 39,000, 12,000, and 3,700 inhabitants per square kilometre in 2019, respectively (Ho Chi Minh City Statistics Office, 2019b). In comparison, the figures of the two schools HCMC_TQT and HCMC_TDP were much higher than of Glasgow city urban context as presented above.

In addition, current challenges of urban development of HCMC are urban sprawl and climate change impacts (Nguyen et al., 2016; Storch & Downes, 2011), for example, increased urban heat island effect and pollutions of water, air, and land. Furthermore, the rapid urbanization process with the growth of both planned and informal expansions has caused the 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 (Dang et al., 2018). The average urban green space of HCMC per citizen in 2017 was 32.4 sqm (Dang et al., 2018; Ho Chi Minh City Statistics Office, 2017). 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 (Hoang et al., 2019).

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 (Dang et al., 2018) and intensive use of air conditioning (Matsumoto & Omata, 2017) 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^{o}C in the mornings and 32-34^{o}C in the afternoons, however, the absolute maximum temperatures can rise to 40^{o}C. HCMC also has a high number of sunshine hours during the year - 2489 hours, which is one of the most important challenges in building design. Besides, the study by Son et al. (2017) showed evidence of worsening urban heat islands in HCMC; in particular, the radiant temperature increased from 22.4-35.8^{o}C in 1996 to 25.3-40.4^{o}C in 2016 and the land surface temperature also rose from 30^{o}C in 1996 to 32^{o}C in 2016 under the impact of the urbanisation process.

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. The recent study by Le et al. (2017) investigating primary schools in HCMC suggested that most children were satisfied at 32.8^{o}C condition when they were in classrooms. HCMC students in this study had higher thermal comfort tolerance than the universal scale of 18-23^{o}C as suggested by Matzarakis, Mayer, & Iziomon (1999). However, students feel completely uncomfortable within the school environment since their thermal comfort range as found in the study is still lower than the temperatures in the afternoon, especially in the hottest months of HCMC. 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.

It is important to note that the investigated periods of HCMC primary schools of this study lasted from February to April, which were among the highest temperature and highest solar radiation months of the dry season, the trade wind flows at 3.1m/s on average. The study by Doan & Kusaka (2018) investigated thermal environment in the month of April showed that the ratio time of all of HCMC urban resident experienced uncomfortable heat were 50% (from

2005 to 2014) and would increase to 80% of the entire month in the 2050s. Besides, students of the public school HCMC_TQT, which locates in the central districts, experienced a higher range of heat exposure than students of non-public schools in the outer areas (Dang et al., 2018). These characteristics would probably affect how students at different school environmental contexts give responses towards the natural elements and stimulus, and where they prefer to spend time within schools.

c) The context of primary education

Management of primary education

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 (Ministry of Education and Training, 2020). The state is responsible for establishing and running public schools. The non-public (private) schools, established by entrepreneurial individuals or organisations from the private sectors, have to receive certification and license by the MoET to operate.

According to the statistical report regarding education in 2019, the growth rates of primary schools and students in HCMC were +1.8% and +2.0% when compared to the year 2018; the non-public schools accounted for only 3.2% in the total, and the average number of pupils per class in public and non-public schools were 31.9 and 13.4, respectively (Ho Chi Minh City Statistics Office, 2019a). MoET (2012, 2020) regulated that the number of students in each class must be no more than 35. However, the figures of HCMC schools in 2019 were higher than this standard with an average of 40 pupils per class. The numbers of students per class of public primary schools located in inner core districts were higher than standardized and average figures. 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. Due to the limitation of state funding, the material facilities of public schools have not been improved much in quality and have not met the high demand of an increased number of pupils enrolling. On the other hand, in non-public or private primary schools, the average number of students of each school was much lower than the standardized figure because of high tuition fees. Besides satisfying national standards as required, these schools had sufficient financial resources to set up studying and playing environments according to their specific strategies for children development. However, studying on non-public schools to evaluate their environmental quality has not been conducted.

The architecture of primary schools

In terms of primary school architecture, the school must meet requirements of the National standard regarding the school site selection, master planning of school site and playground areas, architectural features, infrastructure and facilities, management and administration (MoC and MoST, 2011). This standard specifies that the urban school site area and the classroom size area per student have to be no less than 6 sqm and 1.25 sqm, respectively. 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. Therefore, to provide a comfortable environment for teaching and learning activities in the consideration of reconnecting the child and nature, it is essential to understand children's perspectives in their classrooms.

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 public 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. In non-public schools, their designs vary according to the investors, investment budgets, and strategies of developing children. Due to their greater financial resources and updated educational methods, many of them have forwarded to offering children air-conditioned classrooms, advanced teaching, learning, and playing equipment. The significant feature through most of their websites is indoor and outdoor playground areas with diverse playing equipment and attractive decoration. However, the non-public primary schools in inner core or high-density districts find it challenging to create a large outdoor environment due to urban constraints; whereas the public schools take precedence in regards to larger plots of land from local authorities. These practical contexts of both public and non-public primary schools in 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.

In a summary, the indoor and outdoor conditions of primary schools and children's perspectives on spatial and natural aspects need to be investigated in order to provide them with better educational environments that involve the responsibilities of reconnecting children and nature for their sustainable development.

Primary educational curriculums

According to the primary school curriculum of MoET, pupils from 7 years old learn to distinguish between living and non-living things, identify and classify natural elements, day-night, seasonal-weather states and changes. Older children, from 9 to 11, develop an understanding of species in ecosystems, food chains and webs. Besides, they also have knowledge about the impacts of humans on nature and how to protect nature (including forest, land, water, and air). However, the mainstream curriculum of public schools in HCMC seemed less to offer hands-on experiences of nature for students than those who studied in non-public schools. For example, though following the national standard curriculum like HCMC_TQT school, HCMC_TDP school has many advanced outdoor activities to enhance direct experiences with nature for children. In a significantly different manner, the home school HCMC_TXS is completely underlying the pedagogy and teaching method following Waldorf educational philosophy. Primary-age students at this school are taught about nature through a very rich oral language experience, rich connection with nature through multi-senses, observing more conspicuously, and the arts such as dancing, drawing, and handicrafts regarding the natural world. These features lead to distinct indoor and outdoor spaces to offer direct experiences of nature for children's feelings and thinking. Therefore, these differences might influence how children respond to the perceived nature and their favours of places within studying and playing environments.

4.3.3 Summary

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.

– Due to different climate types, children of two cities would probably have differences in feelings relating to perceived nature and favoured spaces. Furthermore, thermal comfort can significantly influence the usage of indoor and outdoor environments. Previous studies showed the opposite trends of spatial occupancy between different climate conditions, for example, in temperate and cool climates (Eliasson et al., 2007; Kántor & Unger, 2010; Nikolopoulou et al., 2001), or hot and humid climate conditions (Johansson et al., 2018; C.-H. Lin et al., 2013; T.-P. Lin, 2009). Thus, this study investigated how these factors, regarding climate and weather conditions, could significantly affect children's perceptions of natural environments and their spatial-natural preferences between students of Glasgow and 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 public 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.

– In considerations of hands-on experiences of nature, the children at public schools in HCMC had less frequency than those who studied in TGA, Glasgow and HCMC private schools due to curricula and co-curricular activities. These features lead to distinction classrooms and school environments in which natural elements are setting up at indoor and outdoor spaces to offer direct natural experiences for children's feelings and thinking.

These distinct features between case studies are important factors that influence the naturalness degrees that children expose themselves to, and then on children's responses to the perceived nature and their favour of places within studying and playing environments. While these are proven of overall assessment between cities and schools, there is a need for detailed distributions and evaluation of selected participants of each case study as part of this thesis. The section follows will present and discuss this matter.

4.4. Distributions of participants of case studies

Beyond the physical features of primary school environments, the participant distributions, including biological characteristics, living environments, types and frequencies of off-school weekend activities, and preferred sources of natural knowledge, were collected through parents' surveys to examine how these factors relate to children's connectivity with nature.

Parents provided information regarding biological features (age and gender), living environments (accommodation, garden, and pets), off-school activities, and means of studying nature. 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.

4.4.1 Biological distributions

The participants consisted of 197 children from six schools; they ranged in age from 7 to 13 years and were grouped by gender and age as shown in Table 4-9. The TGA participants consisted of 75 pupils without special needs (53% males, 47% females) with all children aged between 7 and 12 years (M_{age} = 8.92 years, SD = 1.50). In HCMC case studies, there were 122 pupils without special needs (46% males, 54% females) with their ages ranged from 9 to 13 years old (M_{age} = 10.11 years, SD = 0.92).

4.4.2 Living environments

The distributions of participants' living environmental conditions are in Table 4-10. Among participants, Glaswegian pupils mostly lived in private housing (65%) with own gardens (72%). Whereas around half of HCMC respondents lived in private houses smaller than 100sqm (41%). This is the most common dwelling typology in urban areas. The ratio of having gardens only accounted for 31% of total HCMC participants. The shortage of living spaces and 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 4-9. Age and gender distributions of participants in studied primary schools

School ID	Numbers of Pupils	Age cohorts	Gender	
			Female	Male
TGA_K_7	17	11-12	9	8
TGA_K_4	15	8-9	9	6
TGA_K_3	10	7-8	5	5
TGA_M	20	7-9	7	13
TGA_N	13	7-8	5	8
Glasgow	**75**		**35** (47%)	**40** (53%)
HCMC_TQT_5	27	11	17	10
HCMC_TQT_4B&C	23	10	11	12
HCMC_TQT_3	19	9	10	9
HCMC_TD_5	9	11	6	3
HCMC_TD_4	14	10	8	6
HCMC_TD_3	16	9	8	8
HCMC_TXS_5	10	10-13	5	5
HCMC_TXS_4&3	4	9-10	1	3
HCMC	**122**		**66 (54%)**	**56** (46%)
Total	**197**		**101** (51%)	**96** (49%)

Table 4-10. Distributions of participants' living environmental conditions

Glasgow city participants			**HCMC participants**		
Accommodation type	Frequency	Percent	*Accommodation type*	Frequency	Percent
Private house	49	65.3	Private house ≤ 100sqm	50	41.0
High-rise flat	1	1.3	Private house > 100sqm	21	17.2
Tenement flat	6	8.0	Low-rise apartment	18	14.8
Others	1	1.3	High-rise apartment	25	20.5
			Others	5	4.1
Home garden			*Home garden*		
With garden	54	72	With garden	38	31.1
Without garden	2	2.7	Without garden	81	66.4
Owned pets at home			*Owned pets at home*		
With pets	22	29.3	With pets	24	19.7
Without pets	33	44.0	Without pets	95	77.9
Total responses	57	76.0	Total responses	119	97.5
Missing	18	24.0	Missing	3	2.5
Total	**75**	**100.0**	**Total**	**122**	**100.0**

4.4.3 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 4-11). 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 4-11. 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_7	Mean	3.75	1.50	3.25	2.06	1.81	3.06	2.88
	Std.	1.183	1.033	1.000	0.772	0.834	1.237	1.204
TGA_K_4	Mean	4.13	1.40	3.67	3.00	2.60	3.87	2.53
	Std.	0.640	0.828	0.816	0.845	0.986	1.060	1.060
TGA_K_3	Mean	4.40	1.90	3.70	2.70	1.90	3.40	2.70
	Std.	0.516	1.287	0.483	0.675	0.994	0.966	1.059
TGA_M	Mean	4.54	1.92	3.15	2.92	2.46	3.38	3.00
	Std.	0.519	1.038	0.801	0.760	0.967	1.121	0.913
TGA_N	Mean	4.33	2.67	3.67	3.00	3.00	4.33	3.33
	Std.	0.577	0.577	0.577	1.000	1.000	0.577	0.577
TGA	Mean	4.18	1.70	3.44	2.67	2.25	3.47	2.81
(N=57)	Std.	0.826	1.034	0.824	0.852	0.987	1.120	1.043
HCMC_	Mean	2.96	2.04	2.28	2.52	2.80	2.20	2.00
TQT_5	Std.	1.241	1.207	0.891	0.872	0.866	1.118	0.707
HCMC_	Mean	3.13	2.30	2.61	2.65	3.17	2.70	2.04
TQT_4	Std.	1.217	1.185	1.118	1.027	0.778	1.185	0.475
HCMC_	Mean	2.88	2.71	2.59	2.53	2.65	2.18	1.94
TQT_3	Std.	1.317	1.263	1.064	1.068	0.862	1.131	0.827
HCMC_	Mean	3.00	3.22	2.33	2.33	2.56	2.00	2.00
TDP_5	Std.	1.323	1.093	0.866	0.866	0.882	1.000	0.866
HCMC_	Mean	3.30	2.30	3.10	2.60	2.50	2.20	1.90
TDP_4	Std.	1.252	1.252	0.738	0.966	1.080	1.229	0.738
HCMC_	Mean	3.13	2.53	2.67	2.87	3.13	2.07	1.80
TDP_3	Std.	1.125	1.246	1.175	0.990	0.915	1.163	0.561
HCMC_	Mean	3.33	2.33	3.50	2.78	1.78	2.22	2.80
TXS_5	Std.	1.323	1.414	0.850	1.093	0.833	1.302	0.789
HCMC_	Mean	4.00	2.75	3.25	2.75	2.25	2.75	2.75
TXS_4.3	Std.	0.000	1.500	0.957	0.957	0.500	0.957	0.500
HCMC	Mean	3.11	2.43	2.66	2.62	2.75	2.29	2.06
(N=112)	Std.	1.211	1.243	1.032	0.961	0.925	1.142	0.723

In regards to studying nature at home (Table 4-12), 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 4-12. Distributions of resource categories children study on Nature at home

School ID	Family	Books	TV. Internet	Outdoor trips & courses	Others
TGA_K_7	64.7%	29.4%	64.7%	64.7%	5.9%
TGA_K_4	73.3%	73.3%	80.0%	93.3%	0.0%
TGA_K_3	100.0%	100.0%	80.0%	90.0%	0.0%
TGA_M	60.0%	50.0%	55.0%	40.0%	5.0%
TGA_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_5	44.4%	48.1%	85.2%	18.5%	7.4%
HCMC_TQT_4	39.1%	39.1%	82.6%	21.7%	4.3%
HCMC_TQT_3	61.1%	44.4%	77.8%	22.2%	5.6%
HCMC_TDP_5	33.3%	55.6%	66.7%	66.7%	0.0%
HCMC_TDP_4	28.6%	42.9%	57.1%	42.9%	14.3%
HCMC_TDP_3	41.2%	29.4%	58.8%	58.8%	5.9%
HCMC_TXS_5	60.0%	70.0%	10.0%	70.0%	40.0%
HCMC_TXS_4&3	50.0%	50.0%	0.0%	75.0%	25.0%
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 intellectual development.

4.4.4 Summary

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.

Firstly, the negative impacts of lower green space ratios and constrained urban primary school environments, participants of HCMC case studies had fewer opportunities to contact 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. Lastly, 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 is 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.

4.5. A summary of chapter

This chapter has provided research contexts of studied primary schools in Glasgow and HCMC. It presented and discussed key issues regarding urban, school, and off-school environments as well as how these features influenced the relationship between children and nature. Focusing on the educational environments, the discussion demonstrated how distinctive built and natural environments of classrooms and playgrounds can help understand how children managed and occupied these spaces. Additionally, the chapter presented and reflected upon the similarity and dissimilarity between studied schools in two cities and among HCMC groups in detail, and it became a key drive in the evaluation of the naturalness levels children get exposed to, how they feel about nature, and which and why they favour a natural element and a particular space within their schools. The discussion of the following chapters' results will consider these issues.

Chapter 5 Naturalness values of Visual and Non-Visual Sensorial Experiences of Nature

"My hope is that as society increasingly acknowledges the critical value to our health and well-being through a direct connection to nature, designing with nature will become a major tool toward creating a vital new architecture for an empathic world."

— **Van der Ryn** (2013)

This chapter aims to evaluate the children's connecting with nature in educational spaces of various studied school contexts. The methodology for measuring children's visual and non-visual sensory experiences is developed to evaluate the connection between naturalness values and spatial environmental qualities across varying Child–Nature–Distance ranges. This chapter outlines the development of the research method and describes the implementation and process undertaken for data analysis. 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 to determine the level of naturalness that children experience, in both internal and external spaces. Following are arguments with a discussion of the factors relating to the urban settings, built environment master planning, architectural features, and interior design. Finally, this chapter finishes the practical implications and values of this method according to all these findings.

Apart content of this chapter is adapted from the article 'An application of measuring visual and non-visual sensorial experiences of nature for children within primary school spaces: Child–Nature–Distance case studies in Glasgow, Scotland' (To & Grierson, 2019).

5.1. Investigated Methodology

According to the psychologist James J. Gibson (Bloomer, 1977, p. 44), our senses are categorized into five sensorial systems, namely, visual system (looking), auditory system (hearing), the taste-smell system (tasting and smelling), the basic-orienting system which leads man to seek a symmetrical balance in "*the relationship between the horizontal ground plane and our vertical posture*" (Malnar & Vodvarka, 2004, p. 42), and the haptic system (touching). In spatial interactions – senses of space – which are both "*biomorphic and anthropological*" (Simonsen, 2005), excluding the basic-orienting system, the human body identifies space through looking, hearing, touching, tasting, and smelling. In order to gain a better understanding of how much naturalness a child directly experiencing within the observed space, the methodology abstracts the child's multiple layers of sensory experience, so that each layer can be examined in relation to spatial attributes. In this study, the existent value of naturalness (VN) is designated as a positive force or essence of the surrounding environment affecting the physical body of a child within the human's anthropological sensorial experiencing distance. Each place generates a different '*real*' value of naturalness (VN), irrespective of whether the child can or cannot perceive the existence of natural elements. In considering nature within the spatial environment, five sensorial systems are arranged coequally and measured within the C-N-D ranges designating specific biological and anthropological characteristics.

5.1.1 Features of Sensory Modality

The sensory apparatus are classified into two groups, including the '*distance*' senses and the '*close*' or '*immediate*' senses (Gehl, 2010, pp. 31–59; Hall, 1966, pp. 40–43). Looking, hearing, and smelling are positioned in the '*distance*' group since they are concerned with the examination of distant objects using our eyes, ears, and nose; while touching and tasting are related to examining the closed surrounding world via our skin, membranes and muscles. Additionally, referring to the particular character of each sense, human's experience via looking is controlled by a '*directional*' effect while other senses are '*omnidirectional*'.

In consideration of our experiences of nature in an urban setting, each sensorial system has specific features varying the interval change effect and the content of the natural environment. Particularly, Gehl suggests 100-metre radius as "*the distance of human's experiences*" (2010, pp. 31–59). This value is reasonably proportionate to the limited distance of the human's visual field. People with unaided eyes can obtain the information within 100 yards (91.44 meters) radius, and remain effective until a mile (1,609.34 meters) (Hall, 1966).

Regarding our sense of hearing, in general, the human's sound sources of a place, defined as '*soundscape*', are classified into three primary classes: biophony (sounds produced by all organisms of nature, such as the songs of birds and insects), geophony (sounds originated from the geophysical environment, e.g. the sound of running water, of falling rain, of wind rustling through leaves) and anthropophony (sounds created by human activities); the integration of these sounds across the landscape generates a '*soundscape*' (Pijanowski et al., 2011). A compounded mixture of various sound sources is the consequence of many land-use and land-cover classes within an area and its neighbouring contexts (M. Zhang & Kang, 2007). Ranges of integration with human auditory distances are explored by Gehl (2010) and Lazarus (1986), confirming that people can hear shouts (range from 84 dB to 96 dB) within 70-meter distance, get one-way communication at loud voice within 35ms (between 72 dB and 78 dB), and confirming that more detailed and articulated hearing levels are achieved when the distance between sound sources is reduced.

Regarding our sense of smell, this is believed to awaken more intensive memories than other sensations (Hall, 1966) as well as define places through spatially ordered, or place-related, scent recollection and recognition as given in the concept of "*smellscape*" (Kubartz, 2014). According to Porteous (1985), factors, including the source of a smell, air currents, direction, and distance from the source, primarily affect the permeable degree of human, especially in the period of childhood (at around age seven). He also described the relationship between smell and spatial dimensions of a place. Through features of a place, smells apparently provide and indicate olfactory sensations, give particular information of urban landscape, natural and built environment settings in combinations with the messages of seasons and time changes. Distinctions between urban and rural areas are probably recognized through the differences in the density and variety of plants and accompanying biological systems. Like with hearing the acuity of our sense of smell also changes according to the distance scale.

Due to particular features of '*close*' or '*immediate*' experiencing, the senses of touch and taste are generally considered at distances where '*hands can touch*' or '*mouths can taste*'. However, there is an exceptional consideration when regarding these senses in the context of '*imported*' nature. The possibility exists for an impact resonance in which natural elements' transition (e.g. from far distances to a child's reachable distances) through an external agency or are self-collected into an environment. Hence, as previously mentioned, within the method, the child's perception and awareness are not considered when the existing value of the '*real*' natural environment is calculated, rather features of touching and tasting provide references to the connectivity between the nearby (peripersonal) environment and the distal (extrapersonal) environments. Consequently, the proximity of the natural resource to a child is reflected in the C-N-D; i.e. when natural elements are closer to a child, there is a higher prospect of touching and tasting, and vice versa.

According to distinct features of each human's sensorial modality in the human–nature connection, the principal concepts are designated as follows:

- the features of '*distance*' and '*close*' experiences are associated with the permeable range of the built envelopes belonging to the observed spatial environment;
- due to the '*directional*' feature, the naturalness of vision (NoL) is distinctly figured by DepthMapX software to quantify the permeable surface area of vision while other senses obtain the similar values of naturalness; and
- the effects of interval variations which are indicated by the C-N-D ranges are defined as the impact values (IV), and these values are adopted to calculate the VN of each sense.

5.1.2 Methodological Approach

To define the value of nature experienced within the spatial environment, there are three statistical parameter systems: the permeability value; the impact values (IV); and the naturalness of looking, hearing, touching, smelling, and tasting. These figures are applied to determine the total and sub-values of naturalness of a space, which reflect (in *whole and part* studies) the interaction between a child and nature within the teaching and leisure spaces of a primary school.

Parameter 1 – the permeability value

The term '*Permeability*' refers to the relationship between the built and natural environments through architectural features of the building envelopes. First, features of building envelopes of the observed space are defined and figured in Table 5-1.

The total permeability values of the observed space, which include three specific sub-values permeability of noise insulation (PNI), permeability of connectivity (PC) and permeability of visibility (PV), are specified as the average value of proportional permeability parameter of internal sections (Table 5-2). In particular, the values of PNI, PC and PV of each section (Si) are labelled as Si_PNI, Si_PC, and Si_PV. They are referred to the percentage of permeable surface area (Si_PSA) to the total surface area (Si_TSA) of the examined envelope, and features of building envelopes which are classified and given in Table 5-1. When the sectional permeability (Si_PNI, Si_PC, Si_PV) attains the value of (1.00, 1.00, 1.00), the observed internal section Si connects entirely with its surrounding natural environment.

Table 5-1. Values of building envelope features

Looking	(FV): visibility of an envelope of the observed section	
	FV = 1.00	visible transmittance (transparent)
	FV = 0.50	partly visible transmittance (only for lighting)
	FV = 0.00	non-visible transmittance
Touching, Smelling and tasting	(FC): connectivity of an envelope of the observed space with the exposed natural environment	
	FC = 1.00	Opening (e.g. window can be opened for natural ventilation)
	FC = 0.00	Fixed (e.g. glass window attached completely for visibility only)
Hearing	(NI): noise insulation of an envelope of the observed space with the exposed natural environment	
	NI = 1.00	Opening
	NI = 0.50	Using materials for the built environment without the specific requirement of noise insulation (e.g. general classrooms of the primary school, class base, general teaching area, small group room)[a, b]
	NI = 0.00	Using materials for the built environment with higher level or specific requirement of noise insulation (e.g. music classroom, library)[a, b]

Note:

[a]These values are given according to the regulations for primary schools of BB93: Acoustic Design of Schools: Performance Standards – Building Bulletin93 (BB93) (Last updated 19 December 2014);

[b]These values are given according to the regulations for primary schools of National standard of Primary school - Design requirements (MoC and MoST, 2011).

Table 5-2. Parameter 1 – The Permeability values of a space

S_i			**Permeability of S_i**		
Area (sqm.)	S_i_TSA	Total surface area	Noise insulation S_i_PNI	Connectivity S_i_PC	Visibility S_i_PV
	S_i_PSA	Permeable surface area			
Feature	S_i_NI	Noise insulation	$\frac{Si\_PSA \times Si\_NI}{Si\_TSA}$	$\frac{Si\_PSA \times Si\_FC}{Si\_TSA}$	$\frac{Si\_PSA \times Si\_FV}{Si\_TSA}$
	S_i_FC	Connectivity			
	S_i_FV	Visibility			
			Total Permeability values of the observed space		
			Noise insulation PNI	Connectivity PC	Visibility PV
			$\frac{\sum_{i=1}^{n} S_i\_PNI}{n}$	$\frac{\sum_{i=1}^{n} S_i\_PC}{n}$	$\frac{\sum_{i=1}^{n} S_i\_PV}{n}$

The p-values (PNI, PC, PV) therefore represent the amount of five sensorial connections from the studied area to its exposed natural environment, through a statistical value between 0.000 and 1.000 where 0.000 is the space which is completely segregated from its surrounding natural environment, and 1.000 is the space which is entirely connected to its nature-at-the-doorstep.

Parameter 2 – the impact value (IV) – Child–Nature–Distance (C-N-D) ranges

Based on the considerations of interval change effect of visual and non-visual sensorial experience with nature, the parameter of C-N-D ranges is used to refer to the IV of the distance from the natural resource to a child. The 100-metre horizontal distance, as Gehl's "*distance of human's experience*", is applied to limit the field of the observed area for both visual and non-visual senses. In this study of the primary school architecture, the observed spaces are the classroom and outdoor playgrounds where children study and play each weekday.

The C-N-D includes four statements by which the IV are labelled as follows: 1.00 = within the studied space (on-site), 0.75 = within the school site boundary to the 50-metre distance, 0.50 = within the 50 to 70-metre distance, 0.25 = within the 70 to 100-metre distance.

Following this, the IV ranges between 0.25 and 1.00, where 0.25 is the degree of influence to a child's senses at the distance from 70 to 100 m, and 1.00 is the highest degree of a child's absorption in the natural environment, within the observed internal classrooms and external school sites.

Parameter 3 – the naturalness of looking/hearing/touching/smelling/tasting

The initial step in the analysed process for each sense is to create a land cover plan to define the VN in a school site and the 100-metre urban setting. Additionally, under the impact ratios which affect the level of a child's visual and non-visual experiences, a 10x10m grid system is attached to the land cover plan. All elements of built and natural environments are coloured representing the relative land classification. 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/upload s/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.

Synthetically, the Description of Land Coverage derived from these documentations and the Space/Nature Syntax methodology (Munro & Grierson, 2016) are developed and modified for the Naturalness Value (NV) in the context of the particular building and its surrounding environment. Building and Structures and Permanent made surfaces are classified into 4 sub-classes (viz., High intensity and Bare surface, Medium intensity, Low intensity, and Open space) accordingly the ratio of constructed materials cover the total surface area. The layers of Natural environments are Barren, Grass, Woodland, Shrub, Heathland and Bog, and Water. The appealing characteristics of the land coverage types are described as thus:

– *Developed – High intensity*: areas where constructed materials cover 80% to 100% of total surface areas or areas with no dominant vegetation cover;

– *Developed – Medium intensity*: areas where constructed materials cover 50% to 79% of total surface areas;

– *Developed – Low intensity*: areas where constructed materials cover 20% to 49% of total surface areas;

– *Developed – Open spaces*: areas where constructed materials cover under 20% of total surface areas, or any composite surface comprising a mixture of artificial and natural elements (e.g. a garden or landscape area which is a 'man-made' natural environment);

- *Developed – Permanent made surface*: areas where are designated as roadway, railway, pathway (paved surface by the side of the carriageway for used by pedestrians), or other made surfaces that are extensive and permanently developed surfaces;
- *Nature – Barren land*: undeveloped areas of thin soil, sand, or rocks where vegetation is less than 20% of total surface area;
- *Nature – Grass*: areas where have improved, unimproved, or recreational and amenity grass;
- *Nature – Woodland*: areas of trees, where trees are woody species capable of achieving >5 meters in height and 25% canopy cover under favourable growing conditions;
- *Nature – Shrub*: areas consisting predominantly of low woody plants and bushes, often with tree regeneration and brambles where canopy cover is >50%;
- *Nature – Heathland and bog*: areas where are dominated by dwarf shrubs and heath species over 25%, or dominated by continuous bracken, or where the water table is usually at or just below the surface, or where dwarf heath, sedge, rush and snow bed vegetation communities exist at high elevations;
- *Nature – Water*: areas of still open water (including silted-up areas with associated vegetation of reeds, rushes and willow), or channels of moving water (e.g., rivers and streams), or land with water-tables at or near the surface for prolonged periods of the year.

The features with coloured keys of land coverage types are developed to create the Land cover plan of primary schools as shown in Table 5-3. Distinctly, NV of built environment's classes ranges from 0.00 to 0.75 in corresponding with the percentage of constructed materials, and all the classes of natural environments account at 1.00. Thus, these values range between 0.00 and 1.00, where 0.00 is the highest ratio in the built environment of total surface area, and 1.00 is associated with an entire nature. In the specific case of the classroom, there is an addition of an '*indoor landscape*' item in an '*on-site*' grid to determine the indoor natural elements which are designed and fixed, e.g. the vertical green wall or the indoor plant area. Next, the examination process for naturalness of visual and non-visual experiences is established and shown in (Table 5-4). The naturalness of hearing (NoH), touching (NoTo), tasting (NoTa) and smelling (NoSm) are identically quantified with the similar parameter in the permeable surface area. Due to the '*directional*' feature, the NoL is distinctly figured with the different method in determining the permeable surface area of vision by DepthMapx-0.50 software (DepthmapX development team, 2017).

Table 5-3. Features and coloured keys of Land coverage classification

Land Coverage Classification		**Percentage of Constructed Materials**	**Naturalness value ratio**	**Key**
Developed	High intensity	80 -100	0.00	
	Medium intensity	50 – 79	0.25	
	Low intensity	20 – 49	0.50	
	Open space	>0 - 20	0.75	
	Permanent made surfaces	80 - 100	0.00	
Nature	Barren	0	1.00	
	Grass			
	Woodland			
	Shrub			
	Heathland and bog			
	Water			

Table 5-4. Parameter 3 - The naturalness of looking, hearing, touching, tasting, and smelling

Labels	**NoX (NoL, NoH, NoTo, NoTa, NoSm)**: Naturalness of Looking, Hearing, Touching, Tasting, Smelling **Nox_{class}**: Naturalness of (***X***) according to the seperated land cover class **NV_{class}**: the Naturalness value of class **IV_{grid}**: the Impact value of the studied grid
Equations	$\mathbf{NoX} = \sum(\mathbf{No}\boldsymbol{x}_{class} \times \mathbf{NV}_{class})$ $\mathbf{No}\boldsymbol{x}_{class} = \sum \frac{\text{Permeable Surface area of } class \text{ within a particular gird } \times (\mathbf{IV}_{grid})}{\text{Total of Permeable surface area}}$
Obtained results	**NoL* ; NoH = NoTo = NoTa = NoSm**

In particular, the **Nol_{class}** value of **NoL** is calculated by the following method:

a) Firstly, architectural drawings of the studied spaces are made ready to examine the visual field with children's sitting and standing eye-heights (according to children's anthropometric dimension data for each region as shown in Table 5-5), and then imported to DepthMapX. An example of how observed view-points were examined the visual fields in TGA_Newlands classroom is illustrated in Figure 5-1.

Table 5-5. Children's standing and sitting eye-heights

	Age	Average standing eye-height (mm)	Average sitting eye-height (mm)
Glasgow, UK*	7-9	1146	573
	10-12	1325	631
HCMC, Vietnam**	8-9	1155	555
	10-12	1245	590

Notes:

*Anthropometric estimates for British 7-12 years in 'Bodyspace: anthropometry, ergonomics, and the design of work' (Pheasant & Haslegrave, 2006);

**TCVN 7490 : 2005 Ergonomics - Requirements on basic dimensions of desks and chairs for pupils of primary and secondary schools based on anthropometric index (Ministry of Science and Technology, 2005).

b) The DepthMapX version 0.50 is used to explore the visible area of observed points within the studied environment (Figure 5-2 and Figure 5-3). This open-source and multi-platform software was developed by two systems of concepts; one was isovist analysis by Benedikt in 1979 which was conducted to create maps of visual field at points within plans of buildings, and the second one was Space Syntax by Hillier and Hanson in 1984.

c) The results were exported to calculate the visible permeable surface area. In the AutoCAD interface, Permeable Surface area of classification within a particular grid-system was measured, and the Total of Permeable surface area was defined as the sum of visible area within the boundary of the visibility graph (Figure 5-4).

d) Next, using Microsoft Excel, the parameter as **Nol$_{class}$** (Naturalness of Looking of each land cover class) were used to calculate the **NoL** as above equations.

e) The process continued with other points (the distance between points from 1.2m to 3.0m in indoor spaces), then the average values of observed points within indoor spaces (classrooms) and points at playgrounds were given as the parameter to calculate the **NoL** value for the corresponding place.

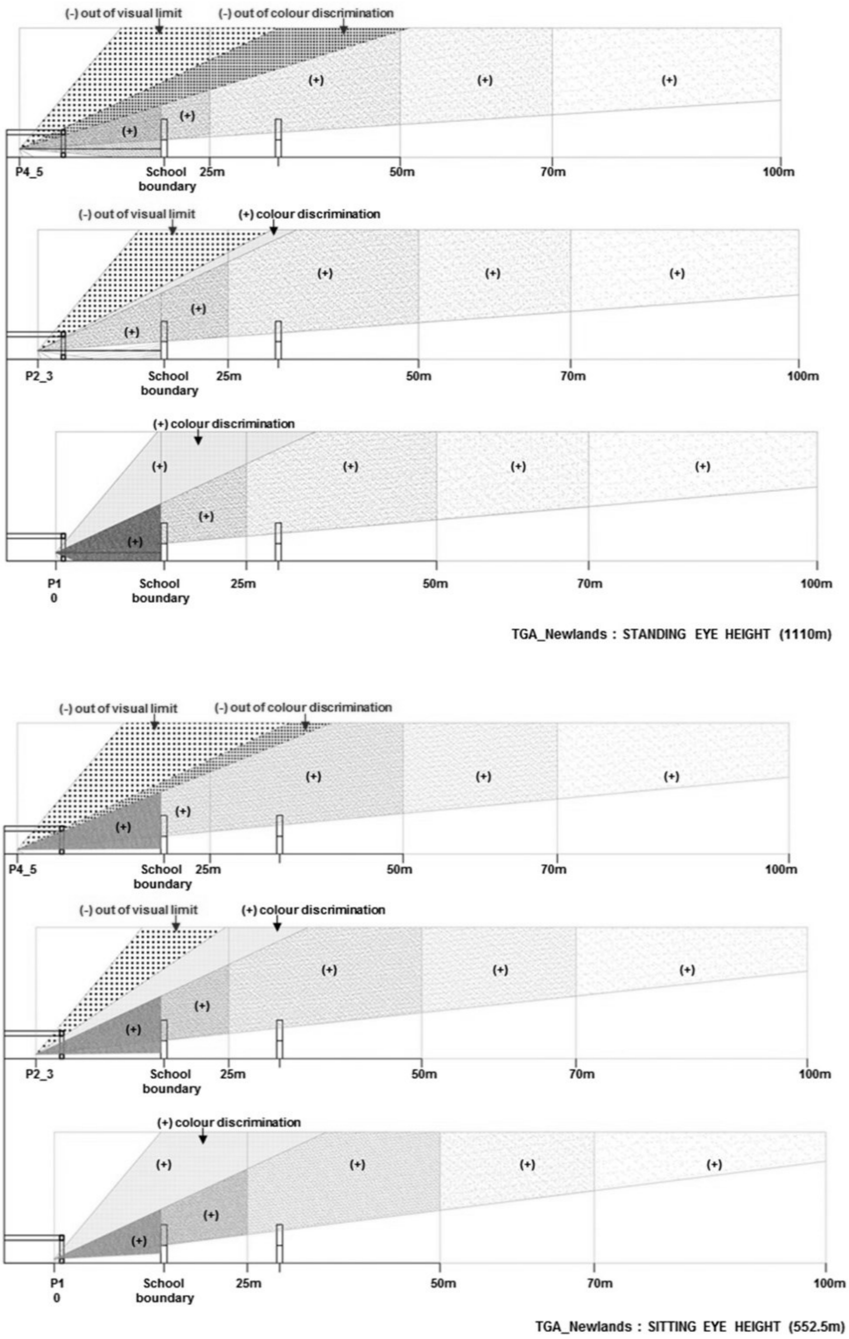


Figure 5-1. Examining visual fields of observed viewpoints according to children's sitting and standing eye-heights in TGA_Newlands classroom

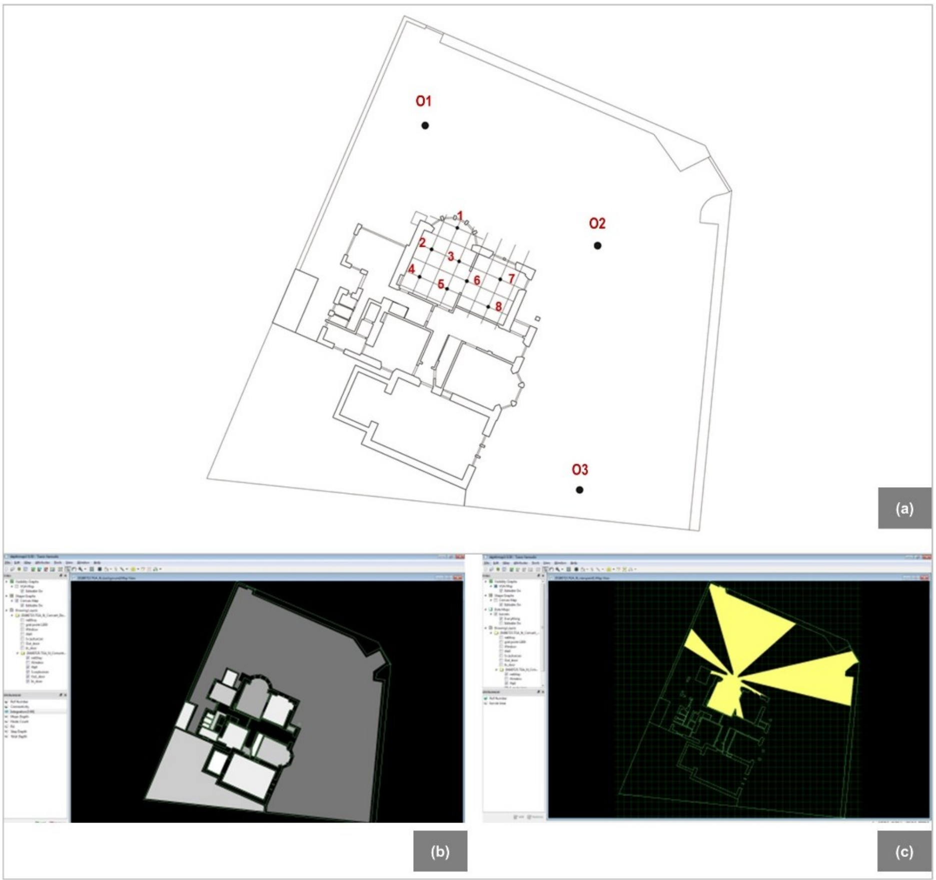


Figure 5-2. The visible graph of an observed point within the built environment of TGA_Newlands is examined in DepthMapX version 0.50;
Notes: (a) Positions of all observed viewpoints, (b) Imported file in DepthMapX, (c) Visible area of the studied point 1 in classroom of TGA_Newlands

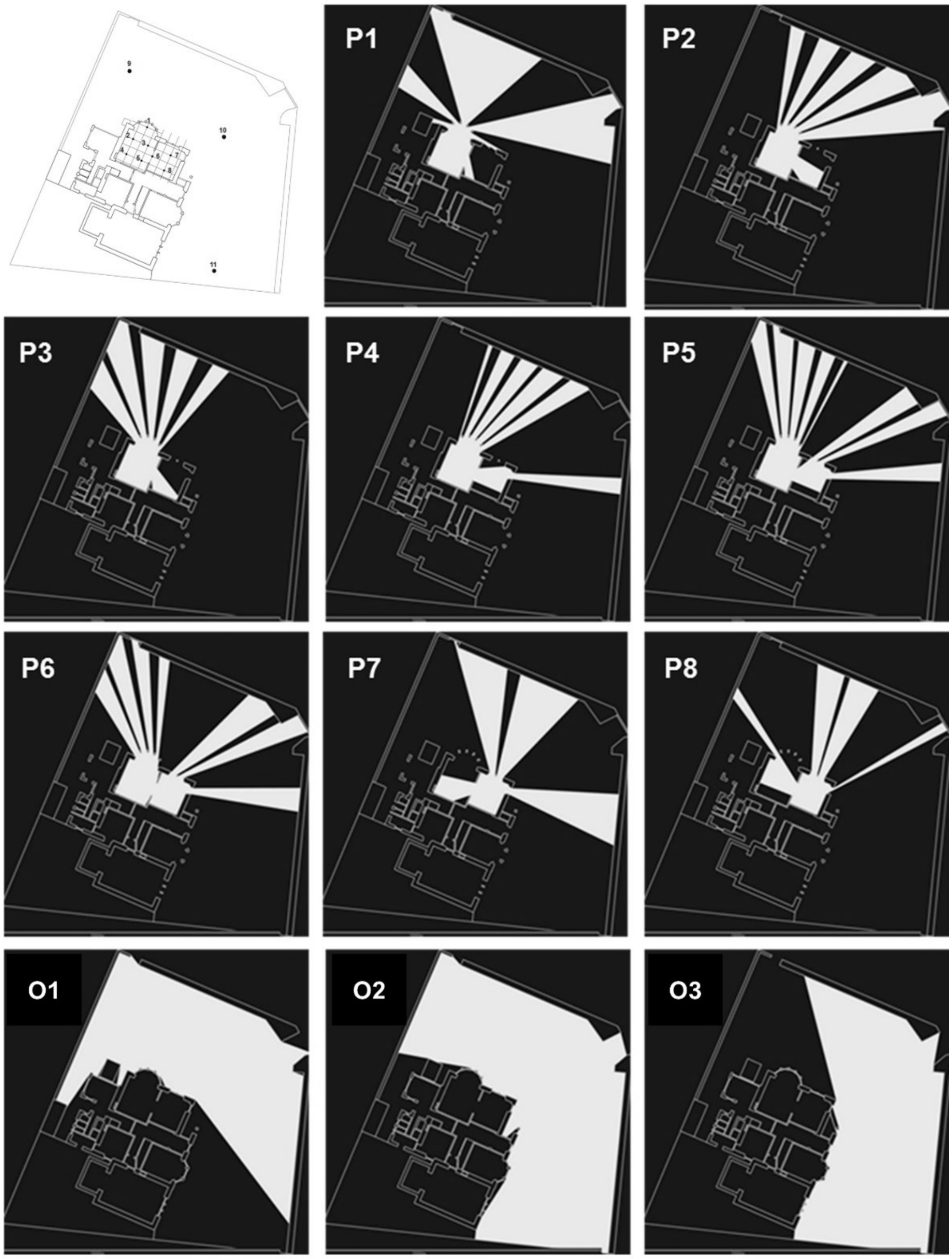


Figure 5-3. Visibility graphs of observed viewpoints of TGA_Newlands' classroom and playground

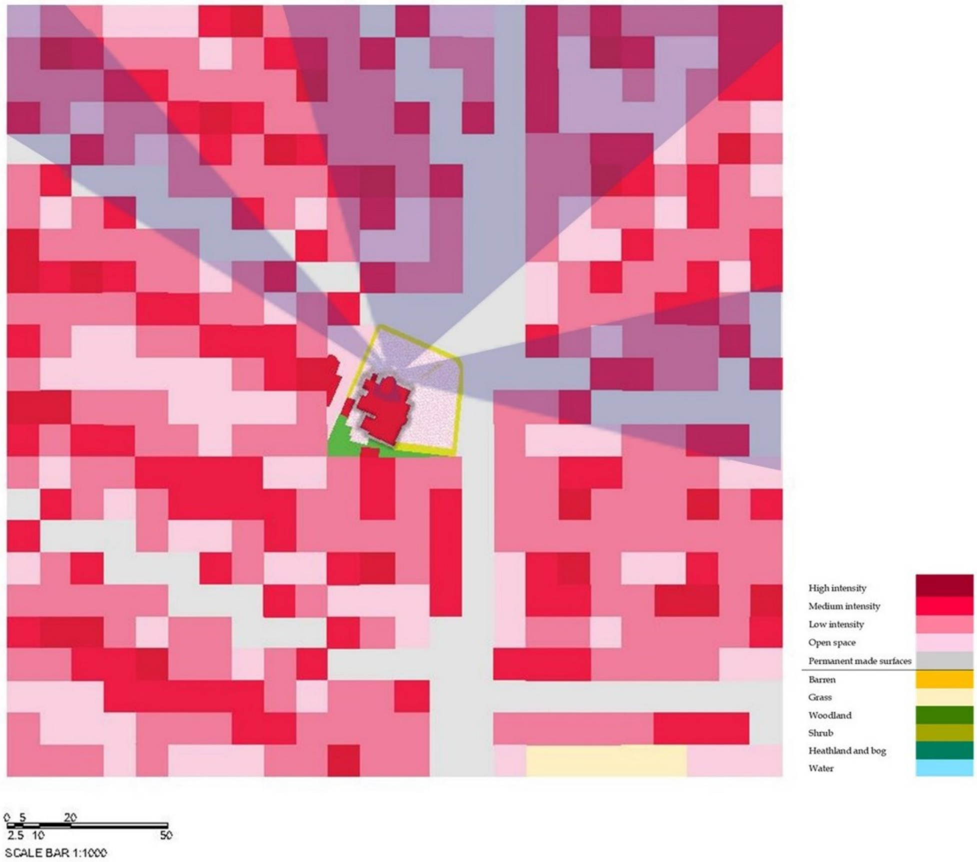


Figure 5-4. The visual graph of the studied point 1 in TGA_Newlands Land Cover Plan for measuring the percentage of visual permeable surface area

The total value of naturalness (VN)

With three framed parameter systems, the Total Value of Naturalness (VN) of the observed space is defined as:

(1) (VN): The Total Value of Naturalness

(2) (NVoL), (NVoH), (NVoTo), (NVoTa), (NVoSm): Naturalness value of Looking, Hearing, Touching, Tasting and Smelling

$$VN = NVo\mathit{L} + NVo\mathit{H} + NVo\mathit{To} + NVo\mathit{Ta} + NVo\mathit{Sm}$$

In particular,

$$NVoL = PV \times NoL$$

$$NVoH = PNI \times NoH$$

$$NVoTo = PC \times NoTo$$

$$NVoTa = PC \times NoTa$$

$$NVoSm = PC \times NoSm$$

The value of each sense ranges from 0.000 to 1.000, where 0.000 is no connection to nature and 1.000 is an entire connection to nature; it means the total VN ranges from 0.000 to 5.000. The higher the value (VN) obtains, the more closely the children in this space (classroom or playground) experience the natural environment via their senses. Besides, the sub-values (NVoL, NVoH, NVoTo, NVoTa, NVoSm) also reflect the different levels of a child directly integrate with nature via each sense in consideration of which sense obtains the highest, medium, and lowest values that could contribute to appropriate design proposals for a multi-sensorial natural experiencing.

5.2. Analysis and interpretation

Following the established method, the process of data analysis was applied to primary school spaces to calculate the permeable range, the NV of each sense, and the total amount of naturalness which pupils could directly connect within their own spaces.

5.2.1 The permeability values

Through site studies and architectural drawings, the plans and sections of classrooms are defined to calculate the permeable areas, and then to explore the permeability values of the relative architectural features. These results are represented in Table 5-6. The connectivity figures of classrooms were reflected the evident conditions of children and teachers' studying activities. Particularly, in the cases of classrooms TGA_K_P7, TGA_M and TGA_N_P3.4, the values of connectivity (PC) account 0.000 because windows and doors were mostly closed during studying hours, they are used only for lighting purposes. With the advantages of large and open glass window systems, classrooms TGA_K_P3 and P4 have the highest levels of visibility, but the figure of connectivity of P4 room accounts for (0.000) while P3 is (0.162) because of '*closed*' and '*opened*' states, respectively. Meanwhile, under the impact of unfavourable location within the building, the outdoor visual and aural ranges of classroom TGA_M are limited in comparison with other rooms. In HCMC schools, the features of HCMC_TXS and HCMC_TQT classrooms offer relatively equal values of three kinds of outdoor connections. In the Waldorf case, the room of grade 5 accounts for higher permeability values than the grade 3.4 room because doors were opened during the survey. What stands out in the figure is the values of HCMC_TDP.3 classroom as (0.000, 0.000, 0.000) because they disconnected thoroughly from outdoor environments.

Table 5-6. The permeability values of studied classrooms

		Permeable surface area (sqm)					Total Permeability		
		S1	S2	S3	S4	Above	Noise insulation	Connectivity	Visibility
School ID	**Area** (sqm)	S1_PSA	S2_PSA	S3_PSA	S4_PSA	SAb_PSA	PNI	PC	PV
TGA_K_P7	60.51	5.81	1.98	2.42	0.0	0.00	0.044	0.000	0.052
TGA_K_P4	54.83	19.72	0.00	1.98	0.0	0.00	0.090	0.000	0.164
TGA_K_P3	53.82	19.72	0.00	1.98	0.0	0.00	0.088	0.162	0.162
TGA_M	35.72	3.38	0.66	1.75	0.0	0.00	0.018	0.000	0.044
TGA_N	49.05	12.00	1.85	1.98	0.0	0.00	0.047	0.000	0.087
HCMC_TQT	43.00	4.97	0.00	7.59	0.0	0.00	0.067	0.050	0.041
HCMC_TDP.5	62.00	0.00	4.71	0.00	13.0	0.00	0.023	0.023	0.023
HCMC_TDP.4	59.00	3.05	4.71	0.00	7.1	0.00	0.027	0.024	0.054
HCMC_TDP.3	63.27	6.90	4.20	0.00	0.0	0.00	0.000	0.000	0.000
HCMC_TXS.5	19.46	0.50	0.00	5.60	0.0	0.00	0.080	0.080	0.080
HCMC_TXS.4&3	19.46	0.50	0.00	3.62	0.0	0.00	0.052	0.052	0.052

All school playgrounds have (1.000, 1.000, 1.000) of the total permeability values because these areas are totally connected with surrounding nearby natural environments. With all sections except ceilings have connections with outdoors, in-between spaces of HCMC schools account (0.800, 0.800, 0.800) of the total permeability values.

5.2.2 The naturalness of looking, hearing, touching, tasting and smelling

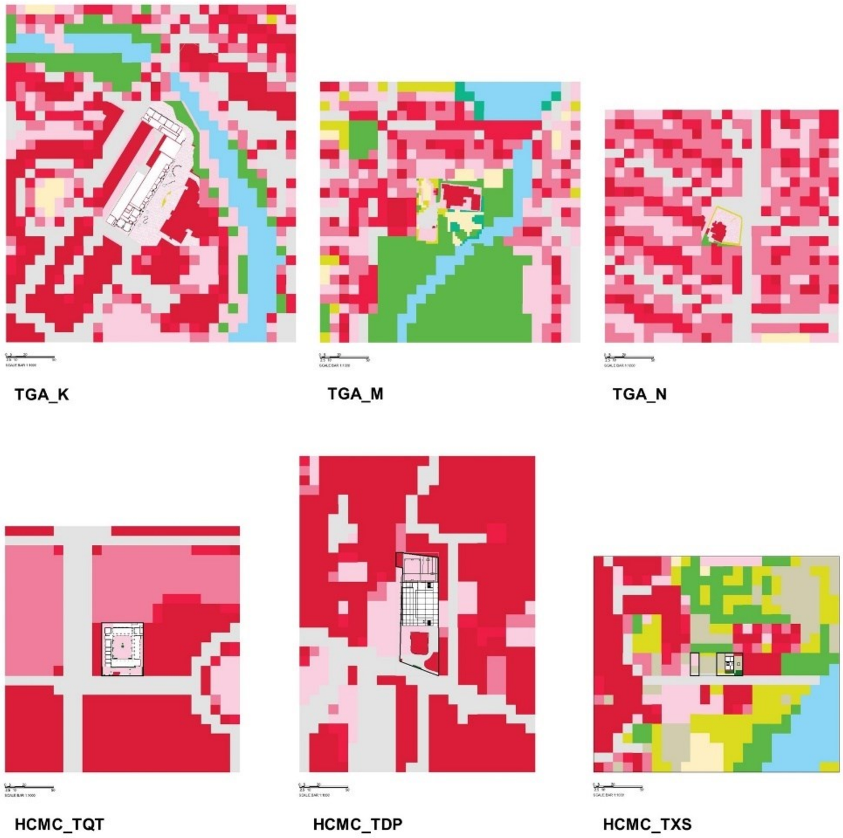
The naturalness of hearing, touching, tasting and smelling

In order to define the naturalness of the five senses, the initial step is creating the land coverage plan with the relative grid system. The sources involved to convert to land coverage plan of each case study are:

- The master plans of Glasgow City and HCMC that are legally downloaded with permissions from Digimap Resources Centre (http://digimap.edina.ac.uk/) and the Land use plan scale 1/2000 (developed by Department of Planning and Architecture, https://thongtinquyhoach.hochiminhcity.gov.vn/en), respectively;
- Satellite images of the studied areas via https://satellites.pro/;
- Aerial photography; and
- Field surveys of the researcher.

In Figure 5-5, 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 (see plans from Appendix F_ 1 to Appendix F_ 6 for detailed information of naturalness of non-visual senses according to built-natural environments and C-N-D ranges of six schools).

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, and thus, its values regarding naturalness of non-visual senses (NoH, NoTo, NoTa, and NoSm) 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.



Figures of the naturalness of non-visual senses

School ID	Total Permeable Area (sqm)	Built environments		Natural environments		Naturalness
		Total area (sqm)	Noto/ Noh/ Nota/ Nosm	Total area (sqm)	Noto/ Noh/ Nota/ Nosm	NoH/ NoTo/ NoTa/ NoSm
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 5-5. The land coverage plans and figures of Naturalness of non-visual senses of six primary schools

In particular results of TGA schools, TGA_N is significantly lower than other schools with permeable natural environments and the naturalness value of each non-visual sense is 0.189 due to the prominent roles of built environments. The area of low intensity accounts for around 40% while other classifications of built environments are approximately 20%. The naturalness value of this school significantly arose from the low intensity and open space classifications; this feature is completely different from other TGA schools. Meanwhile, with higher natural area coverage surrounding the school site at closer distances, that means the greater impact values, these reasons offer the TGA_Kelvinbridge greater values of naturalness than the TGA_Newlands. Only the TGA_Milngavie school site has the natural proportion higher than the built environment (with around 42%) and also accounts for the largest number in terms of permeable natural environment – about 30,500 sqm; this value is much higher than that of TGA_Kelvinbridge and TGA_Newlands. Additionally, in term of natural diversity, TGA_Kelvinbridge and TGA_Milngavie have a greater mixture of natural environments which are surrounded by substantial woodland and water areas with associated vegetation systems. In conclusion, TGA_Milngavie has the most favourable conditions for a general assessment of natural environment of a school site, while the school site of TGA_Newlands is considered as the poorest natural environment both in qualitative and quantitative terms.

Regarding three investigated schools in HCMC, the Steiner private school has the most advantageous conditions for multi-sensorial natural experiences both in values of naturalness and natural diversity. The naturalness value of this school is significantly contributed from natural environments at about 83%. In contrast, the school site of public school HCMC_TQT located in the high-density district is remarkably deficient in the natural environment; the private school HCMC_TDP also has a similar condition. The naturalness values of these schools that followed completely contributed from built environments; particularly, the area of low-intensity land occupies about 78% and the area of open space yields approximately 83% of total naturalness values in HCMC_TQT and HCMC_TDP, respectively.

The naturalness of looking

The values of looking (NoL) are evaluated in the context of each classroom and playground through the measurement of observed points to explore the correlations between the architectural features of envelopes, the fields of viewpoints, and the positions of interior layouts relating to activities of children. The results obtained of TGA and HCMC schools are represented in Figure 5-6 (see Appendix G_ 1 for statistical information) and Figure 5-7 (see Appendix G_ 2 for statistical information), respectively.

Figure 5-6. TGA schools: the visible areas and ratios of built-natural environment of observed viewpoints (the scales of bubbles illustrate the relative amounts of natural visible areas)
Notes: (a) TGA_Kelvinbridge, (b) TGA_Milngavie, (c) TGA_Newlands

Figure 5-7. HCMC schools: the visible areas and ratios of built-natural environment of observed viewpoints (the scales of bubbles illustrate the relative amounts of natural visible areas).
Notes: (a) HCMC_TQT, (b) HCMC_TDP, (c) HCMC_TXS

a) TGA_Kelvinbridge

In TGA_Kelvinbridge, it is evident that the visible area and the amount of nature for the vision of class K_P7 thoroughly differ from the classes of P3 and P4. The average ratios of built environments and nature of investigated points are 86% and 14%, perspective; among them, there is only one point (K_7.3) that has the largest visual area and nature. These figures significantly reflect the current condition of this room where windows are directly opened to the street and an adjacent four-storey building presents a visual barrier in front of two windows; it is also affected by the lowest value of surrounding naturalness.

Classrooms P3 (at first floor) and P4 (at second floor) have almost similar entire visible areas, much higher than P7 room, and their ratios of natural environment are between 29% and 48%. These results are associated with their closely similar positions in the school master planning and the height level change within one storey.

In the case of outdoor playgrounds, there are viewpoint-groups with considerable divergent values. At points K_O.4, O.5, and O.6 which have the rounded buildings as visual barriers, they account for only about half figures in comparison with points O.1, O.2, and O.3 consisting direct eye-sights forwarding to the woodland and water lands in terms of visible areas and the higher percentages of nature. However, due to the impacts of high density in this urban environment, three outdoor viewpoints K_O.4, O.5, and O.6 account 40%, whereas points O.1, O.2, and O.3 reach to 50% for natural proportions.

b) TGA_Milngavie

At TGA_Milngavie, the specific location of the classroom is within the main building. In particular, this room has a large area of glass-windows at the side which is connected via an open-viewed corridor adjacent to an external landscape area – bushes and wooden plants as hedgerow. However, the glass area is above the children's sitting and standing eye-heights. At the side of the main door, there is a band of transom windows for natural lighting only. Its visible area is much lower than the classrooms K_P3 and K_P4, although it is three times higher than K_P7 room. Furthermore, the results also show that positions closer to the high-windows account decreased visible areas. All view-points at the three playground areas demonstrate significant values of connection with nature via looking according to the highest values in terms of visual area and the proportion of nature (in a range between 60% and 70%).

c) TGA_Newlands

Due to the limitations of school size, the total visible area of the TGA_Newlands is mostly affected by features of outdoor views. The observed classroom has many advantages with two sides connecting directly to the outdoor environment through large glass-window systems at appropriate heights. Thus, these figures reflect the considerable and equal area of vision of all viewpoints. In addition, children have larger view-fields when they sit or stand more closely to these openings. Nevertheless, when we consider the impact of the land coverage features in relation to the urban setting, the value of nature for these views is approximate 38% of the total area.

d) HCMC_TQT

At the public school TQT, due to the restriction of high density, the visual area and nature of outdoor places are much lower than other schools, especially the center playground. Although having shade from the rectangle layout of the building, the results show that this layout limits the sizes of children's views. Particularly, their natural proportions of this area (TQT_O.5) are much smaller than other places within the school site (e.g., viewpoints TQT_O.4, O.1, and O.2) as well as other schools' playgrounds.

The urban constraint also causes a greater ratio of built environments in visual areas of the classroom with 78% whereas the average proportion of nature is 22% of the total permeable visual area. Among them, the poorest location is the viewpoint TQT_I_4 with the smallest visual area and nature (less than 1%). Meanwhile, the viewpoints TQT_I_1 and I_7, which are at the nearest distance and in the middle of windows, have significant values. The obtained results show that this classroom accounts for the highest visual area among HCMC studied schools due to windows that were designed to ensure children have proper natural lighting and ventilation.

e) HCMC_TDP

With the same reason of HCMC_TQT, the impacts of high density in urban environments, these indoor and outdoor viewpoints account for lower values for natural than built proportions. Particularly, the natural ratio of the point TDP_O.4 of the main playground is 31%. This point (O_4) which has the high protective wall surrounding the playground boundary and the adjacent building as a visual barrier, accounts for only a quarter of the total visual area and about half the figure in comparison with points O.1 and O.3. Meanwhile, point O.2 which locates in the between of the transition space accounts for the lowest values in terms of visual area and natural area because it is limited by the extended distances to outdoor environments and a reduced view-field as a consequence that follows.

In the cases of classrooms, it is evident that the classroom of 3rd grade is completely disconnected from nature in vision due to its position within the building and separated by other functional spaces and walls. Meanwhile, figures regarding average visual area and nature of classrooms of the 4th grade and 5th grade are much lower than classrooms of TQT and TXS although pupil groups here study in more spacious rooms. In particular, in the classroom of the 4th grade, its total visual area and natural area are about one-third (35%) and a quarter (25%) compared to the TQT classroom, respectively. These figures significantly reflect the current condition of this room where windows are improperly installed for children to look outside. In the real situation of children's studying activities, children only have visual connections with the natural environment through the window on the right side that confronts a residential area, while another window that has a view to the playground is behind children's forward-facing seat of studying. Less favoured condition is the classroom of the 5th grade which only has one window view to the opposite residential area. The unsuitable height and position of the window significantly limit the visual areas from children's desks; its figures are one-third (35%) of the room of 4th grade in relation to the total visible area and natural environment. Furthermore, the results also show that there are only three of eight view-points (5_I_1, 2, and 3) account for natural ratios in a range between 12 and 37%, whereas the value of nature for other viewpoints is less than 4% of the total area. Thus, these figures reflect the inappropriate renovated conditions for visual connections of HCMC_TDP classrooms.

f) HCMC_TXS

At this Waldorf school, all view-points at the three playground areas demonstrate significant values of connection with nature via looking according to the highest values in terms of the proportion of nature than other studied schools. These results reflect the advantages of an undeveloped urban condition that the natural environment nearby the school site is remaining with low built density. Particularly, there are two point-groups with considerable divergent features. At viewpoints O.1 and O.2, they are almost similar natural ratios at 85% on average, much higher than the point O.3 of the sports playground which accounts for 58%. However, the visual area of O.3 is more than three times of O.1 and O.2 because its view-field is not unobstructed by surrounded buildings as conditions of O.1 and O.2 points.

Two classrooms are located and set up similarly at the same position on different floors. Although the door of the grade 5 room was directly opened to the outdoor, the view-fields of observed points are completely limited due to the visual barrier by a confronted wall. In general, the contribution of the land coverage land-use of school urban setting offers a higher proportion of nature than built environments within children's vision areas at most studied viewpoints in these rooms. Nevertheless, the remarkable feature of these rooms is two point-groups with contrast values due to the window's height are improperly installed. This causes the viewpoints which are much closer window (TXS_I_7, 8, and 9) only account for lower values regarding the limited visual areas, natural environments, and proportions of nature (13% on average) than other points at further distances (80% in average).

To summarize, the results in this part indicate that the value of NoL is significantly influenced by factors relating to the interior and architectural design of children's activities within the classroom, the school site master planning as well as the nearby urban environmental properties. Specifically, the scales of visual areas and proportions of natural environments of school playgrounds are mainly dominated by the nearby urban configurations that provide the proportions of built-natural environments within visual areas, the architectural features of protective walls and the master planning within the school site that probably create visual barriers of students' view-fields to urban and in-site nature. In the cases of indoor spaces, the values and features of NoL(s) are controlled and varied primarily by the location within school buildings and school sites, the features (including size, height, and position installations) of openings, and according to observed viewpoints as pupils' sitting positions.

5.2.3 The total value of naturalness (VN)

Finally, the results of TGA and HCMC schools as the case studies of this approach method for Naturalness Value (VN) of space are in Table 5-7 and Figure 5-8.

Three case studies of TGA

Regarding three schools of TGA, it can be inferred that the playgrounds of Milngavie offer the most substantial multi-sensorial natural environment. These spaces also provide children with a comprehensive '*real*' experience of nature where they are exposed via visual and non-visual senses, to the highest level of naturalness available and a wider range of nature's values. However, the figures of M_O3 (wild area) are fairly insignificant in comparison with the two other spaces in Milngavie since the size is relatively small in total, covering an area within 100-meter distance although it is classified as entire nature (Naturalness value = 1.00) and in on-site distance (Impact value = 1.00). Fewer natural connections occur in both the TGA_Kelvinbridge and TGA_Newlands playgrounds. These sites have approximate average values of naturalness in five sensorial-dynamics, but these are slightly lower in the figure of looking while slightly higher regarding touch, hear, smell and taste in the Newlands case.

When considering internal spaces, the classrooms K_P3 exhibits the highest values of nature for all five sensorial modalities, while children in other classes have less direct connections with nature in terms of looking and hearing. The principal reason for this difference lies in the location of these rooms within the school and in part because of the features of windows. In the layout of the entire school master plan, these particular rooms provide direct views of a rich external natural environment; thus, higher values of nature for looking are as followed. Since the window of K_P3 was opened during the observation period, it offers an enhanced opportunity for non-visual sensorial connections. Furthermore, the size, height and style of windows, and their position on two walls of the classroom increased the direct connection with nature and helped to '*bring nature closer to children*'. In contrast, K_P4 with similar window features also accounts for the greatest figure of looking, but the figures of tasting and smelling of K_P4 room are (0.000) because its window was closed. Within the same school, the K_P7 classroom exhibited reduced ranges of natural connections due to an unfavourable location (outlook), and because windows were closed during the observation period.

Generally, the indoor places in Milngavie and Newlands have similarly distinctive features. Although the school Milngavie provides a strong '*Nature-at-the-doorstep*' context, the potential experience from the classroom was limited by its location within the building layout and was negatively impacted by window's forms and positions. Conversely, the results for the Newlands classroom, which has a direct connection with outdoor spaces through a better building layout and considerable size of windows, are lacking for the senses of smelling, tasting and touching since the window was required to be closed for noise insulation purposes relating to an adjacent crossroads. Thus, it reflects the unfavourable impacts of the built–natural environment in an urban configuration.

Three case studies of HCMC

Overall, 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.

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 (NVoL=0.413). 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 for 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. Specifically, the permeability indicators of these spaces account for (0.800, 0.800, 0.800). 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, HCMC schools 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. As the same reason, a much fewer natural connection also occurs in both three classrooms of TDP, they are illustrated through the smallest results in Table 5-7. 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 installation as well as the built-natural environment of an urban context.

Table 5-7. Total value of Naturalness (VN) of child's visual and non-visual experiences

	Total Permeability			Naturalness of sense					Natural value of sense					Total Value of NATURALNESS
	Noise insulation	Connective	Visibility	Looking	Hearing	Touching	Tasting	Smelling	Looking	Hearing	Touching	Tasting	Smelling	
TGA School ID	PNI	PC	PV	NoL	NoH	NoTo	NoTa	NoSm	NVoL	NVoH	NVoTo	NVoTa	NVoSm	VN
K_P7	.044	.000	.052	.118	.224	.224	.224	.224	*.006*	*.010*	*.000*	*.000*	*.000*	***0.016***
K_P4	.090	.000	.164	.191	.224	.224	.224	.224	*.031*	*.020*	*.000*	*.000*	*.000*	***0.052***
K_P3	.088	.162	.162	.185	.224	.224	.224	.224	*.030*	*.020*	*.036*	*.036*	*.036*	***0.158***
M	.018	.000	.048	.452	.348	.348	.348	.348	*.022*	*.006*	*.000*	*.000*	*.000*	***0.028***
N	.047	.000	.093	.171	.189	.189	.189	.189	*.016*	*.009*	*.000*	*.000*	*.000*	***0.025***
K_O				.277	.224	.224	.224	.224	*.277*	*.224*	*.224*	*.224*	*.224*	***1.173***
M_O1 Entrance				.321	.348	.348	.348	.348	*.321*	*.348*	*.348*	*.348*	*.348*	***1.711***
M_O2 Main P		1.000		.349	.348	.348	.348	.348	*.349*	*.348*	*.348*	*.348*	*.348*	***1.740***
M_O3 Wilder P				.379	.348	.348	.348	.348	*.379*	*.348*	*.348*	*.348*	*.348*	***1.769***
N				.183	.189	.189	.189	.189	*.183*	*.189*	*.189*	*.189*	*.189*	***0.939***
HCMC School ID	PNI	PC	PV	NoL	NoH	NoTo	NoTa	NoSm	NVoL	NVoH	NVoTo	NVoTa	NVoSm	VN
TQT	.067	.050	.067	.099	.067	.067	.067	.067	*.007*	*.004*	*.003*	*.003*	*.003*	***0.021***
TDP_5	.023	.023	.023	.061	.069	.069	.069	.069	*.001*	*.002*	*.002*	*.002*	*.002*	***0.008***
TDP_4	.027	.024	.054	.165	.069	.069	.069	.069	*.009*	*.002*	*.002*	*.002*	*.002*	***0.016***
TDP_3	.000	.000	.000	.000	.069	.069	.069	.069	*.000*	*.000*	*.000*	*.000*	*.000*	***0.000***
TXS_5	.080	.080	.080	.238	.309	.309	.309	.309	*.019*	*.025*	*.025*	*.025*	*.025*	***0.118***
TXS_4.3	.052	.052	.052	.238	.309	.309	.309	.309	*.012*	*.016*	*.016*	*.016*	*.016*	***0.077***
TQT_O.4		.800		.056	.086	.086	.086	.086	*.045*	*.069*	*.069*	*.069*	*.069*	***0.321***
TDP_O.2				.095	.069	.069	.069	.069	*.076*	*.055*	*.055*	*.055*	*.055*	***0.297***
TQT_ O.1-3				.095	.086	.086	.086	.086	*.095*	*.086*	*.086*	*.086*	*.086*	***0.440***
TQT_O.5				.132	.086	.086	.086	.086	*.132*	*.086*	*.086*	*.086*	*.086*	***0.477***
TDP_O.4		1.000		.283	.069	.069	.069	.069	*.283*	*.069*	*.069*	*.069*	*.069*	***0.559***
TXS_O.1				.413	.309	.309	.309	.309	*.413*	*.309*	*.309*	*.309*	*.309*	***1.648***
TXS_O.2				.305	.309	.309	.309	.309	*.305*	*.309*	*.309*	*.309*	*.309*	***1.540***
TXS_O.3				.295	.309	.309	.309	.309	*.295*	*.309*	*.309*	*.309*	*.309*	***1.530***

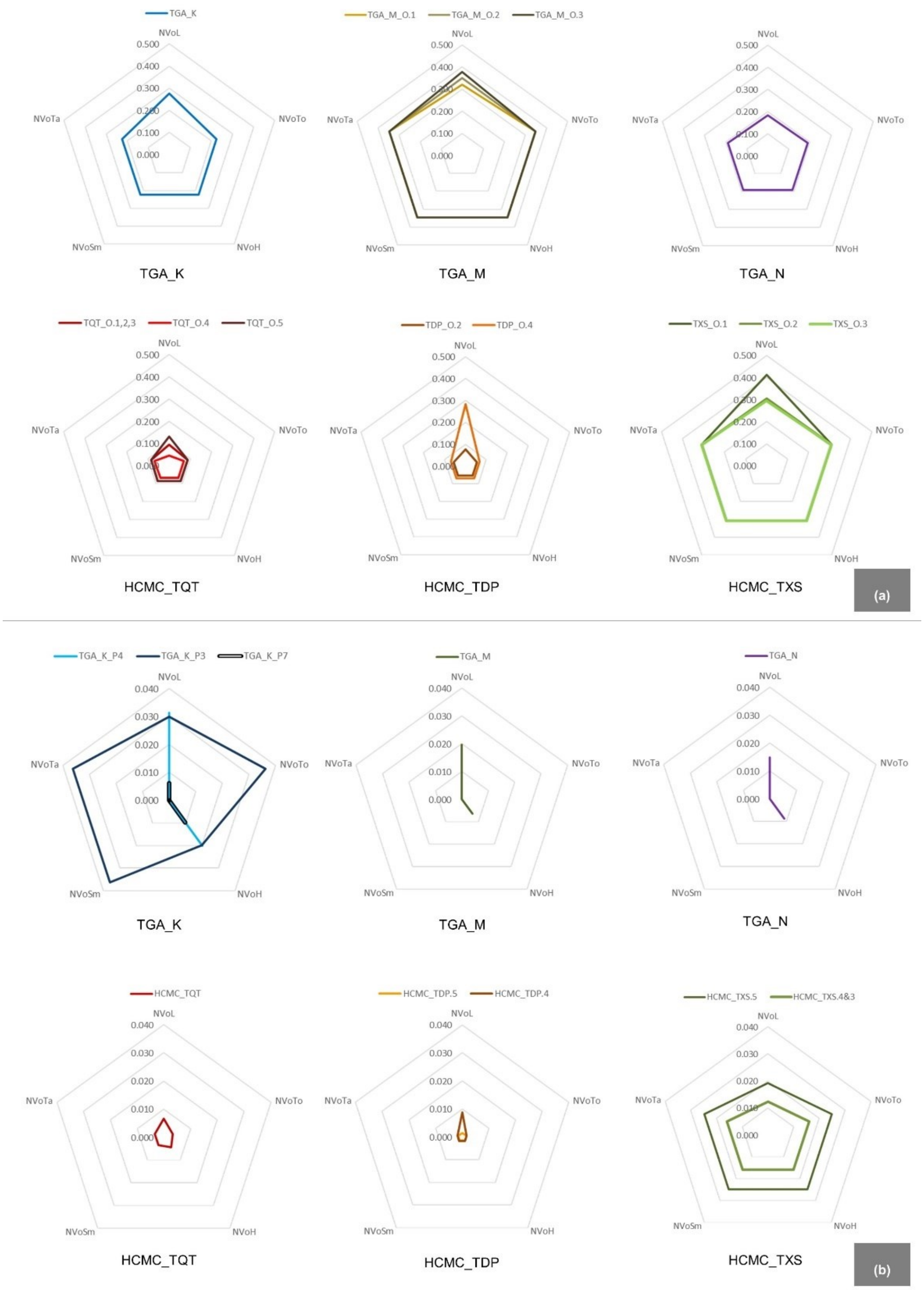


Figure 5-8. The naturalness value of visual and non-visual senses within the playground areas (a) and the classrooms (b) of three TGA and three HCMC primary schools

5.2.4 Summary of results

Generally, the results have revealed the features of urban configuration significantly influence the Child-Nature-Distance ranges 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 when 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 surrounded nature.

Following, important features of the architecture that mainly govern the degrees of natural connections are as follows:

For vision natural connections:

The layout of studying and playing environments within school buildings and school sites decides the scale of visual areas and the proportion of nature. In cases of indoors, the specific locations of classrooms of TGA_Milngavie and HCMC_TDP_3, which are within the main building layouts, negatively impact the figures of looking. Or the TGA_Kelvingbridge_P7 exhibited reduced ranges of natural connections due to unfavourable locations that offer a higher degree of built environments and visual barriers within the school site.

The installed positions, size, height, material, and opened-closed status of openings are important factors to enhance or restrict the connections with nature through visual and non-visual senses of indoor environments. The results show the evidence that if windows are more appropriately designed, more viewpoints have a greater scale of visual areas and less divergent value between them, whereas inappropriate openings cause uneven visual connections of nature due to high contrast values between viewpoints. For example, positions closer to the high-windows of TGA_Milngavie and HCMC_TXS account decreased visible areas and offer significantly divergent values. In contrast, while with a large glass window setting, children of grades 3 and 4 of TGA_Kelvinbridge, TGA_Newlands, and HCMC_TQT have larger view-fields when they sit or stand at almost all viewpoints.

For non-vision natural connections:

The obtained values support the view that most classrooms are operated without considerations of naturalness for non-visual experiences of nature (such as Kelvinbridge_P7 and Milngavie of Glasgow, and two private schools of HCMC). Furthermore, the different status of windows and doors also vary the degrees of natural connections through non-visual senses, such as divergent values regarding tasting, touching, and smelling between TGA_Kelvinbridge_3 and 4 or between HCMC_TXS_5 and 3.4. This evidence reveals the influences of opening's architectural features that are represented through connectivity and sound installation indicators on children's non-vision connections with nature.

5.3. Findings and Implications

Through the application of developed method to six case studies at primary schools in Glasgow and HCMC, it is suggested 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 findings of this section, including features of urban configuration, school settings, and architectural features, corresponding proposals are developed and shown in Table 5-8. 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.

Table 5-8. 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	
Visual and non-visual connections are influenced by: • the built-natural distributions of urban configuration, • the distances of natural sources that verify degrees of natural exposure.	*Decision-making process to select appropriate locations for future schools should take these priorities:* • 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.

In terms of outdoor spaces for children's restorative experiences, under the IV of distance, landscape reconstructions can be designed to increase the NV 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.

In the conceptual design process, the approach can also support decision-making by examining the VN of a school site within an urban context to inform appropriate urban planning and development decisions involving proposals for new schools at the macro level.

5.4. A summary of chapter

In summary, this chapter has presented the developed methodology and applied it to examine the relationships between the direct level of child–nature direct connection via sensorial modalities and primary school spaces (indoor and outdoor) within the context of urban and architectural decision making. The results find that children's experiences are significantly influenced by factors relating to an urban setting, built environment master planning, architectural features, and interior design of primary school environments.

This chapter has answered the first research question: '*How do spatial configurations in school and urban contexts influence the extent of children's direct natural experiences through visual- and non-visual senses within the school environments?*' through this methodology for measuring visual and non-visual sensorial experiences of nature. It is proposed to help understand '*real*' natural value, dependent upon, not only various factors of the biological characteristics, culture, ethnic and individual experiences, but across varying Child-Nature-Distance ranges and taking account of the impacts of spatial environmental properties within urban settings. The methodology for measuring visual and non-visual sensorial experiences of nature, and its application to children's learning and leisure spaces within primary school architecture could offer a tool for assessing current schools and evaluating future design proposals for new schools. Moreover, apart from primary school architecture for children, this methodology could be fully developed to the comprehensive human–nature relationship under the impacts of physical features and societal of other diversified environments in a future study. This approach, in the urban and architectural facets, helps to determine related factors and consequences of experiences associated with human-nature connectedness levels through investigations in different spatial scales and features, and to propose solutions to (re)connect human and nature.

Next, these results and findings of this chapter are used to discuss with results and findings that relate to examine the process of altering from '*real*' to '*perceived*' nature of users' cognitions, attitudes, and behaviours within the exposure proximity to nature in Chapter 6 and 7 that follow.

Chapter 6 Children’s Visual and Non-visual Experiences with Nature

“Nature lore is a mixture of love and knowledge, and it comes more by way of the hear than of the head.”

— **John Burroughs** (2000, p. 29)

This chapter demonstrates results and discusses the findings of children’s open-ended questionnaire surveys within their classrooms and playgrounds. First, the classifications and characteristics of natural elements children explored and described in their paper-works are shown. Second, the spatial and natural features analysis related to pupils’ favourite natural elements and places is addressed. These sections include investigations of both case studies in Glasgow and HCMC. The obtained results regarding children’s spatial-social-natural interactions of three case studies in HCMC are discussed and complemented by the findings of architectural implications in primary school design.

6.1. Children's Discovery of Nature

Firstly, how children discover nature within their classrooms and playgrounds is analysed through their answers to the following questions:

- *What nature do you See/Hear/Touch/Taste/Smell?*
- *What does it look like (Colours/shape/action)?*
- *How do you feel?*

The results are presented and discussed as following.

6.1.1 Attributes of natural classifications

For both the classroom and playground, the matrix of children's multi-sensorial experiences with nature and the descriptor terms for emotional notations are explored through their reports. Figure 6-1 and Figure 6-2 are examples of paper-works collected after the surveys from children of Glasgow and HCMC case studies, respectively. The natural elements children quoted in words or images were grouped into natural classifications according to a synthesis of facets regarding education, nature and landscape, and biophilic design (as shown in Table 6-1). They are synthesized and defined as follows:

- Air,
- Astro-sky,
- Minerals (e.g., soil, rock, stone, mud),
- Water (e.g., water, river, lake, brook),
- Weather (e.g., sun, rain, cloud),
- Wind,
- Light (e.g., sunlight, daylighting, and natural lighting),
- Fauna species, and
- Flora species (e.g. tree(s), plant(s), bush(es), grass, moss, and sub-objects, for example, flower(s), leaf (leaves), and twig).

Table 6-1. Natural attributes according to involved research facets

Educations	Six areas of children's knowledge and understanding about nature and natural environments through all sense within a school site and its surroundings: - Climate - Soils, rocks, and minerals - Water - Materials and resources - Plants - Animals	(J. Palmer, 1998), (National Association for Environmental Education (NAEE), 2016)
Nature and Landscape	Three principles of sciences of nature that are experienced through humans' senses of sight, touch, smell, taste, and behavioural responding toward seasonal changes are as follows: - Geography (minerals) - Botany (plants) - Zoology (animals)	(Dansereau, 1975)
	Nature is described through existences of: - Animals - Plants - Effects of weather and light - Transformation of land, water, raw materials, and its essential elements	(Williams, 1985)
Biophilia and Biophilic design	Natural features and settings for healthy childhood development are: - Light - Sound - Odour - Wind - Weather - Water - Vegetation and animals - Landscape	(S. R. Kellert, 2008, pp. 3–20)
	Natural attributes of direct experiences of Biophilic design are: - Light - Air - Water - Plants - Animals - Weather - Natural landscapes and ecosystems	(S. Kellert & Calabrese, 2015)
	Nature in a space or place regarding human's multi-sensorial experiences are: - Plant life - Water - Animals - Breezes - Sounds - Scents - Other natural elements and systems	(Browning et al., 2014a)

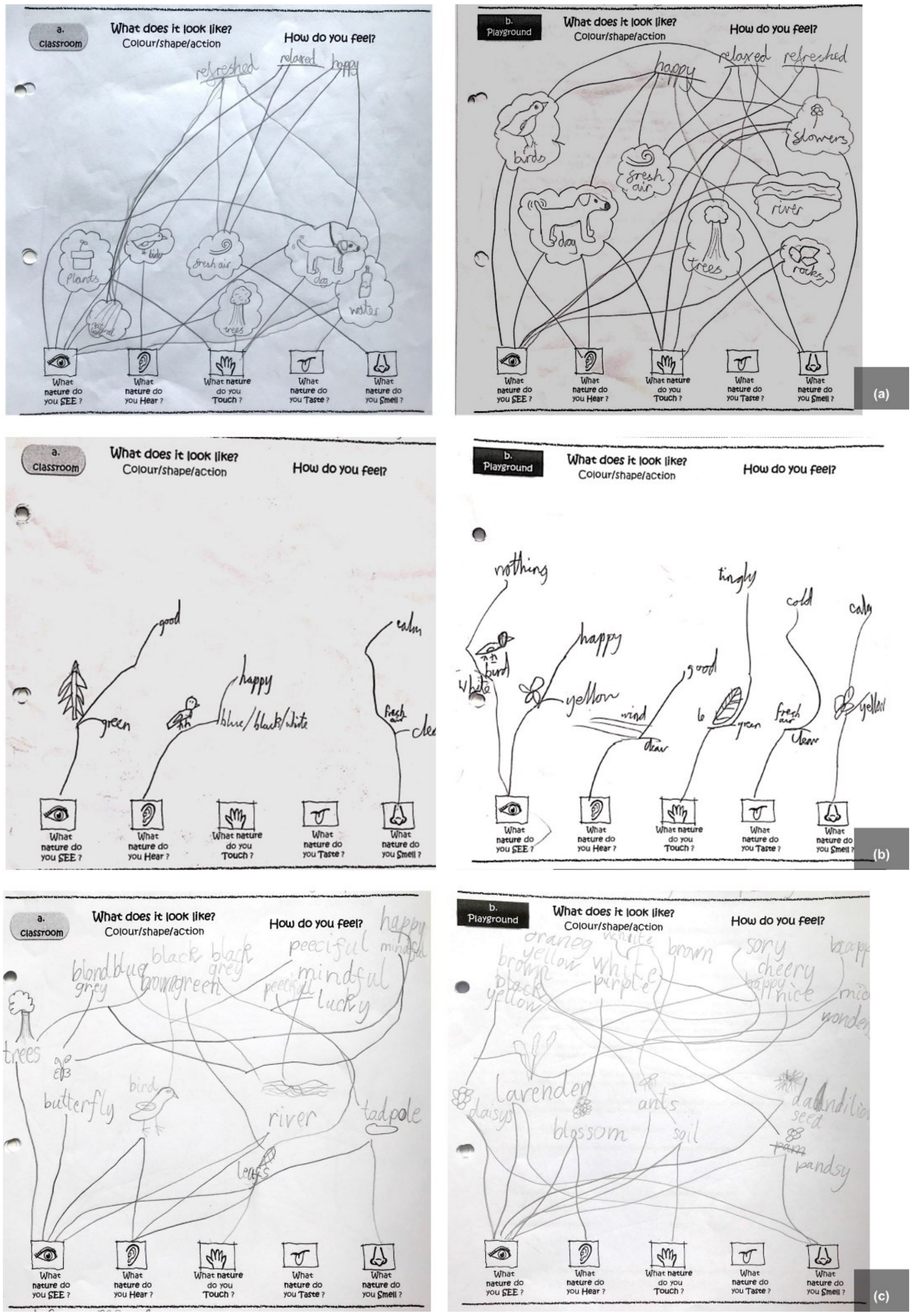


Figure 6-1. TGA_Kelvinbridge children's paper-works in classrooms and playgrounds; Notes: (a) TGA_K_P7_6, (b) TGA_K_P4_4, (c) TGA_K_P3_8

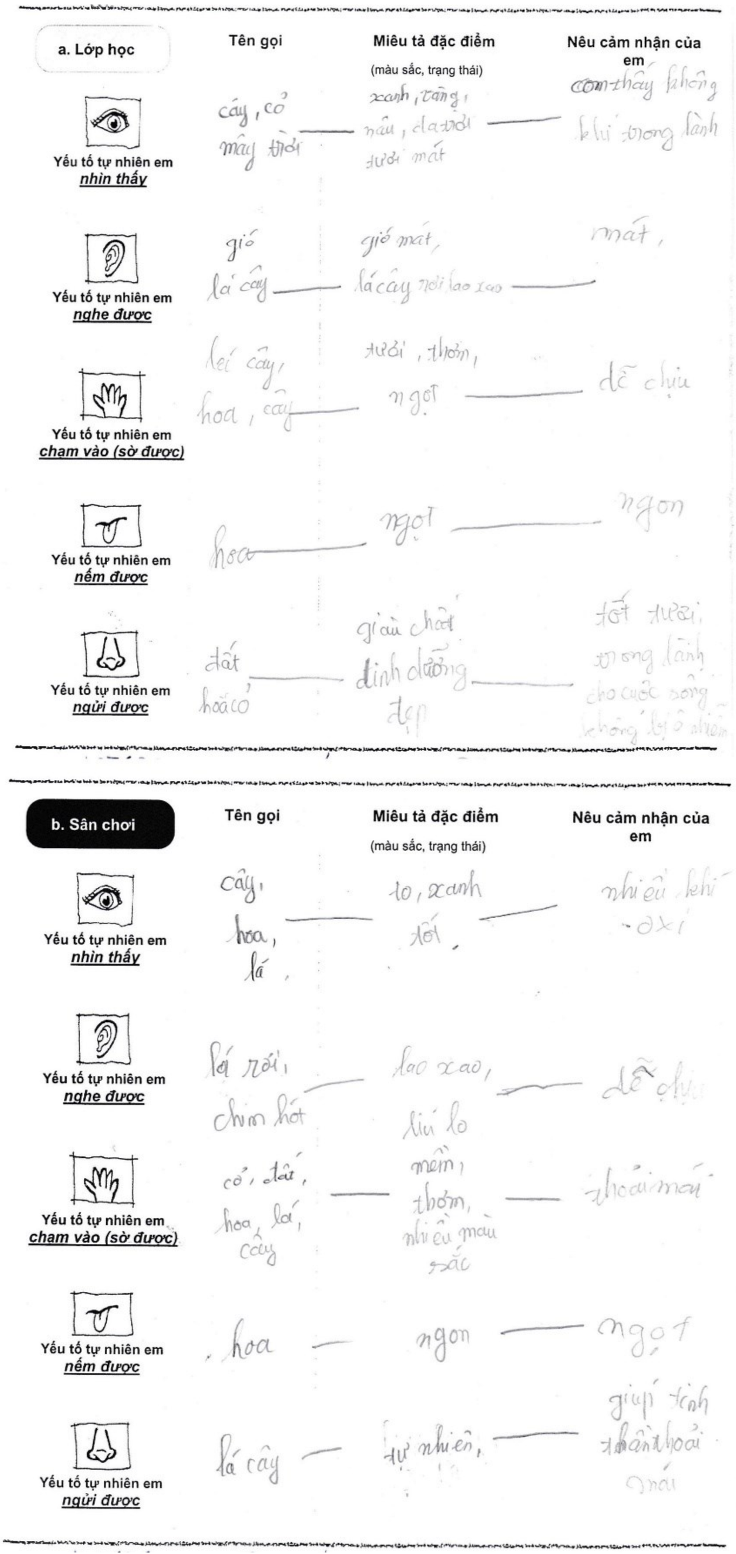


Figure 6-2. HCMC_TQT_5B_4 pupil’s paper-works in classrooms and playgrounds

6.1.2 Perceived Nature by children's multi-sensorial experiences

The perceived extent of each natural type is demonstrated through the frequency of coding techniques. Firstly, the descriptive statistics of children's responses according to places, sub-sensorial, and total sensorial experiences are illustrated in Table 6-2.

Table 6-2. Means of perceived natural elements (NE) and natural types (NT) through children's visual and non-visual senses within classrooms and playgrounds

School ID		Mean values of perceived nature											
		Classrooms						Playgrounds					
		Look	Hear	Touch	Taste	Smell	**Total**	Look	Hear	Touch	Taste	Smell	**Total**
K_7	NE	2.88	1.56	1.25	0.25	0.69	**5.06**	4.44	2.25	2.25	0.75	1.13	**6.29**
	NT	2.13	1.31	1.13	0.31	0.63	**3.12**	2.88	1.88	1.50	0.75	1.13	**4.24**
K_4	NE	1.07	1.14	0.43	0.21	0.79	**3.00**	2.40	0.87	1.47	1.00	1.07	**4.60**
	NT	1.07	1.14	0.43	0.21	0.79	2.73	1.60	0.80	1.20	0.93	0.93	2.93
K_3	NE	2.60	2.30	0.30	0.30	1.00	**4.60**	4.90	1.50	2.70	0.50	2.00	**5.80**
	NT	1.70	2.10	0.30	0.30	1.00	2.90	2.10	1.00	1.60	0.50	1.00	2.70
M_O.1	NE	1.71	0.12	0.41	0.12	0.29	**2.30**	2.67	0.75	1.19	0.44	0.89	**4.00**
	NT	1.12	0.12	0.35	0.12	0.29	1.40	1.83	0.75	0.94	.44	0.89	2.37
M_O.2	NE							3.56	0.56	1.13	0.25	0.69	**5.16**
	NT							2.06	0.56	0.81	0.25	0.50	2.63
N	NE	1.46	0.77	0.77	0.23	0.15	**2.85**	1.92	1.23	1.38	0.46	1.08	**4.92**
	NT	1.00	0.77	0.62	0.23	0.15	1.85	1.54	1.15	1.15	0.46	1.08	2.69
TQT_5	NE	1.37	1.00	0.93	0.33	0.85	**3.59**	1.52	1.26	1.70	0.70	0.93	**4.59**
	NT	1.22	1.00	0.78	0.33	0.85	**2.85**	1.11	1.22	1.11	0.70	0.89	**2.89**
TQT_4	NE	1.09	0.91	0.57	0.09	0.65	**3.04**	1.00	0.65	0.83	0.09	0.65	**3.04**
	NT	1.09	0.91	0.48	0.09	0.61	1.87	0.91	0.65	0.78	0.09	0.65	2.30
TQT_3	NE	1.06	0.89	0.39	0.06	0.06	**2.39**	1.50	0.72	0.67	0.72	0.39	**3.44**
	NT	1.06	0.89	0.39	0.06	0.06	2.00	1.22	0.72	0.67	0.72	0.39	2.28
TDP_5	NE	0.78	0.67	1.00	0.33	0.44	**2.44**	1.56	1.33	1.33	1.00	0.78	**4.44**
	NT	0.78	0.56	0.78	0.22	0.33	2.11	1.11	1.22	1.00	0.89	0.78	2.78
TDP_4	NE	1.21	0.43	0.21	0.07	0.29	**2.00**	1.36	0.57	0.57	0.14	0.64	**3.00**
	NT	1.07	0.36	0.21	0.07	0.29	1.86	0.79	0.57	0.36	0.14	0.43	1.64
TDP_3	NE	0.00	0.00	0.00	0.00	0.06	**0.06**	1.53	0.41	1.18	0.12	0.47	**1.82**
	NT	0.00	0.00	0.00	0.00	0.06	0.06	0.94	0.41	0.71	0.12	0.47	1.18
TXS_5	NE	1.10	0.70	1.00	0.30	0.60	**2.10**	3.10	1.70	2.80	1.40	1.70	**4.50**
	NT	0.90	0.70	0.80	0.30	0.50	1.40	2.20	1.40	1.70	0.80	1.10	2.90
TXS_4.3	NE	1.50	0.75	0.50	1.25	0.75	**2.50**	0.75	1.00	0.25	0.25	0.25	**2.00**
	NT	1.00	0.75	0.50	0.75	0.75	1.00	0.75	1.00	0.25	0.25	0.25	1.25

Generally, pupils reported higher numbers of natural elements and types at playgrounds than in classrooms in both Glasgow and HCMC cases. The perceived intensity of each and total sensorial experience increasingly expanded when moving from indoors to outdoors. Except for looking, children in classrooms reported more perception of nature via hearing and touching than tasting and smelling. At playgrounds, the greater natural values were experienced by touching and smelling whereas tasting was least noted.

Children in TGA schools reported more natural elements and types than those of HCMC in the classrooms and playgrounds, especially figures of looking. The older group of pupils of TGA_Kelvinbridge_P7 has the highest level of natural exploration, including numbers of elements and types, in both their classroom and playground. In contrast, the figures related to the perceived nature in the classroom (NE=2.30, NT=1.40) and in the area at the entrance gate (NE=4.00, NT=2.37) of younger pupils of TGA_Milngavie are the lowest. Pupils from Newlands and grade 4 of Kelvinbridge have slightly higher perceived natural elements and types within their playgrounds. In consideration of the difference between three children groups in Kelvinbridge, although they did the task at the same playground, the oldest children of grade 7 lead the ability to explore nature (NE=6.29 and NT=4.24), whereas the mean figure of natural elements for the grade 3 group (NE=5.80) is higher than that of the grade 4 group (NE=4.60). Relating to children of the Milngavie group who did tasks within different sites, the wilderness playground reported higher natural elements (NE=5.16) than within the area at the entrance gate; although, the difference in natural diversity between the two sites is not significantly illustrated.

Regarding HCMC cases, the older groups of all three schools (TQT_5, TDP_5, and TXS_5) have relatively figures of perceiving natural elements and types within playgrounds that are also higher than younger groups of each school. Among them, figures relating to sensorial experiences of TXS_5 are more significant than other schools, especially looking (NE=3.10 and NT=2.20) and touching (NE=2.80 and NT=1.70). Within classrooms, results show that children of TQT explored the greatest amounts of nature. The significant outcome is that the perceived nature capability was positively correlated to an increased age range when all three groups did their tasks in the same room. Meanwhile, the divergence trend appears in the results of two groups of the TXS school; particularly, the older group TXS_5 reported less perceived nature than the younger group TXS_4.3, although the classroom setting of grade 5 has more advantages for permeability values than of grade 4.3. In regards to children groups of TDP, results of grade 5 and 4 pupils have relatively similar figures of perceived nature with TXS groups. Understandably, due to a complete disconnect with outdoor environments, results of TDP_3 accounted for the lowest figures of total and sub-sensorial natural exploration.

With regards to the distribution of natural diversity according to sensorial experiences, the results of TGA and HCMC revealed that flora and fauna were the dominant attributes that children responded to within classrooms and playgrounds (as shown in Table 6-3). The summarized frequencies of flora, the most perceived nature within the entire places, were 53% and 62.7% in total responses of TGA and HCMC schools, respectively. Animal species were the second-highest explored group; however, TGA results showed the ratio of fauna-related responses was around 25% of the total while only about 10% of HCMC children's total responses were mentioned. Following fauna and flora groups, wind was highly reported with 10.7%, whereas water, weather, and light were the least perceived groups in cases of HCMC pupils. Regarding TGA children, the proportions of water, air, minerals, and wind quotes were relatively low at around 5%.

Table 6-3. Synthesized distributions of children's perceived natural classifications according to places of TGA and HCMC schools

	TGA				HCMC			
	Classrooms	Playgrounds	Total		Classrooms	Playgrounds	Total	
	(Frequency)			(%)	(Frequency)			(%)
Air	17	29	**46**	4.8	17	29	**46**	5.1
Astro - Sky	0	4	**4**	0.4	16	17	**33**	3.7
Fauna	105	135	**240**	24.9	25	62	**87**	9.7
Flora	132	378	**510**	53.0	176	386	**562**	62.7
Light	3	0	**3**	0.3	17	6	**23**	2.6
Minerals	0	39	**39**	4.1	13	31	**44**	4.9
Water	11	39	**50**	5.2	2	1	**3**	0.3
Weather	13	15	**28**	2.9	1	1	**2**	0.2
Wind	23	19	**42**	4.4	58	38	**96**	10.7
Total	304	658	**962**		325	571	**896**	

Following, to figure out the distributions and classifications of nature according to particular sensorial experiences, obtained from children's reports of six schools, are circumstantially described as following.

a) TGA_Kelvinbridge

Results concerning the distributions of natural classifications according to certain sensorial experiences of three groups of TGA_Kelvinbridge conducted within three different classrooms, and the playground area are illustrated in Figure 6-3 and Figure 6-4, respectively.

Classrooms

Concerning Kelvinbridge_P7 pupils, this group heads the amounts of natural elements and diversity even though this classroom involves fewer advantages of direct experiences of nature than rooms of grades 4 and 3. Children explored nature primarily through looking and hearing and offered the highest ratios of plants (46.2%) and animals (24.5%). Prominently, the flora group included quotes as "*plant(s)*", "*tree(s)*", "*leaves*", and "*flowers*". "*Dog*" (that suddenly appeared on the street and barked during the survey period), and "*bird(s)*" were regularly mentioned for hearing. The weather condition was also demonstrated as "*cloud*" and availability of "*wind*" with 8.5% and 13.2% of total responses, respectively. Their answers related to available indoor plants, "*avocado seedling*" pots, which were present for studying nature.

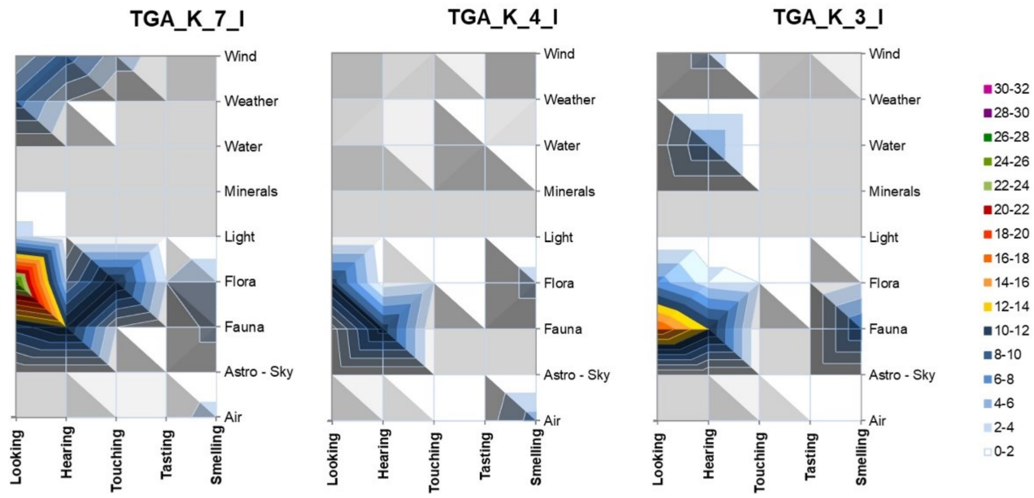


Figure 6-3. Frequencies of perceived natural classifications according to sensorial experiences of TGA_Kelvinbridge pupils within classrooms

In regards to indoor results of Kelvinbridge_P4, the amounts of perceived nature and natural diversity were much lower than outcomes of grade 3 children. However, these classrooms are relatively similar except for differences in the state of the window and weather conditions during the survey periods. Particularly, looking "*tree(s)*" and hearing sounds of "*bird*" were two major features of direct natural experiences with 35.4% and 22.9% of total responses, respectively. The remarkable result was 20% of total responses covered "*(fresh) air*" linked to smelling and touching, although the window was closed during the survey time. Furthermore, some children also reported a smell of "*leaves*".

With the advantages of opened windows confronted to greenspace and water landscape, and available indoor nature for studying (tadpoles), the amounts of natural elements and types that Kelvinbridge_P3 reported were much higher than children of P4 room. The notable outcome was a dominance of animal species over other natural types, with about 58% of total answers in regards to senses of look, hear, and smell. Particularly, via looking, "*bird*", "*caterpillar*", "*tadpoles*", "*(chrysalis) butterfly*", and "*minibeasts*" were mentioned. "*Bird singing*" was also reported besides sounds of "*wind*", "*water*", and "*river*" due to opened status of the window, surrounded water landscape, and weather effects. In regards to smell, there were 8%

of responses of "*tadpoles*" and "*insects*". Referring to flora species that accounted for 21%, "*tree(s)*" and "*lots of leaves*" were mainly figured out through vision. Children also reported hearing sounds and smelling scents of "*leaves*" and "*tree*" in this room.

Playground

The Kelvinbridge_P7 children continued heading the capacity of exploring nature within their playground. With 40% of total responses, flora species was the most significant natural feature that was figured out by five senses, especially looking, touching, and smell. Quoted words were "*tree(s)*", "*leaves/leaf*", "*flower(s)*", "*bush(es)*", "*freshwood*", "*vines*", "*daisies*", and "*moss*". Concerning animal species that accounted for 27% of total answers, children highlighted in looking and hearing sounds of dogs and birds. With surrounded water landscape, children not only saw and heard sounds of "*water*" and "*river*", but also figured out "*mud*", "*stone*", "*rocks*", and "*soil*". Meanwhile, "*air*" was mainly distributed in touch, taste, and smell concerns.

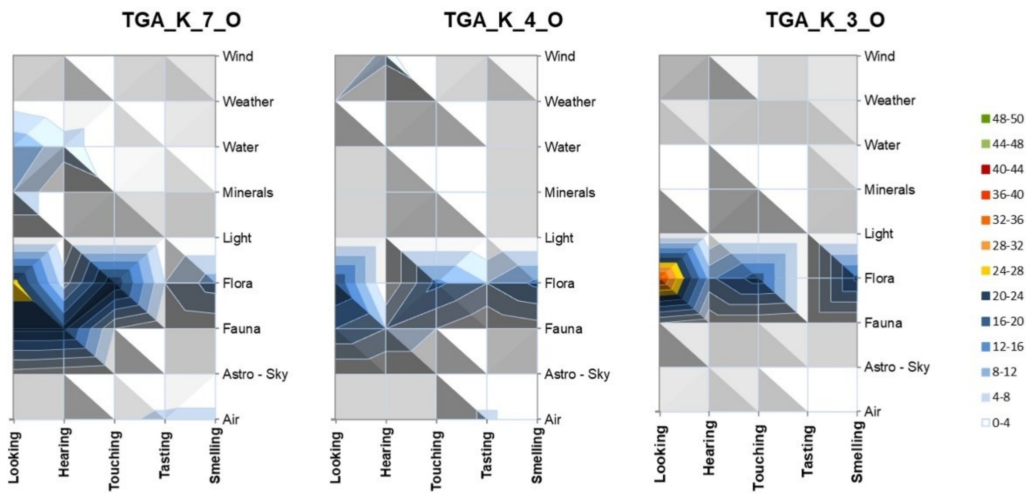


Figure 6-4. Frequencies of perceived natural classifications according to sensorial experiences of TGA_Kelvinbridge pupils within the playground.

Although investigating within the same outdoor place, the results of the Kelvinbridge_P4 group were lower than of grade 7 and 3 groups. Minus hearing, 53% of total perceived natural were classified into the flora group that was distributed into all sensorial experiences; for example, children saw, touched, tasted, and smelled "*tree(s)*", "*plant(s)*", "*leaves*", "*flower(s)*", and "*grass*". Meanwhile, appearances of a dog, birds (e.g. "*bird*", "*seagull bird*", and "*feather*"), and insects (e.g., "*worm*" and "*beetle*") were shown in children's responses regarding look, hear sounds, touch, and smell. The weather condition was also reflected when children saw and touched "*sun*" besides heard sounds of "*wind*" or tasted "*wind*". Besides, some pupils also mentioned they touched "*soil*" and "*rocks*" of flower beds besides "*fresh air*" of tasting. Significantly, this group of pupils was not concerned about the water feature within this playground.

Children of grade 3 head the proportion of flora species compared to the other Kelvinbridge with more than 70% of total responses. Particularly, a half of flora-related answers reported in looking while hearing, touching, and smelling accounted for the other half. The flora species included "*tree(s)*", "*grass*", "*plant(s)*", "*leaf/leaves*", "*twigs*", "*sticks*", "*bush(es)*", and various types of flowers (e.g. "*flower(s)*", "*lavender*", "*daisy*", "*pansy*") that existed in the flower bed. Due to observing this area, children also explored "*soil*" and "*stones*" that could be both seen and touched. Furthermore, the windy and gentle rainy situation during the survey time influenced the variety of nature children could experience with additions of "*rain drops*" that were perceived through looking, touching, and tasting. Meanwhile, "*wind*" caused sounds that were reported out through its sound and sounds of "*leaves*". Besides, some pupils also noticed "*air*" as the natural element of all sensorial exploration except hearing. In contrast, the most significant outcome of this group is children least mentioned animal species with around 5% of total perceived nature; there were few pupils who saw and heard sounds of "*bird(s)*".

b) TGA_Milngavie

Figure 6-5 represents the outcomes of Milngavie pupils within their classroom (TGA_M_I), and two different outdoor areas, including TGA_M_O.1 and TGA_M_O.2, are related to the area at the main entrance gate and the wilderness area, respectively.

Classroom

Among investigated indoor places of three TGA schools, pupils of Milngavie explored the least numbers of natural elements and types within their classrooms. The proportion of flora group (including "*tree(s)*", "*bush*", "*leaves*", "*moss*", "*flower(s)*", and "*plant(s)*") significantly lead the experienced natural types for more than 80% and primarily distributed into vision. Pupils here remarkably noted indoor-decorative potted plants with colourful flowers. In contrast, animal-related and "*cloud*" responses accounted for around 18% and 2%, respectively.

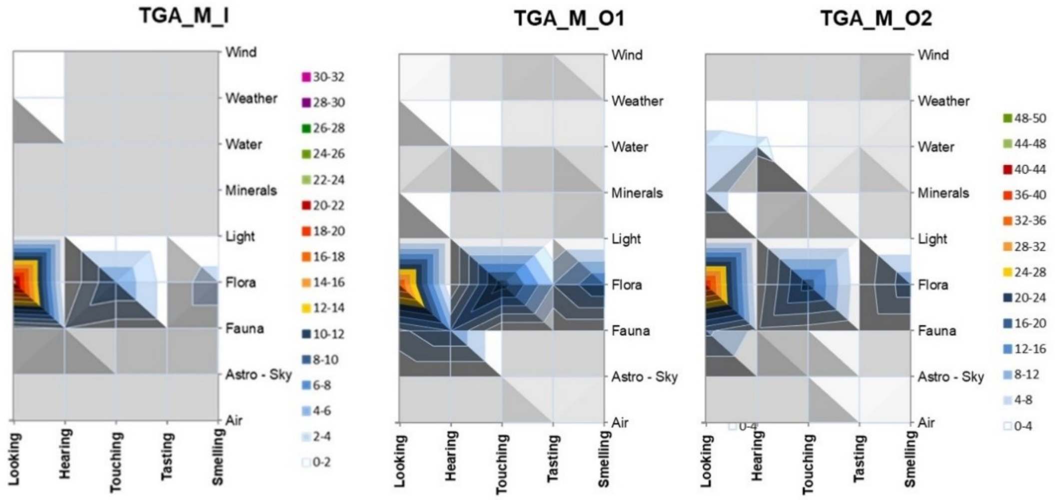


Figure 6-5. Frequencies of perceived natural classifications according to sensorial experiences of TGA_Milngavie pupils within the classroom (M_I) and two playground areas (M_O1 and M_O2)

Playground

Within the area at entrance gate Mingvie_O.1 where have various plant species and flower-plants, the results showed the dominance of the flora group with 70% of total children's responses. "*Tree(s)*", "*plant(s)*", "*bush(es)*", and "*flower(s)*" were mainly distributed into the exploration of looking, touching, and smelling. With lots of plant diversity, pupils also interacted with "*soil*" and "*water*" frequently. Besides, children noted appearances of "*butterfly*" and "*bird*" that were classified into fauna species (around 16%) and dispersed into visual and aural experiences. Few pupils mentioned "*cloud*" and "*wind*" as actual weather conditions during the survey period.

Although moving to wilderness area Milngavie_O.2, the total figure of perceived natural elements was slightly lower than within the entrance gate area. What stands out in Figure 6-6 regarding TGA_M_O.2 is the greatest proportion of flora group that was mainly experienced through looking, touching, and smelling (36%, 16.4%, and 10%, respectively). Various flora species were named here, such as "*tree(s)*", "*grass*", "*leaves*", "*moss*", "*fern*", "*skunk cabbage*", "*bud*", "*blossom tree*", "*nettles*", "*bush*", "*wood stump*", "*roots*", "*log*", and "*weeds*". Here, the ratios of animals and water were relatively similar at about 12% of the entire responses. In regards to the fauna group, children saw and touched many diverse species, for instance, "*worm*", "*beetle*", "*slug*", "*woodlouse*", "*moth*", "*snail*", "*wood louse*", and "*ants*". Meanwhile, "*lake*" and "*river*" were water features that children explored through all senses except smell. Less than 10% of total responses, mineral features, such as "*soil*", "*rock*", and "*stone*", were mentioned by some pupils who explored through look and touch.

c) TGA_Newlands

Results of TGA_Newlands children's perceived natural classifications according to particular sensorial experiences within their classroom and playground area are in Figure 6-6.

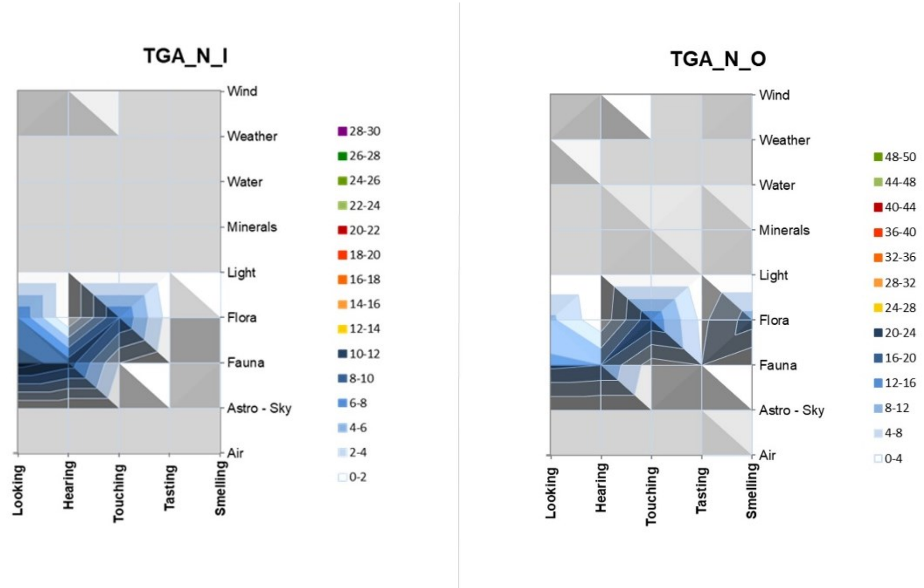


Figure 6-6. Frequencies of perceived natural classifications according to sensorial experiences of TGA_Newlands pupils within their classroom and playground

Classroom

Within the classroom for Newlands pupils, two primary perceived natural groups were fauna and flora species that constituted approximately 53% and 44% of the total. In contrast, only one pupil mentioned the sound of "*breeze*" besides two above groups. In regards to animal-related responses, the "*caterpillar*" glass boxes of butterfly's life cycle subject, the appearances and sounds of birds (e.g. "*bird(s)*" and "*squirrel*"), and "*fly*" species were explored through multi-senses except tasting. Concerning flora features, children quoted "*leaf/leaves*", "*twig*", "*stick*", "*wood*", and "*tree*" that were mostly collated into visual and audio experiences.

Playground

According to Figure 6-6, related to outdoor explorations, the discrepancy between visual and non-visual experiences was not significant like other TGA school cases despite the highest ratio of vision (around 30%). Similarly, like indoor outcomes, flora and fauna head the proportions of perceived natural types with about 39% and 49%, respectively. On the contrary, quotes of "*soil*", "*sand*", "*sun*", "*air*", and "*wind*" only accounted for the lowest rates. Within the flora-associated responses, children had the greatest concerns of touch (40%), smell (26%), look (24%), taste (8%), and hear (3%) of "*leaf/leaves*", "*flower(s)*", "*tree*", "*hedge*", and "*moss*". Meanwhile, responses of animals, such as "*(midway) bird(s)*", "*insect*", "*woodlice*", "*woodlouse*", "*ant*", "*butterfly*", "*bee*", and "*owl*", were mainly sorted into looking (42%) and hearing sounds (39%) while less explored through taste (13%) and touch (7%) manners.

d) HCMC_TQT

Figure 6-7 and Figure 6-8 provide the results obtained from analysing three pupil groups of HCMC_TQT. The most intriguing aspect of these graphs is distinct differences in relation to frequencies and distributions of perceived natural classifications between three groups; even though they did the exploration in the exact same environments

Classrooms

Children of grade 5 lead the amounts of perceived natural elements and types; particularly, through visual and non-visual sensorial exploration, they reported air, astro-sky, fauna and flora species, minerals, weather, and wind. Among them, over half of those responses was for the flora group that was perceived through senses of vision (46%), hearing (20%), touching (19%), tasting and smelling (15%) of "*leaves*", "*flowers*", "*tree(s)*", "*grass*", and "*vegetables*" within and from the classroom. One surprising aspect of children's answers related to the indoor seedling trays which were present for studying; thus, the "*soil*" was reported as a perceived feature (9%) and collaborated into touch and smell. Meanwhile, animal-related responses (sounds of "*bird singing*") accounted for the lowest figure (3%). Children also paid their attention to "*wind*" for its appearance, sound, and smell besides visible features of "*sky*" and "*cloud*", and scents of "*air*" and light "*rain*". These perceived natural groups were relatively high, with approximately 11% to 12% of total responses for each category.

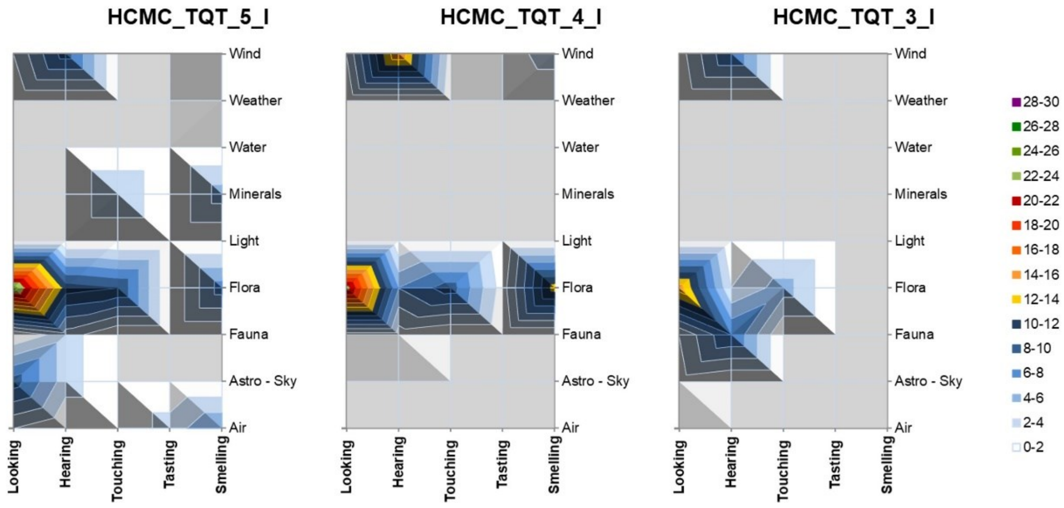


Figure 6-7. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TQT pupils within the same investigated classroom

The TQT_4 pupils accounted for 75% of the older group TQT_5_I. However, their responses regarding flora and wind made up higher ratios at 67% and 30% of the total figure, whereas around 3% was bird-related. They mainly described "*tree(s)*" through senses of looking (44%), smelling (25%), touching (17.3%), hearing sounds of "*leaves*" (11.5%) and finally, least tasting "*flower*" and "*leaves*". The responses reporting hearing sounds of the "*wind*" was 16, which yielded about 70% wind-response rate while the rest was related to experiences of wind through non-aural senses.

The total perceived natural elements of the youngest group TQT_3 was much lower than two older groups, approximately 40% of the TQT_5_I figure. There were only four natural classifications they explored within this classroom, including flora (52%), fauna (24%), wind (21%), and sky (2%). Regarding the flora group, most children were significantly concerned with visual experiences of "*tree*" while few students touched and heard sounds of "*leaves*". In contrast, "*birds*" were mostly heard (80% of responses); there were only two pupils saw "*birds*" flying. Similarly, the dominant trend of "*wind*" responses was sound that accounted for 8 of 9 answers.

Playgrounds

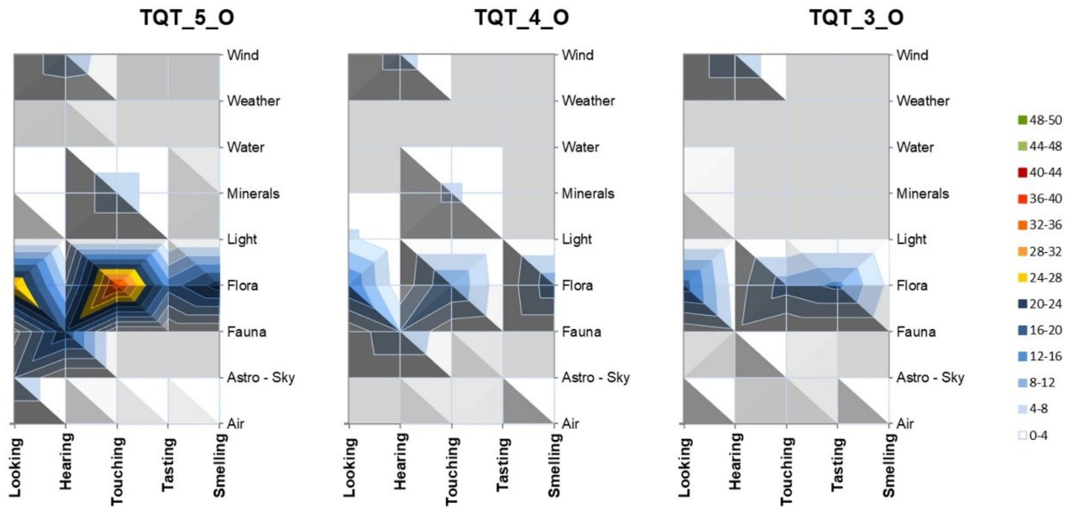


Figure 6-8. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TQT pupils within the playground areas

As shown in Figure 6-8, this oldest group TQT_5 continued leading the figures of perceived nature compared to younger children when moving to the playground area. The TQT_5 group had significant accounts of flora species that made up around 65% of reports. What stands out in this group is that children figured out more flora features via touching (34% of flora-related responses) than via looking (26%). In visual connections, children identified "*tree(s)*", "*flower(s)*", and "*leaves*". Regarding physical contact, they also touched and recognised the scents of "*trees*", "*flowers*", "*leaves*", "*grass*", and "*wood*". Besides, some pupils heard sounds of "*leaves*" and "*trees*" rustling. Interestingly, the obtained results showed that 14 pupils of this group tasted "*flower (nectar)*", this response rate was much higher than that of other groups in Glasgow and HCMC cases. Around 12% of total responses concerned sounds of "*bird*" that was the unique species sorting in the fauna group. "*Wind*" was also mainly experienced through hearing by 6% of participants. Few students described that they touched "*soil*" and "*stone*" as well as had views of "*cloud*" and "*rain*" as real weather situations during the survey.

In regards to TQT_4 children, the total amount of perceived natural elements of this group within the playground area was about 42% of the grade 5 group's figure. In Figure 6-8, the proportion of flora group was highest at 57% and distributed into experienced senses of look, touch, and smell that were mentioned as "*(Delonix regia) tree(s)*", "*plant wall*", "*leaves*" and "*flowers*". About aural exploration, sounds of "*birds singing*" and "*wind*" accounted for below

10% of total answers. The least perceived natural types were the smell of "*air*", physical contact with "*soil*", and their attention toward views of "*light*" and "*sunlight*".

The youngest children of TQT_3 explored nature the least among groups of TQT within their playground area, both natural elements and types. They mostly figured out flora species (about 68% of total responses) through the main roles of vision, touch, and taste rather than aural and scent manners. Similar to the two above groups, "*trees*", "*leaves*", and "*flower (nectar)*" was reported; especially, "*flower nectar*" was the unique element of tasting responses. Sounds of "*birds singing*" and "*wind*" head for aural experiences within the playground area. Although, the responses of birds were half of wind which accounted for around 12%.

e) HCMC_TDP

Figure 6-9 and Figure 6-10 compare the obtained results of three pupil groups conducted in three different classrooms and within their playground area.

Classrooms

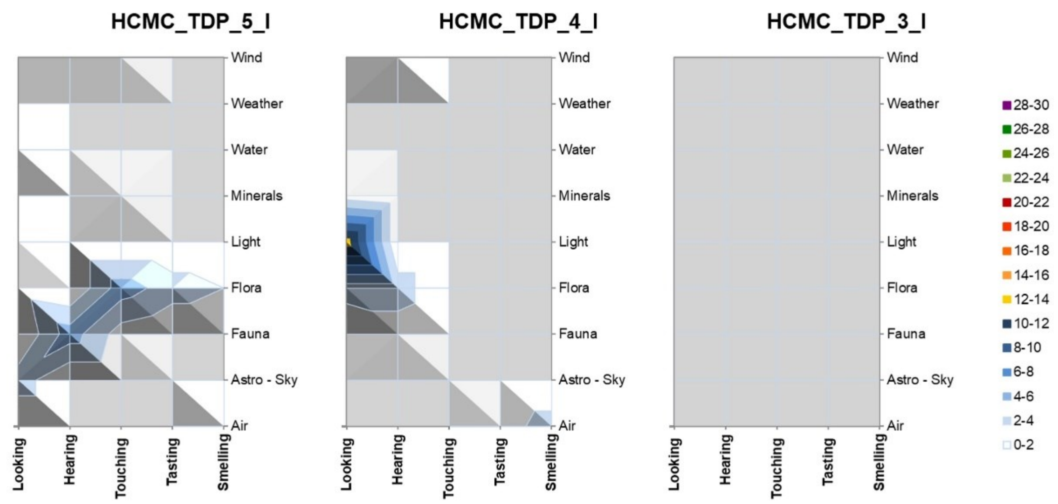


Figure 6-9. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TDP pupils within three different investigated classrooms

In general, pupils of TDP_5 within this classroom reported a variety of natural types even though the frequencies of particular groups according to senses were below six responses. The response rate of the flora group, including quotes as "*tree(s)*" and "*leaves*", was around 37%

and mainly sorted into senses of touch, taste, and smell. Meanwhile, 20% of the total responses indicated that children heard "*bird*" and "*cock crow*" sounds. Furthermore, few pupils also mentioned views of "*sky*", "*cloud*", and "*wind*".

The figure of the grade 4 group relating to total indoor perceived nature was slightly lower than of TDP_5. "*Light*" had the greatest rate of 48%, which was only found in vision. Meanwhile, few pupils saw "*tree*", "*leaves*", and "*tree trunk*" besides heard sounds of "*leaves waving*", "*bird*", and "*wind*".

Meanwhile, due to the disadvantages of the classroom, grade 3 pupils did not give any natural-related answers within their classroom. Instead, furniture and facilities, which are made from natural and artificial materials (e.g. "*(wooden) pencil*", "*(wood) shelves*", "*(wood) tables, chairs*" and "*books*"), and human (for example, "*people*" and "*my friend(s)*") made up the majority of responses. In this study, wood and wooden objects were considered as the productions of trees – not be in raw materials and remained original natural features. Therefore, according to the definition and classification presented in section 6.1.1 and Table 6-1, they were not put in natural elements for analyse.

Playgrounds

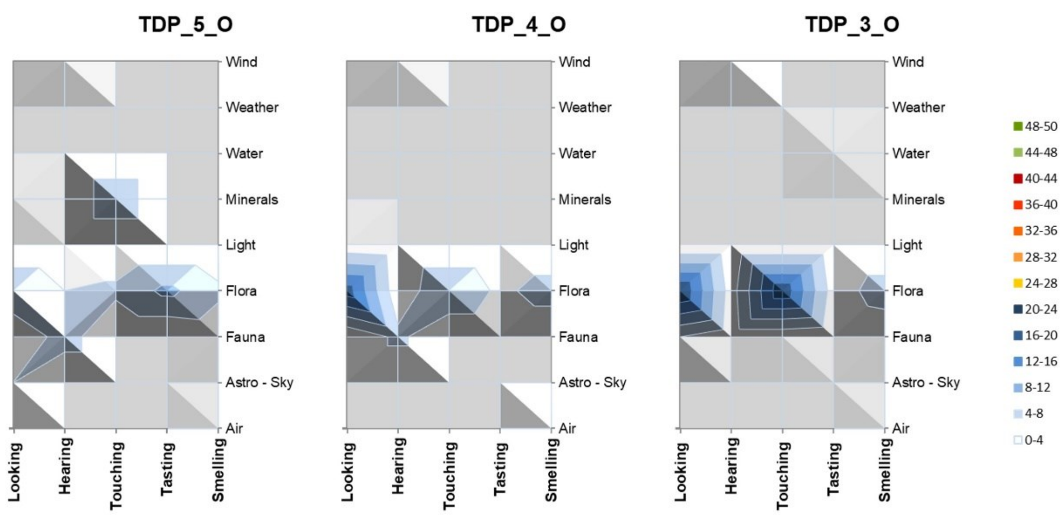


Figure 6-10. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TDP pupils within the playground area

Generally, the frequencies of perceived nature within outdoor environments of three groups of TDP were much lower than of TQT except for the youngest children. Relating to the oldest group TDP_5, they mainly reported *"(bamboo) tree(s)"*, "*leaves*", and "*flower (petals)/ (nectar)*" that accounted for approximately 60% of total responses; these elements were perceived through visual and non-visual senses, especially tasting and looking. They experienced other natural types with their remaining senses, such as listening to sounds of "*bird*" and "*wind*", touching "*gravel*" and "*stones*", and having views of "*cloud*" within the playground.

Between three groups, the most significant figure of TDP_4 was flora species (about 77% of total answers) that were explicitly explored through visions. Similar to the TDP_5 group, *"(bamboo) tree(s)"*, "*leaves*", "*flowers*", and "*grass*" were flora-related quotes, while sounds of "*bird*" and "*wind*" were also mentioned in hearing.

The youngest children of TDP_3 had the highest total frequencies of natural elements among the three groups within the same playground. The children reported the figure of flora species (about 80% of total answers) that were distributed between looking and touching, including *"(bamboo)/(catappa) tree(s)"*, and tree-related elements as "*trunk*", "*flower (petal)*", "*leaves*", "*branches*", and "*grass*". The main animal species that was reported here was "*bird*" as the second highest exploration. In contrast, other natural types accounted for very low rates.

f) HCMC_TXS

Two pupil groups of this school explored nature within different classrooms and playgrounds. The obtained results were illustrated in Figure 6-11 and Figure 6-12.

Classrooms

The frequencies of indoor perceived natural elements of the two groups were low compared to indoor values of other schools. In concerns of TXS_5, the most outstanding outcome was that the majority of these participants shared the statements that "*Humans and God are nature*". Therefore, more than 70% of total responses were regarded to "*Saint*" and their friends' nicknames that are represented various natural elements, for example, "*Rabbit*", "*Cloud*", "*Sunny*", "*Pig*", "*Peanut*", and "*Apple*". After selecting according to determined natural classifications of this research, the appropriate answers then accounted for about 27%. Among them, a half was about flora species that were linked with senses of look, touch, hearing, and smell. The second significant natural group was "*wind*", that were mostly experienced through aural manners.

With regards to the four younger children TXS_4.3, the figure of total responses was quite small because of the limited number of participants. What stands out in the Figure 6-11 is the dominant distribution of flora species, except one pupil who mentioned his view of "*sun*". These pupils described "*tree(s)*", "*leaves*", and "*flowers*" as natural elements they experienced through visual and non-visual senses within their classroom.

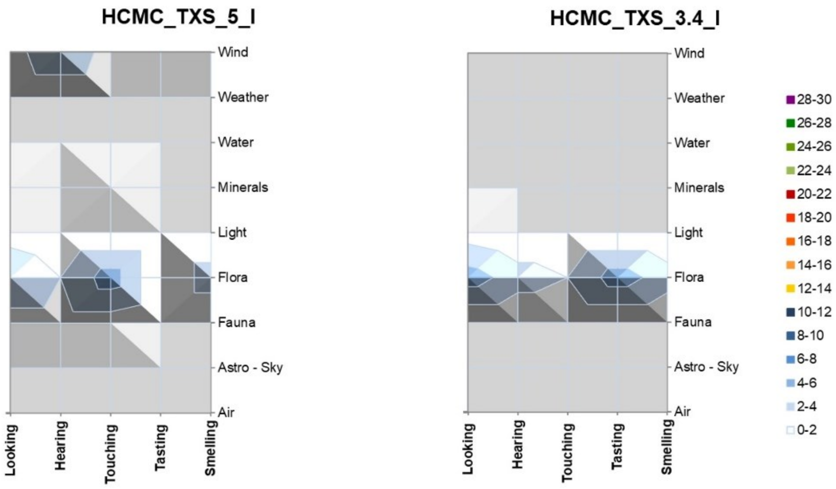


Figure 6-11. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TXS pupils within three different investigated classrooms

Playgrounds

When moving to the investigated outdoor studying area that compounded various vegetation plants, grass, and sand ground, the figures of grade 5 tripled their indoor perceived natural elements. Specifically, the flora-related quotes (such as, "*(Muntingia) tree*", "*leaves*", "*grass*", "*wood*", and "*fruits*"), head the explored ratio with more than 70% while other natural types, including "*bird*", "*air*", and minerals (e.g. "*sand*" and "*soil*", and "*water*") accounted for insignificant percentages. Experiences through looking and touching constituted the greatest variety while senses of hearing, taste, and smell were less adopted with flora species and minerals.

Meanwhile, within the sports playground area that was included hard and sandy surfaced grounds, the obtained outcomes of the younger group TXS_4.3 were much lower in both amounts of perceived natural elements and types. The frequencies of the outdoor place were half of their indoor value. Particularly, most of the responses were about "*trees*" and "*leaves*", while there were only two quotes for sounds of "*bird*" and "*wind*".

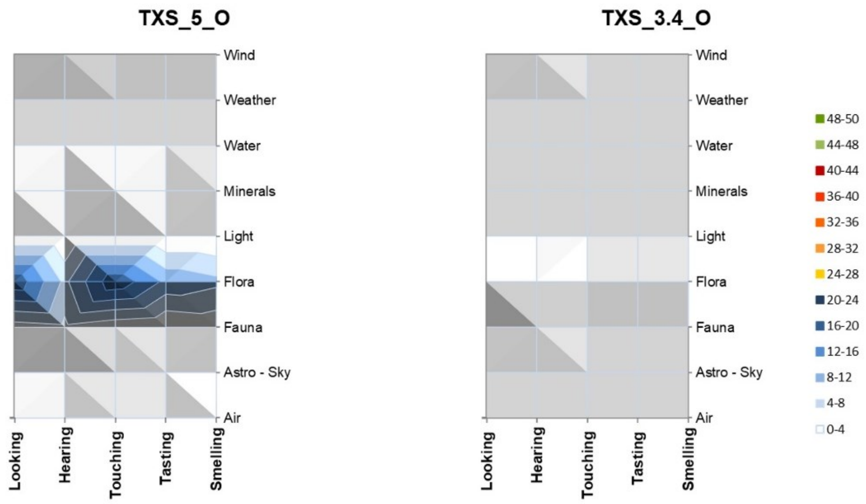


Figure 6-12. Frequencies of perceived natural classifications according to sensorial experiences of HCMC_TXS pupils within two different playground areas

6.1.3 Results according to features of children's biological characteristics, off-school environments and activities

The statistical analysis was set out to investigate the differences between various children groups regarding their exploration nature within classrooms and playgrounds of TGA and HCMC schools.

a) Age and gender differences

Within the school playground of TGA_Kelvinbridge where three groups explored, significant differences in the perceived nature between aged ranges and genders were detected. There was a statistically significant difference in numbers of natural types between children grades of 7, 4, and 3 as demonstrated by one-way ANOVA ($F\_NT\ (4,41) = 3.66$, $p=.013$). Particularly, the older children were, they increasingly explored more various natural classifications. There were noteworthy differences in both frequencies and types of nature between genders; the results were ($F(1,41) = 16.34$, $p=.000$) and ($F(1,41) = 7.62$, $p=.009$), respectively. The mean figures of female groups were ($M\_NE=6.96$, $SD\_NE=2.92$ and $M\_NT=3.91$, $SD\_NT=1.50$)

while of male groups were ($M\_NE=3.90$, $SD\_NE=1.70$ and $M\_NT=2.80$, $SD\_NT=1.03$). In cases of TGA_Milngavie and Newlands, there were no differences between age and gender in children's natural exploration.

Regarding cases of HCMC schools, except the statistical analysis of the Waldorf school which each group explored different classrooms and playgrounds did not show any differences between genders, significant differences between children's ages and degrees of indoor and outdoor perceived nature were detected in HCMC_TQT and HCMC_TDP.

Within the investigated classroom of HCMC_TQT, the results illustrated that perceived nature significantly increased according to children's age ranges. The results of ANOVA tests for age differences in natural elements and types were ($F\_NE\ (2,67) = 4.06$, $p=.022$) and ($F\_NT\ (2,67) = 9.96$, $p=.000$). In addition, there was a significant gender difference in the number of natural types between girls ($M\_NT=2.5$, $SD=.98$) and boys ($M\_NT=2.03$, $SD=.85$). When moving out to the playground area, there was a significant age difference in frequencies of natural elements reported that demonstrated by the results of the ANOVA test ($F\_NE\ (2,67) = 6.41$, $p=.003$); the older children explored more natural elements than the younger group within the same place. Similarly, significant age differences were found and increased according to children's aged ranges in three pupil groups exploring nature within their main playground area. The results of ANOVA tests for differences in natural elements and types were ($F\_NE\ (2,37) = 3.79$, $p=.032$) and ($F\_NT\ (2,37) = 9.59$, $p=.000$), respectively.

In summary, TGA and HCMC results indicated that the degree of children's natural exploration increases according to age. It could be explained by the augmented levels of cognition, understanding, and knowledge of child's education. As Cobb (1959) and S. Kellert (1985) pointed out, children from 10 to 13 years of age possess a significant growth of cognitive development than younger children.

In relation to gender, with exceptions, Glaswegian girls experienced nature within outdoor environments more than boys whereas gender differences in HCMC_TQT groups strictly appeared in an indoor environment. These differences can be explained by the greater intensively attractions of female pupils toward various types of colourful flower-plants within playgrounds of TGA schools for decoration purposes than male pupils. Meanwhile, there were fewer amounts and diversity of flower-plants at HCMC playgrounds where shade trees and leafy plants are dominant natural settings.

b) Off-school environments and activity differences

There was no finding regarding children's off-school living environments and activities in-between groups of TGA and HCMC except only one interesting finding of HCMC_TQT school. In concerns of statistically significant differences concerning frequencies of visiting nearby parks and playgrounds in exploring outdoor nature, the results of ANOVA tests were ($F_{NE}(3,64) = 4.42$, $p=.007$) and ($F_{NT}(3,64) = 3.76$, $p=.015$). More often children visited, fewer natural elements and natural classifications children reported. It is difficult to explain this result, but it might be related to the activities and behaviours of children when they play at these places. For example, they could focus on active recreational activities and facilities rather than be attracted to natural landscapes. Furthermore, the lower ratios of studying nature through family members and outdoor trips in HCMC, that were analysed and discussed in Chapter 4, could be additionally attributed to children's limited capacity to identify the biodiversity of nearby or close environments. These results seem to be consistent with the study that found that primary-age children's natural perception of the nearby environment was limited even though they live in a rich area of biodiversity (Morón-Monge et al., 2021). This issue stresses the necessity of instructions from adults to children in natural environments, especially younger children, for particular goals of nurturing their biological and cognitive developments.

Additionally, these obtained results showed insignificant differences regarding the living environment in the capacity of natural observations from children. Some previous studies show the positive benefits of greenness in the home environment to children's cognitive levels, for example, children's attentional capacities by Wells (2000) and Dadvand et al. (2017) or children's performance on acquired academic knowledge (Reuben et al., 2019). These aspects differ from the findings presented here that focused on the level of observations and knowledge of natural science rather than academic knowledge.

6.1.4 Findings

The goal of this present study was to explore how children '*read*' and '*define*' the natural elements, according to the way they look, sound, touch, taste, and smell, from external environments. The results indicate that architectural features, spatial settings, and age ranges exert influences on pupils' natural exploration.

Regarding indoor environments, vision is the most substantial manner that children experience with nature. Flora and fauna species were two principal natural groups children discovered among them. Trees and colourful flower-plants significantly caught the observers' attention more than other natural elements. Similarly, the richness of vegetations within openings' views contributed to abundant appearances of other natural elements and stimuli according to time, weather, and seasonal changes. The influences of architectural features and spatial layout within buildings and school sites were illustrated through children's reports. For instance, within classrooms with windows facing wealthy natural environments, the values of children's perceptions of nature are enhanced. This can be seen in the cases of Newlands, Kelvinbridge grades 3 and 4 classrooms where varieties of plants and animal species were noted highly. In contrast, more adverse locations of the Milngavie and HCMC_TDP grade 3 classrooms revealed disconnections between pupils and the outdoor natural environments. Features of installed openings, including position, height, and size, also importantly contribute impacts on the multi-sensorial connections with nature, considerably for vision. This feature was shown in divergent results of HCMC_TQT and HCMC_TDP classrooms where windows were appropriately and inappropriately installed, respectively. The different states of windows (opened or closed) also involved dissimilarities of perceived natural ranges between Kelvinbridge grades 4 and 3 or between HCMC_TXS grades 5 and 4.3 classrooms. Therefore, appropriate decision-making on classroom locations, and the inclusion of permeable features in building envelopes, can considerably enhance children's experience and perception of nature. Another important finding is the children's attention to indoor natural elements. The hands-on and regular learning of natural elements evoked pupils' awareness through five senses, mainly through look, touch, and smell. Within places where connections with outdoor nature were limited, children's responses with detailed descriptions demonstrated a higher intensity of focus on indoor natural objects.

When a child is exposed to outdoor environments, the more wilderness and richness of natural diversity prevail, the greater numbers of natural objects and types he or she can explore. Glaswegian pupils in this study showed a tendency to be impressed by uncommonly natural types (for instance, slug, woodlouse, moss, snail, and worm) than common familiar ones (e.g., birds and intimate insects) within wilder areas. This tendency relates to inherent features of the ground cover and landscaping of a particular location. For example, the earthy ground of the Milngavie site offers a diversity of underground flora and fauna species not found on hard-surface grounds. During the study, pupils in Milngavie became excited to overturn a log to find snails or woodlice or touch moss on a stone. Likewise, water landscapes are a rich source for children's discovery, providing aquatic ecosystems, abiotic components, and a more diverse soundscape. These features contribute to the significant difference between natural land typologies and hard-surfaced playgrounds related to the increased diversity of natural objects as seen in Milngavie and Kelvinbridge groups compared to Newlands and three schools in HCMC. Another important finding was the contributions of plentiful vegetations that include different types of trees and colourful flower-plants in various manners. Firstly, these natural features could attract children's attention and impressions through looking, touching, and smelling. For instance, responses from pupils of Kelvinbridge, Milngavie at the entrance gate, Newlands, and HCMC_TQT schools, especially female groups, showed this. Secondly, the richness of flora species could involve higher frequencies of animal species, such as birds, insects, and friendly pets, which offered more chances for natural interaction to children. Lastly, a rich natural diversity, under the weather conditions and seasonal changes, generated a variety of natural stimuli associated with different elements. With the changes in colours and smell of vegetation, sounds of birds, movement of rivers, the rustling of leaves in the wind; the perceived intensity of stimuli varies, and children experience natural diversity through a comprehensive sensorial experience, even when in classrooms. In contrast, the hard surface setting and poverty of vegetation had limited degrees of sensorial experiences with nature.

In summary, regarding the architecture features, spatial settings and configurations of classrooms and playgrounds at six investigated schools, key issues influencing the child-natural multi-sensorial exploration are: indoor natural settings, built-envelopes' permeability, the spatial layout within school buildings and sites, distributions, and classifications of nature within and surrounded school sites. Furthermore, observing and exploring nature increase according to children's age ranges and level of natural education.

6.2. Children's feelings and favours to natural classifications

Following, this section discusses children's feelings toward explored natural elements and features of their favourite nature.

6.2.1 Emotional feelings

From the raw data of surveys, the relevant themes, short descriptions, and representative keywords were recorded, categorized for coding, and presented in Table 6-4. According to the concept of the circumplex model of affective appraisals (Russell, 1980), these themes were categorised into pleasant-unpleasant responses ranging from high to low stimulus toward perceived natural elements within investigated environments.

Overall, results showed pupils gained both pleasant and unpleasant feelings toward nature through direct multi-sensorial exposure within school environments (Table 6-5). However, approximately 90% of the respondents, both of TGA and HCMC pupils, indicated positive feelings (biophilic), including senses of surprise, excitement, satisfaction, appreciation, relaxation, and calmness. These findings demonstrate the dominance of biophilic responses from children. The results of word frequency coding in Figure 6-13 illustrated major features regarding feeling distinction. Notably, "*happy*" was the most reported word from TGA pupils while "*cool*" and "*comfortable*" were given mainly by HCMC pupils to describe their refreshing, satisfied, and comfortable states at a fairly low temperature from trees with leaves and wind. Some natural elements incurred unpleasant feelings (biophobia) which disgusting and fear were more slightly prevalent than boring and sadness, in the TGA cases. Conversely, the situation reversed in the HCMC cases with boredom and sadness reported higher.

Table 6-4. Themes of affective feelings related to perceived nature

Features of feelings		**Coding categories**	**Relevant words**	
			TGA	HCMC
Pleasant	High arousal	Surprise	*different, surprised, weird, strange, odd, exotic,*	*awake*
	Moderate – high arousal	Excitement	*cool, excited, excited, exciting, welcome*	*interesting*
		Joy	*happy, very happy, joyful, delighted, funny*	*funny, happy, enjoy*
	Moderate – low arousal	Satisfaction	*fresh, nice, fine, refreshed, lucky, good*	*comfortable, cool, fresh, good, open, pleasant, shade, sunshades, shadows*
	Low arousal	Appreciation	*new, alive, mindful, make … positive, helpful, like, refreshing, fresh, cool, warm, colourful, cheery, wonderful, lovely, loving, cute, love, gentil: beautiful*	*beautiful, colourful, cute, breathable, greenery, health, helpful, like, lovely, natural, sweet, tasty, warm, important, likely*
		Relaxed	*relaxed, relax*	*relaxed*
		Calmness	*calm, peaceful*	*peaceful, tranquil,*
Unpleasant		Boredom	*normal, nothing, blank, tired*	*normal, boring*
	Moderate – low arousal	Sadness	*sad*	
	Moderate – high arousal	Craving	*jealous, hungry*	
	High arousal	Disgust	*yucky, grumpy, not to good, dirty, disgusting, sick*	*bad, don't like, glare, unpleasant*
		Anxiety, Fear	*alarmed, a bit scarred*	

Regarding differences between places, the results obtained from TGA pupils illustrated an increased trend of diverse feelings and high arousal states outdoors, especially of unpleasant feelings. Therefore, through multi-sensorial experiences of nature (other than visual), a child could perceive more diverse natural information and stimuli outdoors and report disparate or contrasting opinions to a perceived natural element. Meanwhile, HCMC pupils mostly described their satisfaction of surrounding nature; particularly, their pleasant feelings at low arousal levels (e.g., appreciation, satisfaction, relaxation, and calmness) slightly increased when children were in outdoor environments.

Figure 6-13. Frequencies of coding regarding children's feelings toward perceived nature

Table 6-5. Means of children's affective feelings toward perceived nature by places

School ID	Pleasant feelings				Unpleasant feelings		
	Surprise	Excitement, Joy	Appreciation, Satisfaction;	Relaxed, Calmness	Boredom, Sadness	Disgust	Anxiety, Fear
TGA							
K_7_I	-	.24	.29	.24	-	.06	-
K_4_I	.20	.73	.53	.60	-	.13	-
K_3_I	-	1.0	.50	.70	-	-	-
M_I	-	.25	.25	.10	-	.10	-
N_I	.08	.08	.08	-	-	-	-
K_7_O	.12	.47	.59	.29	.18	.18	.06
K_4_O	.20	.87	.67	.40	.13	.13	-
K_3_O	.10	.60	.50	.20	-	-	-
M_O.1	-	.25	.10	.15	-	.10	-
M_O.2	.05	.15	.30	.05	.10	.10	-
N_O	.23	.46	.38	.15	.15	.08	.08
HCMC							
TQT_5_I	.04	.11	1.0	.07	.11	.04	-
TQT_4_I	-	.70	1.0	.04	.22	.13	-
TQT_3_I	-	.84	.68	-	.26	-	-
TDP_5_I	-	.11	.89	-	-	.11	-
TDP_4_I	-	.14	.43	-	.07	.14	-
TDP_3_I	-	-	.38	-	-	-	-
TXS_5_I	-	.10	.40	-	.10	.10	-
TXS_4.3_I	-	.75	.50	-	.50	.25	-
TQT_5_O	-	.22	1.0	.07	.07	.07	-
TQT_4_O	-	.35	.87	.04	.17	.13	-
TQT_3_O	-	.63	.79	.11	.05	-	.05
TDP_5_O	-	.22	1.0	.11	-	.22	.11
TDP_4_O	-	.14	.64	-	.14	-	-
TDP_3_O	-	.06	.44	-	-	.13	-
TXS_5_O	-	.10	.30	-	-	-	-
TXS_4.3_O	-	-	-	-	.50	-	-

Regarding TGA children, among their responses according to natural classifications, vegetations and animals accounted for the highest percentages of positive responses according to their large frequencies of explorations (as illustrated in Table 6-6). In particular, trees, plants with leaves, and colourful flowers mostly generated senses of happiness, satisfaction, and aesthetical appreciation through looking, touching, and smelling. Pet-orientated species (e.g., dog, cat, birds, squirrels, and butterflies) predominantly incur pleasant feelings of looking and hearing. Concerning water, most responses from Kelvinbridge and Milngavie pupils indicated a greater distinct attribute of the water element with a lower arousing degree than stimulus from other natural types. Children reported that they felt relaxed and calm when looking and hearing divergent moving states of water. In contrast, unpleasant feelings were described when they directly tasted, smelt, or touched other natural elements, for instance, "*tired*" of smell a flower, "*sick*" when looking at skunk cabbage, and "*yucky*" when in touch, taste, and smell of soil.

Regarding emotional responses of HCMC children, the obtained results shown in Table 6-7 revealed the noticeable predominance of vegetation that accounted for the highest variation of feelings through different sensorial experiences. The remarkable outcome of HCMC pupils was how trees with leaves and wind significantly evoked pupils' satisfaction of cooling demands with quotes such as "*cool*", "*good*", "*fresh*", "*pleasant*", "*breathable*", "*comfortable*", "*avoid the sun*", and "*create sunshade*" or appreciation of "*provide me oxygen*" and "*rich vitamin*". Similar to TGA pupils, flowers mostly generated senses of aesthetical appreciation through looking and smelling, for instance, "*beautiful*", "*colourful*", "*cute*", "*smell good*", "*tasty*" and "*sweet*". Birds as the dominant animal species, incur pleasant feelings (e.g. happy-, funny-, pure-, beautiful- sound, lovely, and cute) of visual and aural connections. Focusing on air, most responses indicated an appreciation of "*…providing us oxygen*", "*breathable*", "*… I am alive when I breathe air*" or "*… I am still alive*". Meanwhile, pleasant and unpleasant feelings were both described regarding mineral elements.

Through children's descriptions here, it might be deduced that sensorial emotions vary with more natural diversity. Furthermore, pleasant and unpleasant feelings, ranging from lowly to highly arousal levels, are evoked when their explorations are unlimited.

Table 6-6. Ratios of TGA_children's affective feelings according to perceived natural types and senses

			Fauna							Flora								
	Senses	**Air**	Pets	Insects	Birds	Total	**Astro - Sky**	**Light**	**Minerals**	Tree, plant	Flowers	Leaves	Grass	Others	Total	**Water**	**Weather**	**Wind**
Pleasant – High arousal	L	-	.32	.60	.14	.26	1.0	-	-	.31	.44	.11	-	.14	.31	.14	.20	-
	H	-	.18	-	.36	.25	-	-	-	.13	-	-	-	-	.01	.09	-	.19
	To	.05	.09	-	-	.02	-	-	-	.12	.02	.11	-	-	.07	-	-	-
	Ta	-	-	-	-	-	-	-	-	-	.02	.07	-	-	.02	-	-	.06
	Sm	.14	-	.13	-	.02	-	-	-	.04	.12	.07	-	-	.07	-	.20	.06
Pleasant – Low arousal	L	-	.23	-	.10	.11	-	1.0	.44	.27	.12	.21	1.0	-	.19	.32	.40	-
	H	-	-	.07	.36	.22	-	-	-	.04	-	.04	-	-	.02	.27	-	.44
	To	.05	-	-	-	-	-	-	-	.10	.12	.11	-	-	.10	-	-	.06
	Ta	.27	-	-	-	-	-	-	-	-	-	.07	-	-	.01	.05	-	-
	Sm	.41	-	.07	-	.01	-	-	-	.06	.10	.04	-	.29	.08	-	-	.06
Unpleasant – Low arousal	L	-	-	-	-	-	-	-	-	.02		.04		.29	.03		.20	
	H	-	-	-	.02	.01	-	-	-	-	-	-	-	-	-	-	-	-
	To	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.09	-	.06
	Ta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sm	-	-	-	-	-	-	-	-	.00	.02	-	-	-	.01	-	-	-
Unpleasant – High arousal	L	-	-	.07		.01	-	-	.11	-	.02	-	-	.29	.02	.05	-	-
	H	-	.14		.02	.05	-	-	-	.02	-	-	-	-	.01	-	-	.06
	To	-	-	-	-	-	-	-	.22	-	-	.04	-	-	.01	-	-	-
	Ta	.09	-	-	-	-	-	-	.11	-	.02	.04	-	-	.01	-	-	-
	Sm	-	.05	.07	-	.02	-	-	.11	-	.02	.07	-	-	.02	-	-	-
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Notes:
Pleasant – High arousal: Surprise; Excitement, Entrancement, Interest; Joy
Pleasant – Low arousal: Appreciation, Adoration, Admiration, Awe, Satisfaction; Relaxed, Calmness
Unpleasant – Low arousal: Boredom, Sadness
Unpleasant – High arousal: Disgust, Craving; Anxiety, Fear

Table 6-7. Ratios of HCMC_children's affective feelings according to perceived natural types and senses

			Fauna							Flora								
	Senses	**Air**	Pets	Insects	Birds	Total	**Astro - Sky**	**Light**	**Minerals**	Tree, plant	Flowers	Leaves	Grass	Others	Total	**Water**	**Weather**	**Wind**
Pleasant – High arousal	L	-	-	.17	.06	.07	.30	-	-	.23	.03	.05	-	-	.12	-	-	.01
	H	-	.50	.17	.31	.30	-	-	-	.02	.01	.09	-	-	.03	-	-	.06
	To	-	-	-	-	-	-	-	-	.04	.01	.08	-	-	.04	-	-	-
	Ta	-	-	-	-	-	-	-	-	.01	.03	.03	-	-	.02	-	-	-
	Sm	.04	-	-	-	-	-	-	-	.01	.02	.01	-	-	.01	-	-	-
Pleasant – Low arousal	L	.12	.50	.33	.04	.08	.70	.80	.19	.42	.16	.11	-	-	.26	-	-	.08
	H	-	-	-	.58	.50	-	-	-	.01	-	.13	-	-	.03	-	-	.64
	To	.12	-	-	-	-	-	-	.25	.11	.10	.22	-	-	.13	-	-	.04
	Ta	.04	-	-	-	-	-	-	-	-	.29	.04	-	-	.10	-	-	.03
	Sm	.64	-	.17	-	.02	-	-	.25	.05	.30	.09	-	-	.14	-	-	.08
Unpleasant – Low arousal	L	-	-	-	-	-	-	-	-	.06	.02	.01	-	-	.03	-	-	-
	H	-	-	-	-	-	-	-	-	-	-	.05	-	-	.01	-	-	.04
	To	-	-	-	-	-	-	-	.06	.03	.01	.05	-	-	.03	-	-	-
	Ta	-	-	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	-
	Sm	-	-	-	-	-	-	-	-	-	.03	.03	-	-	.02	-	-	.03
Unpleasant – High arousal	L	-	-	.17	-	.02	-	.20	-	-	-	-	-	-	-	-	-	-
	H	-	-	-	-	.02	-	-	-	-	-	.01	-	-	-	-	-	-
	To	-	-	-	-	-	-	-	.06	.01	-	-	-	-	-	-	-	-
	Ta	-	-	-	-	-	-	-	-	.01	.01	.01	-	-	.01	-	-	-
	Sm	.04	-	-	-	-	-	-	.19	-	-	-	-	-	-	-	-	-
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Notes:
Pleasant – High arousal: Surprise; Excitement, Entrancement, Interest; Joy
Pleasant – Low arousal: Appreciation, Adoration, Admiration, Awe, Satisfaction; Relaxed, Calmness
Unpleasant – Low arousal: Boredom, Sadness
Unpleasant – High arousal: Disgust, Craving; Anxiety, Fear

6.2.2 Children’s favours to natural classifications

Following the predominant positive feelings, it can be seen from the obtained results in Table 6-8 that flora and fauna groups were mainly favoured in cases of Glasgow. In contrast, only the flora group was greatly favoured by HCMC pupils.

For Glaswegian pupils, flora and fauna groups accounted for 63.9% and 29.3% of total TGA responses, respectively. Among these, the beauty of colourful flowers and the aesthetic utility to schools were strongly identified besides impressive frequencies of appearances of birds and their sounds. Meanwhile, rivers and brook were only identified by pupils of Kelvinbridge and Milngavie. Warm weather was also favoured by some pupils expressing their feelings of comfort during the investigated spring season; this is an important feature of experiences with natural environments within a cold climate.

Table 6-8. Percentages of children's favours to perceived natural classification

Natural classification		**TGA** (%)	**HCMC** (%)
Fresh air		5.3	4.1
Astro-sky		0.0	2.4
Fauna	*Pet-orientated animals*	5.3	0.0
	Birds	20.0	4.9
	Insects	4.0	0.0
Flora	*Trees*	17.3	30.3
	Plants with flowers	45.3	12.3
	Grass	1.3	0.8
Light		0.0	1.6
Minerals		0.0	0.8
Water		8.0	7.4
Weather		2.7	1.6
Wind		1.3	4.1

On the contrary, due to hot weather conditions, especially during the survey periods, HCMC pupils strongly expressed their preferences for cool and fresh air with wind and appearances of clouds. Additionally, trees were most frequently selected for their shadows with 30.3% of total HCMC pupils’ responses, and this figure was approximately double that of flowers. Due to much deficiency in animal species within school environments in comparison with TGA, this group was the least identified by HCMC pupils.

Therefore, through how children described and selected favoured natural elements, the results revealed the significant privilege of a rich vegetation setting within school environments. Furthermore, the consequential distinction between various weather conditions and thermal comforts ultimately influences children's perceptions on natural types. To illustrate, for pupils in HCMC, providing tree shade and windy pathways to enhance children's pleasant feelings within school sites would be important to bring them back to outdoor nature. In contrast, a windy space in cold seasons could diminish TGA pupils' comfortable feelings and their willingness at outdoor spaces for hands-on natural experiences.

6.2.3 Results according to features of children's biological characteristics, off-school environments and activities

a) Age and gender differences

Children's feelings toward perceived nature

The results according to genders and age ranges of children's feelings toward perceived nature in TGA and HCMC are presented in Table 6-9 and Table 6-10, respectively.

Table 6-9. Means of children's feelings toward nature according to genders

		Surprise	Excitement, Joy	Satisfaction, appreciation	Relaxed, Calmness	Boredom, Sadness	Disgust, Craving	Anxiety, Fear
TGA								
Indoor	Male	.05	.38	.18	.27	.00	.05	.00
	Female	.06	.46	.49	.31	.00	.09	.00
Outdoor	Male	.02	.45	.40	.30	.13	.15	.05
	Female	.06	.66	.63	.20	.11	.11	.00
HCMC								
Indoor	Male	.00	.37	.66	.00	.06	.09	.00
	Female	.02	.32	.79	.05	.12	.08	.00
Outdoor	Male	.00	.21	.68	.05	.05	.05	.02
	Female	.00	.30	.79	.05	.12	.09	.02

Table 6-10. Means of children's feelings toward nature according to age ranges

		Surprise	Excitement, Joy	Satisfaction, appreciation	Relaxed, Calmness	Boredom, Sadness	Disgust, Craving	Anxiety, Fear
TGA								
Indoor	7-9	.07	.47	.33	.31	.00	.07	.00
	11-12	.00	.24	.29	.24	.00	.06	.00
Outdoor	7-9	.12	.52	.38	.22	.07	.09	.02
	11-12	.12	.47	.59	.29	.18	.17	.06
HCMC								
Indoor	9-10	.00	.48	.65	.01	.18	.09	.00
	11-12	.02	.11	.87	.04	.07	.07	.00
Outdoor	9-10	.00	.30	.66	.04	.12	.06	.01
	11-12	.00	.20	.87	.07	.04	.09	.02

Focusing on the results of TGA pupils, there were no differences between aged groups and feelings toward indoor and outdoor perceived nature. With regards to gender differences, there are interesting results to underline. Generally, as shown in Table 6-9, female pupils showed higher preferences to express perceptions and attitudes toward nature in the given tasks; their responses were double that of boys. They also reported more positive feelings (e.g., senses of excitement, fun, satisfaction and appreciation, relaxing, and calmness) than male pupils who described high arousal levels and unpleasant feelings toward their recognised natural objects, for example, through expressions of surprise, boredom, disgust, and fear.

Meanwhile, the results of HCMC found age differences in their feelings. As shown in Table 6-10, the older children greater reported senses of satisfaction and appreciation both within classrooms and playgrounds while the younger groups greater indicated their preferences for excitement and joy toward nature within classrooms.

Children's favourite nature

Table 6-11. Percentages of children's favourite natural classifications according to gender and age ranges

Natural elements	TGA (N=75)		HCMC (N=81)		TGA (N=75)		HCMC (N=81)	
	Male	Female	Male	Female	7-9	11-12	9-10	11-12
Astro-sky	0	0	1.8	1.5	0	0	0	4.4
Pet-orientated animals	2.5	8.6	0	0	3.4	11.8	0	0
Birds	27.5	11.4	3.6	6.1	22.4	11.8	3.9	6.7
Insects	2.5	5.7	0	0	5.2	0	0	0
Fresh air	5.0	5.7	3.6	4.5	1.7	17.6	2.6	6.7
Water	10.0	5.7	7.1	13.5	3.4	23.5	5.2	11.1
Weather	0	5.7	3.6	0	3.4	0	0	4.4
Wind	2.5	0	5.4	3.0	1.7	0	6.5	0
Trees	22.5	11.4	42.9	19.7	8.6	47.1	31.2	28.9
Plants with flowers	27.5	65.7	12.5	12.1	44.8	47.1	11.7	13.6
Grass	0	2.9	0	1.5	0	5.9	1.3	0
Light	0	0	3.6	0	0	0	2.6	0
Minerals	0	0	1.8	0	0	0	1.3	0

Table 6-11 presents the percentages of natural classifications children favoured according to their age and gender aspects. There were considerable differences between children of groups 7-9 years old and 11-12 years old. Trees and water were more favoured by the 7th-grade children with 47.1% and 23.5% within-group, respectively. Whereas the younger group highly preferred flowers (44.8%) and birds (22.8%). Interestingly, three children (M_FB: male; N_ER and N_O: female) identified worm, woodlice (or woodlouse) as the most liking elements. The differences between gender were also found out in TGA children's favouring to plants flower-planting species. Particularly, about 66% within the female group showed their impressions of flowers; the followings were birds (11.4%) and trees (11.4%). Within-group of TGA pupils, boys preferred flowers and birds with the highest proportions with 27.5% for each element, while the number of trees was less mentioned by them (22.5%).

In cases of HCMC children groups, boys had higher ratios of favouring trees than girls with 42.9% and 19.7% of total sub-responses, respectively. Plants with flowers were the second greatest preference by males (12.5%) while water was slightly higher favoured than females (13.5%). Regarding age differences, the results of 9-10 and 11-12 aged groups showed the relative similarities that trees and flower-plants were the most preferred natural elements within school environments.

b) Off-school environments and activity differences

In TGA cases, the statistical analysis hinted significant results regarding favouring trees between visiting adventurous playgrounds and learning nature through books. There was a significantly negative association between selecting trees as favourite nature and the frequencies of visiting adventurous playgrounds (r= -.408, ρ <*.01*); this suggests that children who more frequently visited these activities less favoured trees.

In HCMC, no finding was found for children's off-school living environments and activities.

c) Summary

The most important finding to emerge from the analysis of children's feelings and favouring towards nature is the divergent results regarding age and gender differences in TGA and HCMC. However, the results of their living environments and off-school activities did not show significant differences between groups with clarities.

The difference between age groups in cases of TGA was somewhat limited due to an unequal distribution in this study. This was solely found in HCMC pupils regarding low and high arousal levels of pleasant feelings toward nature. The younger the children were, the higher arousal feelings (e.g., exciting, fun, and enjoyment) they reported; the older children, in contrast, they inclined lower arousal senses, such as satisfaction and appreciation toward nature. These results demonstrated that high arousal levels of feelings toward nature decreased according to children's increased ages; they felt less excitement when growing up. This result may be explained by the familiarity of unchanged and less diverse nature within school environments.

In relation to gender, the obtained results of TGA and HCMC corresponded with the finding of previous studies. For example, Tikka et al. (2000) found that female pupils have high emotional positive attitudes toward nature, or S. R. Kellert & Berry (1987) showed that girls positively gain pleasant feelings toward aesthetical appealing flora species. Girls, in this study, significantly preferred to emphasize their happiness and aesthetic appreciation toward not only colourful flowers but also species with less aesthetical appealing as non-flower species, such as leafy plants, high trees, and grass through direct multi-sensorial exploration with nature other than visions. A significant gender difference was found in TGA results while this was not detected in HCMC; the possible reason could be explained by the fact that TGA school environments had various colourful flower-plants for decoration purposes and the survey period was during the blooming spring season. Therefore, these features cause the greatest attractions and positive feelings of TGA females than those of HCMC conditions. In addition, the diversity of nature, especially fauna and flora species were somewhat limited; shade trees, leafy plants, and birds were the dominant and common natural elements within HCMC school environments. These features could not reliably attract female or male children's attention like high aesthetical appealing or impressive animal species. Therefore, this difference in nature diversity provided significant differences between genders in the case of TGA.

Another important finding was related to TGA pupils' attitudes toward insects which females' responses were inclined to biophilia feelings more than males. This result is in contrast to earlier findings. For example, Herzog et al. (1991) showed that boys highly preferred worms and ants compared to females when they looked at children aged 9 – 15 in Norway. In a study by Prokop & Tunnicliffe (2010) with Slovakian primary school children aged 10 to 15 years, results showed females had greater positive attitudes about squirrels as popular animals while there were no gender differences toward beetle species. W. Zhang et al. (2014) reported that 9-10 years-old female students obtained less positive feelings than males toward 12 kinds of common and a good representation of animal specimens in China. Although the butterflies, sparrows, and squirrels have been excluded lately due to most of the children expressed positive feelings, the rest species were frog, beetle, earthworm, caterpillar, mantis, spider, sparrow, slug, and grasshopper. Similarly, obtained results here are in contrast with 9-12-year-old Japanese females who more likely considered negative (biophobia) feelings to animal species in the case study in Tokyo (Soga et al., 2016). The possible reason for the conflicts with cases studies in China and Tokyo might be about the social-cultural factors, these studies were both conducted in Eastern contexts where boys are encouraged to be unafraid of natural things and have higher inhibitory control abilities than girls (W. Zhang et al., 2014). For the above Western empirical works, it might be considered as closer social-cultural contexts with this study, the familiarities of insects and disgust animals, such as caterpillars, tadpoles, and worms, within the studying and playing environments is one of the explanations for the biophilia feelings of female students.

6.2.4 Findings

It has clearly been seen that natural elements and stimuli evoke diversified and intense emotions through children's observations and perspectives. The results of this section revealed that children, regardless of their culture and educational aspects, had similar distributions of positive feelings toward nature. These results not only support the Biophilia hypothesis of Wilson (1984a) that there is an innate intimacy between a child and nature, but also indicate that there are disparate or contrasting opinions to a perceived natural element through multi-sensorial natural experiences. Furthermore, the more wilderness and richness of natural diversity children experience, the more they involved positive feelings of wonder, joy, satisfaction, senses of surprise, and calmness. On the other hand, there are chances to develop feelings of disgust and fear through experiences with new natural elements and stimuli. These obtained results that comprised of degrees of pleasant to unpleasant and ranging from high to low arousal degrees of feelings, illustrated how vivid features of nature existing through children's observation and perspectives. Although some children had disgusting or scary feelings of unfamiliar natural features, others showed their interests and affections. These divergent responses reveal the constructive contributions of experiencing with nature for humans benefit pleasures.

In addition, another important finding regard to TGA children's emotional reactions toward indoor natural elements is the greater biophilia feelings toward species that are commonly considered to be disgusting or less favoured, for instance, caterpillars, worms, and tadpoles (Almeida et al., 2014; Matchett & Davey, 1991). The familiarities could explain this positive alteration of the children's perception within the studying environments. Results of TGA children suggest that there are advantages in reconsidering indoor natural settings to upgrade pupils' direct experiences and nurture their biophilia feelings toward a wide range of natural elements.

In combination, these findings suggest that there are advantages in reconsidering the more wilderness and richness of natural diversity within outdoor and indoor environments to upgrade pupils' direct experiences and nurture their biophilia feelings toward a wide range of natural elements that could not be thoroughly digitally manipulated via indirect and/or vicarious natural experiences.

The following prominent finding to emerge from the analysis is that flora species accounted for the principal distribution within school environments and were mostly favoured by children, especially female children in Glasgow and HCMC cases. Girls highly favoured colourful flower-plants due to their beauty and aesthetical utility to the appearances of schools. Moreover, the diversity of vegetations is the principal factor that could enhance the appearances of animal species, especially birds within school environments that were most preferred due to their outward forms and pleasant sounds from opinions of TGA and HCMC pupils. These findings suggest the valuable contribution of vegetation richness for awakening emotions and feelings toward various classifications of nature within school environments.

The results of this part also revealed that weather conditions remarkably affect how children evaluate their feelings and favour toward some corresponding natural types and stimuli, such as wind, sunlight, and trees. Some TGA pupils appreciated the warmth of the sunlight and felt cold, while most HCMC pupils preferred wind and cloudy weather for cool demands. Furthermore, most pupils of HCMC schools also significantly appreciated tree shade because of their comfortable satisfaction during the survey time. In contrast, this appreciation was not reported in the answers of TGA pupils. From these findings, it is tempting to suggest that it is important to adopt a climate-based design approach and consider the microclimate of natural settings to enhance the child-nature connections.

6.3. Children's Environmental Preferences

After investigating the influences of schools' architectural features and spatial configurations on how children explore, feel, and favour nature, indoor and outdoor spaces were examined based on distinctive design features according to children's quotes. A favoured environment was evaluated through children's concerns of physical, emotional, and social meanings of learning and recreational activities at schools. Indoor environments were treated as a composite group, whereas outdoor environments included sub-categories according to different features of playground areas within six primary schools, as shown in Figure 6-14 and Table 6-12.

Figure 6-14. Outdoor environments of six investigated schools

Table 6-12. Significant features of outdoor environments

		Outdoor developed spaces								Wild area
		Surface features			Functional settings					
		Hard	Artificial grass	Natural grass/Earthy	General*	Sport	Adventure	Outdoor	Garden	
TGA_K	(a)	●			●					
	(b)		●				●			
TGA_M	(a)		●		●					
	(b)			●						●
TGA_N	(a)	●			●					
	(b)	●				●				
HCMC_TQT		●			●					
HCMC_TDP	(a)		●			●				
	(b)	●			●		●			
TXS	(a)	●				●	●			
	(b)			●				●	●	
	(c)			●			●			

* A general playground is hard-surfaced covered ground and designated for children freely playing within an empty space that is set up without any additional facilities regarding sports, climbing or adventurous activities.

6.3.1 Results

The total respondents of TGA were 100% of participants, while there were 66.4% of 122 participants in the case of HCMC schools because it was related to the selected group of in-depth interviews. The particular distributions of children's favourite places according to groups are presented in Table 6-13. The results, with approximately 70% and 73% of the total TGA and HCMC respondents respectively, indicated that outdoor areas for various creational activities were the predominately favoured place by most primary-school children. What stands out in the table is the disparate trend of TGA_Kelvinbridge grade 7 when 65% of those surveyed indicated that built environments were their most preferred places at school, whereas other groups dominantly selected outdoor places.

In regards to TGA_Kelvinbridge, responses of the oldest group reflected their significant inclination for indoor spaces; the least favourite option was sports playgrounds. In contrast, most children in grades 4 and 3 selected outdoor spaces, especially adventurous playgrounds that set up trim-trail and climbing wall facilities with artificial grass-surfaced covering the ground. A half of TGA_Milngavie children reported the main artificial grass-surfaced playground area as the place they like spending time at school, while a minority of participants (20%) selected the wilderness area. In the case of TGA_Newlands group, two different areas for playing outdoor, including the general setting for all pupils and a particular setting for playing sports, both accounted for equal importance (38%), while 23% of participants preferred indoor places.

Table 6-13. Ratios of children's favourite places distributions

School_ID	Children's Preferences on Built-Natural Environments						
	Built Environments	Outdoor developed spaces					Wild area
		General	Sport	Adventure	Outdoor	Garden	
TGA_K_7	.65	.35	.12	.00	-	-	-
TGA_K_4	.07	.40	.07	.47	-	-	-
TGA_K_3	.20	.30	.00	.50	-	-	-
TGA_M	.30	.50	-	-	-	-	.20
TGA_N	.23	.38	.38	-	-	-	-
HCMC_TQT_5	.17	.83	-	-	-	-	-
HCMC_TQT_4	.43	.57	-	-	-	-	-
HCMC_TQT_3	.15	.77	-	-	-	-	-
HCMC_TD_5	.22	.22	.33	.33	-	-	-
HCMC_TD_4	.20	.20	.30	.30	-	-	-
HCMC_TD_3	.33	.22	.22	.22	-	-	-
HCMC_TXS_5	.30	.20	.40	.10	.30	.20	-
HCMC_TXS_4.3	.50	.00	.50	.00	.00	.00	-

Regarding HCMC results, except for the public school TQT, children of other schools had more than two playground areas with different features of settings to consider, especially the adventurous condition of the Waldorf school. Thus, when TQT participants were asked their favoured place, the majority commented the main playground area as the exclusive outdoor option. This response accounted for 83%, 57%, and 77% of responses of grades 5, 4, and 3, respectively. Following, the grade 4 group head the ratio of favoured indoor environments with 43% in comparisons with values of older and younger groups at same school. Concerning results of three groups of HCMC_TDP, the youngest children reported their preference for indoor places (33%), an equal distribution of responses for three outdoor developed areas (22%), such as the areas of hard surface ground with or without adventurous playing facilities, or artificial grass-surfaced covering for playing football. Meanwhile, results of two older groups HCMC_TDP (grades 5 and 4) indicated football and adventurous playground areas as their highest priorities. For the specific case of HCMC_TXS where offers the greatest variety of outdoor environments, results of the older pupils of HCMC_TXS indicated that they had many choices of place at school. In particular of grade 5, within a group of 10, four participants reported the sports playground area, three pupils selected the outdoor classroom with garden concerns included, three pupils favoured staying within their classroom, and the rest mentioned the adventure playground setting. Half of the grade 4.3 selected the sports playground while another half preferred indoor places.

Following general results of children's favourite places presented above, it requires further exploration of their reasons for favouring particular places. Overall responses revealed that children selected particular places for at least one reason regarding their comfort, interests, and habits, with or without the need for social interactions; for example:

Togetherness – interact with other peoples

TGA: *… talk to friend, … hang out in it, … I get to hang out with my friend, … you get to talk to friends, … I like being with my friend there, … my friends play with me there, … we have a very good teacher, …for everyone.*

HCMC: *… chatting with my friends and having snacks, … running out with friends, … play hide and seek, play blind man's buff and other games with my friends, … play tag game with my friends, play chess and hopscotch with my friends, … play jump rope with my friends, … like do carpentry with teachers, …like playing football with friends.*

Natural concerns – mentioned nature in their responses

TGA: *a lot of sun …, it is sunny …, … has sun, … you get air, … the tree in the corner, it's quiet, … you can climb tree.*

HCMC: *… I like playing near old tree, … lots of shades of trees, … its cool with shades of trees, … many trees for sunshades, … take honey from flowers, … I could plant trees and vegetables in garden, … it is too sunny.*

Functional satisfactions

TGA: *… do science, … we get food, … we can eat there, … where you get food, … has a big stage, … has a trim-trail, … can watch funny videos, … good for my Parkour, … there are very cool thing, … helps us be fit and healthy, … get lots of parties here.*

HCMC: *… to practice dancing, … where I can study, … play IT games, … read books, … there are many books, … like eating, … have air-conditioners to study, … to use computers, … to study here.*

Recreational satisfactions

TGA: *… we get a break from our work, … it means no work, … you can relax, … play (football), … run around.*

HCMC: *… play, … like to play, … lots of interesting games, and various types of games (for example, run around, hide and seek, blind man's buff, tag game, chess and hopscotch, jump rope, climbing, and football).*

Challenges

TGA: *… get to explore, … get to lose part here, … a bit tricky.*

HCMC: *… many tricky games and climbing overhead games, … adventurous games*.

Fun and enjoyment

TGA: *… have fun there and it's enjoyable, ... I enjoy it, … (very) fun, … I am just happy there, … lots of fun.*

HCMC: *… fun.*

Comfortable satisfactions

TGA: *… cosy and spacious, … quiet, … lots of space, … big, … warm.*

HCMC: *… open and cool, not stuffy, … spacious, … cool, … clean.*

Aesthetical satisfactions

HCMC: *… beautiful.*

This result is consistent with previous studies (Aziz & Said, 2012; Chaudhury et al., 2019; Kalessopoulou, 2019; Khan et al., 2019; Menconi & Grohmann, 2018). Table 6-14 shows that both TGA and HCMC pupils preferred places for their recreational demands and interactions with others rather than being attractive with natural features. However, the remarkable differences between these pupil groups are the divergent trends of evoking fun and comfort feelings. Children of TGA schools greater reported favourite places where they had higher arousing levels (e.g. fun and enjoyment). In contrast, HCMC pupils indicated greater relaxing and comfortable feelings within their desired places. Additionally, differences in natural concerns related to sunny and trees with shadows are also found between two groups due to divergent climatic conditions and thermal comfort ranges.

Following, Spearman's correlation coefficient analyses for non-normally distributed data were conducted to examine the relationship between the classifications of places and features of children's social-spatial-natural concerns. Obtained results from these tests for particular cases of TGA and HCMC were presented in Table 6-15 and Table 6-16, respectively.

Table 6-14. Means of spatial features of favourite places according to children's environmental self-regulations

School ID	Social interactions		Natural concerns	Spatial concerns					
	Solitary	With others		Functionality	Recreation	Challenge	Fun	Comfort	Aesthetic
TGA									
K_7	.06	.47	.00	.35	.35	.00	.12	.12	.00
K_4	.13	.47	.20	.07	.80	.13	.27	.20	.00
K_3	.10	.20	.10	.00	.50	.10	.30	.10	.00
M	.15	.20	.10	.20	.45	.10	.25	.10	.00
N	.15	.08	.00	.23	.31	.00	.23	.23	.00
Total	.12	.29	.08	.19	.48	.07	.23	.15	.00
HCMC									
TQT_5	.17	.25	.25	.17	.58	.00	.00	.33	.08
TQT_4	.21	.36	.14	.21	.43	.00	.21	.36	.07
TQT_3	.08	.33	.00	.17	.67	.00	.00	.58	.00
TDP_5	.11	.22	.11	.11	.78	.11	.11	.22	.00
TDP_4	.00	.40	.10	.30	.50	.10	.20	.40	.00
TDP_3	.00	.40	.00	.00	.90	.20	.00	.10	.00
TXS_5	.00	.20	.10	.30	.60	.00	.10	.10	.10
TXS_4.3	.25	.50	.00	.25	.75	.00	.00	.00	.00
Total	.10	.32	.10	.19	.63	.05	.09	.30	.04

Table 6-15. Correlations between TGA children's favourite places and environmental self-regulations

Correlation[c]			TGA_Preferences on Places					
			Built Environment	Outdoor developed spaces				Wild area
				General	Sport	Adventure	Grass	
Social Interactions	Solitary	*r*	**.377****	-.223	-.128	.063	-.087	-.088
		p	.001	0.055	.275	.593	.458	.455
	With others	*r*	-.174	**.406****	-.033	-.201	-.145	-.023
		p	.134	.000	.779	.083	.215	.847
Natural concerns		*r*	-.196	.044	-.102	.139	.104	.149
		p	.092	.705	.384	.233	.373	.203
Spatial concerns	Functionality	*r*	**.646****	-.212	-.166	-.209	-.266*	-.114
		p	.000	.069	.156	.072	.021	.331
	Recreation	*r*	**-.581****	.205	.014	.236*	.170	.128
		p	.000	.077	.906	.042	.145	.273
	Challenge	*r*	-.178	-.161	-.092	**.321****	.151	**.412****
		p	.127	.167	.431	.005	.195	.000
	Fun	*r*	-.084	-.110	.226	.111	.158	.155
		p	.475	.346	.052	.342	.177	.184
	Comfortable	*r*	.215	.006	-.143	.025	-.133	-.098
		p	.064	.961	.220	.834	.254	.401
	Aesthetic	*r*	-	-	-	-	-	-
		p	-	-	-	-	-	-

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
c. Listwise N = 75

Table 6-16. Correlations between HCMC children's favourite places and environmental self-regulations

			HCMC_Preferences on Places							
Correlation[c]			**Built Environment**	**Outdoor developed spaces**						**Wild area**
				General	Sport	Adventure	Grass	Study	Garden	
Social Interactions	Solitary	*r*	**.542****	-.220*	-.051	-.117	-.053	-.065	-.053	-
		p	.000	.048	.649	.298	.640	.565	.640	-
	With others	*r*	-.063	.166	.013	-.075	.061	-.135	-.109	-
		p	.576	.139	.911	.507	.588	.230	.331	-
Natural concerns		*r*	-.109	.278*	-.158	.146	.214	.154	.214	-
		p	.332	.012	.159	.192	.055	.169	.055	-
Spatial concerns	Functionality	*r*	**.495****	-.246*	-.064	-.067	-.076	.243*	.129	
		p	.000	.027	.572	.550	.501	.029	.251	-
	Recreation	*r*	**-.451****	.036	.234*	.108	-.043	.015	-.043	-
		p	.000	.749	.035	.335	.705	.894	.705	-
	Challenge	*r*	-.139	-.209	-.109	**.645****	-.036	-.045	-.036	-
		p	.215	.061	.334	.000	.748	.692	.748	-
	Fun	*r*	.010	-.106	.080	.031	-.049	-.060	-.049	-
		p	.931	.348	.480	.783	.664	.593	.664	-
	Comfortable	*r*	.029	**.328****	-.240*	-.057	.071	.016	.071	-
		p	.795	.003	.031	.611	.529	.888	.529	-
	Aesthetic	*r*	.027	-.049	-.093	-.069	-.031	**.308****	**.390****	-
		p	.809	.667	.406	.539	.782	.005	.000	-

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
c. Listwise N = 81

Results of Glaswegian pupils (Table 6-15) indicated that there were significant correlations between favouring indoor places for individual activities (r= .377, ρ <*.01*) and for functionality (r= .646, ρ <*.01*). Conversely, demands for playing were significantly negatively associated (r= -.581, ρ <*.01*). There was a significant correlation between children who preferred general playground settings and spending time here with friends (r= .406, ρ <*.01*). At the same time, challenges were significantly associated with adventurous playgrounds (r= .321, ρ <*.01*) and the wilderness area of Milngavie school (r= .412, ρ <*.01*).

Similarly, the obtained results of HCMC cases (Table 6-16) also illustrated favouring indoor environments significantly positively associated with needs of individual activities (r= .542, ρ <*.01*) and for functional satisfaction (r= .495, ρ <*.01*) whereas significantly negatively related to relaxing desires (r= -.451, ρ <*.01*). Positive correlations were found between general playground area and comfortable feelings (r= .328, ρ <*.01*) and between adventurous outdoor spaces and challenges of playing (r= -.645, ρ <*.01*). Children of TXS school also indicated they favoured the outdoor classroom area with the garden because of its aesthetical values.

From this analysis of different places and relative spatial-social-natural features according to children's environmental self-regulations, it is evident that each favourite space offers particular characteristics that vary across children's desires and needs at schools. The indoor environments are sufficiently contributed to individual activities and functional satisfaction of utility settings. Outdoor environments, in general, were favoured due to recreational activities and social interactions with friends. Children significantly described they hunted for challenges or opportunities to play their sporty preferences at schools that offered specified areas for adventurous or sports activities rather than only shared playground settings for everyone without any additional utilities.

6.3.2 Results according to features of children's biological characteristics, off-school environments and activities

a) Age and gender differences

The results of statistical analysis of children's age and gender differences in favouring places and relative spatial-social-natural features were illustrated in Table 6-17 and Table 6-18, respectively.

Table 6-17. Correlations between children's favourite places and age – gender differences

Correlation		Preferences on Places							
		Built Environment	Outdoor developed spaces						Wild area
			General	Sport	Adventure	Grass	Study	Garden	
TGA	Age	**.328****	.038	-.066	-.200	**-.299****	-	-	.035
	Gender	-0.158	-.020	-.063	**.321****	.132	-	-	.016
HCMC	Age	0.010	-.036	.024	.049	.073	.129	.168	.118
	Gender	-0.058	.055	-.182	.228*	.174	.083	.174	.122

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
TGA (N=75), HCMC (N=81)

Table 6-18. Correlations between age-gender differences and spatial features of favourite places according to children's environmental self-regulations

Correlation		Social interactions		Natural concerns	Spatial concerns					
		Solitary	With others		Functionality	Recreation	Challenge	Fun	Comfort	Aesthetic
TGA	Age	-.027	**.348****	-.135	.218	-.037	.055	-.104	-.078	-
	Gender	-.016	.043	.020	-.037	.171	-.036	-.123	.217	-
HCMC	Age	.056	-.128	.202	.072	-.136	-.094	.091	-.110	.129
	Gender	.056	-.128	.202	-.054	-.118	.020	.071	.002	.214

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
TGA (N=75), HCMC (N=81)

What stands out in these tables is that the significant correlations of age and gender were found in TGA pupils only. Although the aged range was not equally distributed among TGA except Kelvinbridge, there were a significantly positive correlation of favouring indoor places ($r = .328$, $\rho < .01$) and a slightly negative correlation to grassed playground inclination ($r = -.299$, $\rho < .01$). This significant difference regarding favoured built environments of ANOVA test of three Kelvinbridge groups was $F (4,37) = 4.78$, $p = .003$. Besides, a positive correlation was found between age ranges and the desires for interactions with friends ($r = .348$, $\rho < .01$). These results indicated that the older children were, the more they favoured built environments, the more they inclined to socialized interactions, and the less preferred to natural environments.

Regarding gender, the independent-sample t-test also showed the difference between female pupils ($M = .29$, $SD = .46$) and male pupils ($M = .05$, $SD = .22$); $t (73) = -2.89$, $p = .005$. These results suggest that younger female pupils favour adventurous and energetic activities with the grassed surface or even nature-based challenges of the wilderness area in the Milngavie school.

b) Off-school environments and activity differences

No significant correlation and difference was found between children's favourite places and their off-school living environments and activities.

6.3.3 Findings

According to children's answers, generally, the results indicated that outdoor environments for recreational activities are the predominately favoured places, and also revealed that various spatial functions were major considerations in environmental preferences rather than the multi-sensorial natural experiences by most pupils in both Glasgow and HCMC studied schools. Through their environmental self-regulation that could provide them the freedom to refer to people, physical features, activities, or any concern that seemed important, the most significant findings to emerge from the analysis of this part are as follows:

- **Indoor environments:** children demanded individual activities, specific functions, and artificial facilities. They highly noted features of spaces for their comfort satisfaction (for example, big, warm, quiet, cosy, and spacious) while natural concerns were less given.
- **Outdoor structured playing areas:** children mostly stressed physical activities and interactions with others; they felt fun here. The challenges of playing were also mentioned by children who favoured trim-trail or adventured playgrounds for non-

natural facilities. Meanwhile, the outdoor studying area and garden were highly recommended for aesthetical satisfaction by Waldorf pupils only.

- **Wilderness areas:** they mentioned specific activities, such as climbing trees, exploring, and playing loose parts there. Their descriptions showed the differences between wilderness and outdoor developed spaces relating to higher creative, challenging levels; the former addressed that nature was playing facilities for their activities while the artificial settings were related to the latter.

The need for social interactions, energetic and physical activities with higher arousing emotional degrees, are increased according to the expansion of naturalness of outdoor recreational areas; the greater wilderness is preferred, the more nature concerning is given by children's descriptions. Considering outdoor areas including vegetable gardens for studying are featured by high aesthetical quality.

In summary, these sections have investigated how pupils explore and express their perceptions toward perceived nature and environmental preferences within studied primary schools in Glasgow and HCMC. Results have identified and described key issues influencing children's multi-sensorial natural explorations, and their natural and spatial preferences at primary schools through children's cognition and perceptions. The following section continues to study the child's nature connection within classrooms and playgrounds as a combination of three kinds of interactions: natural – spatial – social at three primary schools in HCMC.

6.4. Children's Spatial – Social – Natural Interactions

Firstly, within classrooms when children explore nature, there were two categories: natural interactions with natural environments and social interactions with his/her classmates. The obtained results regarding time distributions across various types of children's activities and interactions in classrooms are shown in Table 6-19 and Appendix H_ 1. There were three groups of HCMC_TQT, two groups of HCMC_TDP, and two groups of HCMC_TXS. Due to an unexpected technical problem during the survey time of the grade 3 group of HCMC_TDP, the recording was not collected; thus, the results of indoor investigations at this school included two classes grade 5 and 4.

In the playgrounds, interactions between children and a space, other people, and natural elements/landscapes were recorded and analysed through behaviour mappings. Maps of observations and results provide characteristics of children's interactions within each place which present the findings that follow.

Table 6-19. Means of distribution time across activities of children during natural exploration periods of indoor tasks

School ID	N		Social Interaction			Natural and Non-natural interactions		Off-task
			Solitary behaviours	Conversations with peers	On looking behaviours	Natural exploration	Working on paper	
TQT_5	25	Mean	.59	.41	.09	.14	.50	.06
		Std.	.19	.19	.05	.07	.12	.08
TQT_4	20	Mean	.83	.17	.10	.21	.53	.03
		Std.	.17	.16	.07	.10	.17	.07
TQT_3	17	Mean	.81	.20	.14	.21	.47	.05
		Std.	.20	.20	.08	.10	.15	.08
TDP_5	9	Mean	.98	.02	.04	.19	.70	.00
		Std.	.03	.03	.04	.13	.13	.00
TDP_4	14	Mean	.93	.06	.14	.18	.62	.00
		Std.	.06	.06	.12	.09	.17	.00
TXS_5	8	Mean	.75	.25	.05	.09	.59	.09
		Std.	.15	.15	.02	.04	.15	.16
TXS_4.3	4	Mean	.93	.08	.14	.04	.73	.06
		Std.	.05	.05	.06	.02	.13	.13

6.4.1 School HCMC_TQT

The results obtained from the interaction analysis of HCMC_TQT participants in classrooms and schoolyards are set out in Figure 6-15 and Figure 6-16, respectively.

a) In classrooms

The results obtained from the analysis of three groups within the same classrooms are illustrated in Figure 6-15 when children were on natural exploration tasks.

Generally, recording children's observations noted that they frequently referred to windows as the primary source to explore nature from every desk in their comfortable postures of sight directional field. However, the time distributions across activities regarding natural exploration, looking on papers and other pupils, did not reflect the differences between children's positions in considerations of viewpoints' naturalness of looking measured in Chapter 5. Significantly, the remarked difference in the three groups was seating arrangements due to the dissimilar number of participants, although the class was set up with two tables in each row. Due to the largest attendance of grade 5 (TQT_5), the consequence was the closest distances between them, whereas children of TQT_3 group were seated individually in rows at the furthest distances. Mixed seating arrangements had occurred within the case of TQT_4 group which some pupils seated in pairs while others seated individually at further distances. It can be seen that children of three groups spent more time working individually and focusing on their papers rather than having conversations with others and observing surrounding environments. As shown in Figure 6-15, intimate distances between children's desks increased their time proportions of discussing with peers. In contrast, children seated at personal distances tend to work individually and interact less with others.

Through statistical analysis tests, the significant differences in social and natural interactions between three groups were detected, including the differences in how they communicated with others ($F(2, 61) = 10.49$, $p=.000$), worked individually ($F(2, 61) = 10.80$, $p=.000$), spent time to explore nature ($F(2, 61) = 4.95$, $p=.010$). Particularly, compared to others, grade 5 group heads the figure of spending time communicating with other people ($M=.41$, $SD=.19$) and least time to observe surrounding environments for natural explorations ($M=.14$, $SD=.07$). In contrast, younger children took much time to work individually and to detect nature. These features demonstrated figures of solitary behaviour time that accounted ($M=.83$, $SD=.17$) in grade 4, and ($M=.81$, $SD=.20$) in grade 3. Furthermore, there was a slightly significant difference in behaviour of looking at others during time on-task ($F(2, 61) = 3.60$, $p=.034$) between grade 5 pupils who spend less time on this activity ($M=.14$, $SD=.07$) and younger groups ($M=.21$, $SD=.10$).

According to genders, it was found that the activities of looking onto others of grade 5 groups differ between genders ($F = 7.01$, $p=.014$) in which girls ($M=.11$, $SD=.05$) spent more time than boys ($M=.06$, $SD=.04$). Meanwhile, in the grade 3 group, boys had more time off-task than girls; their mean figures were ($M=.10$, $SD=.088$) and ($M=.01$, $SD=.036$), respectively.

These results indicated marked differences in social and natural interactions between the consequences of seating arrangements, age, and gender when children explored nature within an indoor space.

b) In playground areas

When conducting outdoor environments for natural exploration tasks, the interactional mappings of three groups are combined and shown in Figure 6-16 to evaluate and explore variations. In these maps, the grey colour patterns show the shadows of buildings covering the playground areas according to survey times. Grades 5 and 3 conducted surveys in the mornings (10:10-10:20 am and 09:20-09:30 am) while children of grade 4 had afternoon tasks

(2:15-2:25 pm). It is clearly seen that the covering sizes and locations of shaded areas varied between mornings and afternoons in sunny weather conditions. Following, what is striking about these maps is that the sunny areas were, for the majority of time, not occupied by TQT_4 children when do their tasks related to natural exploration thoroughly avoided these areas even though flowers and plants existed within here. Instead of heavily concentrating in the centre playground area like TQT_5 and TQT_3 groups, TQT_4 pupils spread throughout the shaded areas, from corridor to the open main hall, the visitor parking area, and the parking area at the left side of the entrance gate where had high trees and the vertical green wall. In contrast, the maps show that children of grades 5 and 3 had the highest concentrations located at the central area of the main playground, which was decorated with many flower-plants. These maps revealed that children had the highest concentrations at the places where were decorated with attractive and visible natural elements. Furthermore, the hands-on distances between participants and these natural features supported higher frequencies of direct experiences through senses of touch, taste, and smell.

Examining observational maps also illustrate pupil's heavy concentration in groups in areas where there are seating opportunities, for example, the circular centre area at the main playground where pupils are seated around, benches, steps, clean ground, and even motorbikes at parking areas. Conversely, pupils who explored nature individually at positions where space is open, largely empty of substance, and free space to walk around to figure out other natural elements rather than flower-plants. Significantly, the older groups tended to occupy their comfortable seating during the survey period longer to observe nature from visual distances. Younger pupils were likely moving around and had the highest degrees of natural interactions clustering in existing visible natural objects at closed distances. A possible explanation for this is that many outdoor environments were occupied for many other activities that happened during the survey time, for example, a group studying physical courses and lunch preparations at the in-between space and areas along the L-shape corridors. These could limit the movements of the grade 5 pupils in comparison to other groups.

These maps also show the higher level of personal distances and unclearly groupings by genders of grade 3 pupils due to their preferences of movements. In contrast, the intimate distances and same-gender groupings were most frequently observed from grades 5 and 4. These results suggest differences in how children explore nature between age ranges and genders within outdoor environments.

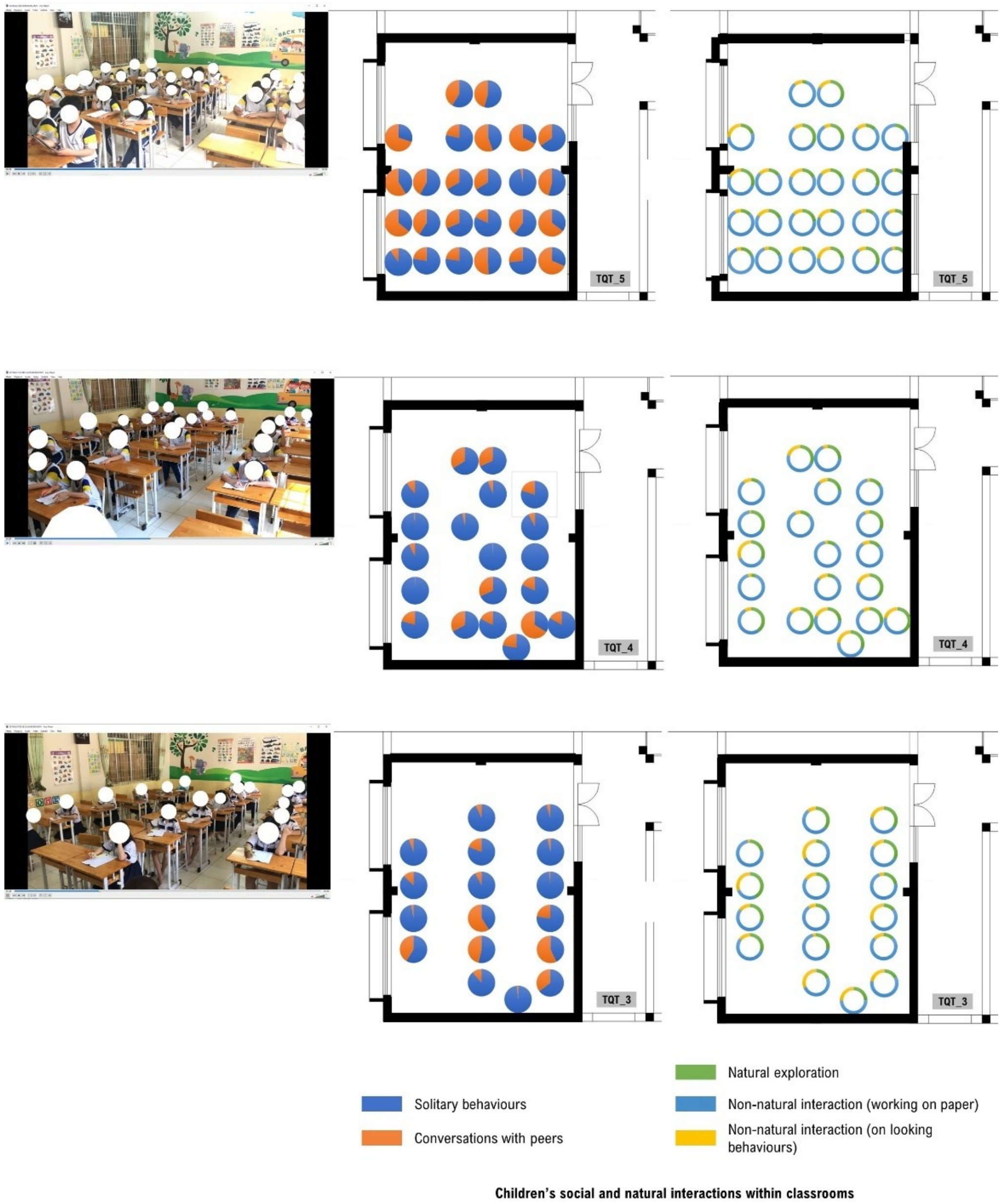


Figure 6-15. Indoor interactions in time on-task of HCMC_TQT pupils groups

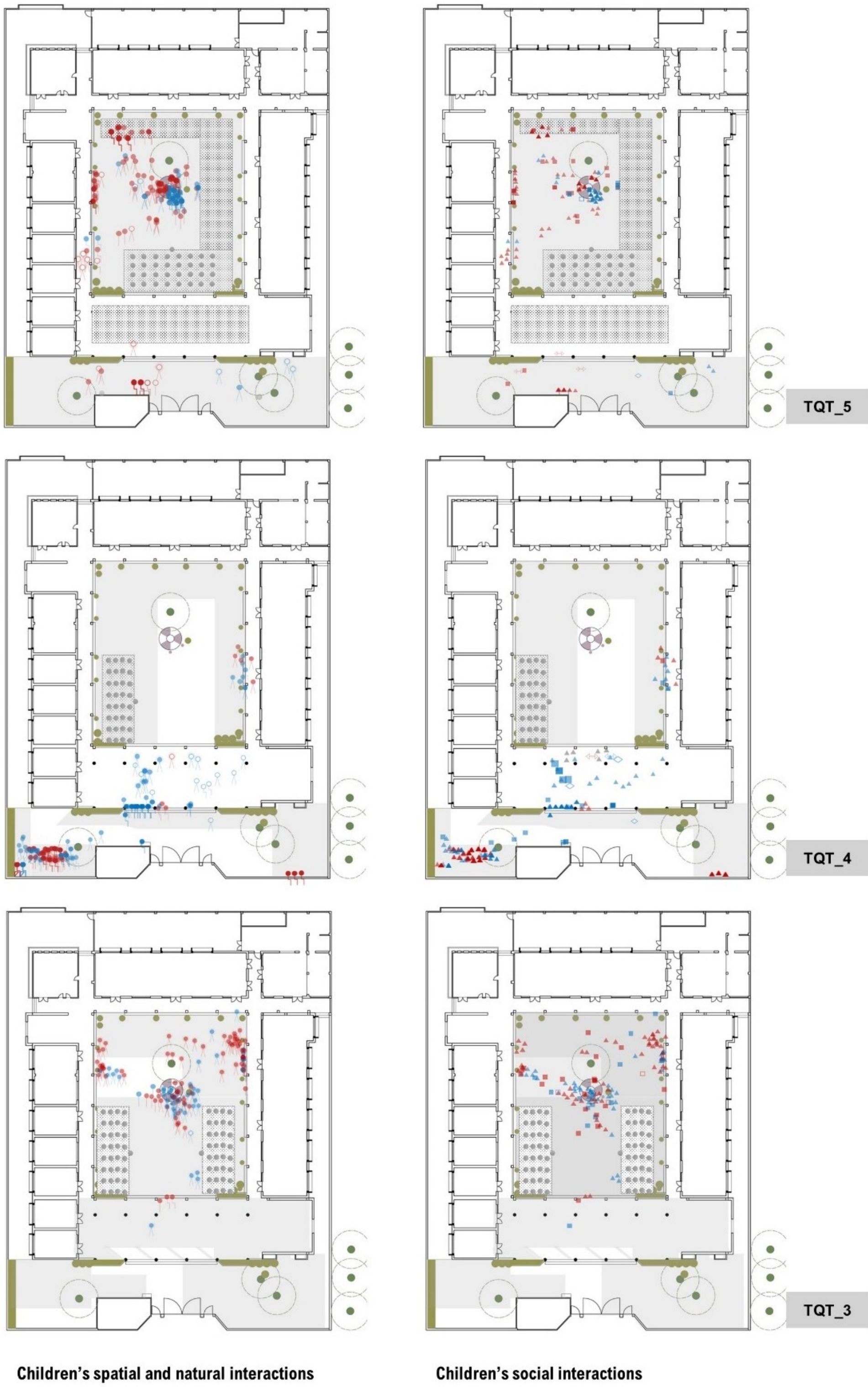


Figure 6-16. Maps of children's spatial – social – natural interactions in time on-task of three pupil groups within HCMC_TQT playground areas

6.4.2 School HCMC_TDP

The results obtained from the interaction analysis of HCMC_TDP participants in classrooms and schoolyards are set out in Figure 6-17 and Figure 6-18, respectively.

a) In classrooms

Children of grades 5 and 4 carried out the natural exploration tasks within their classrooms in which individual desks are arranged in rows and at personal distances. This is a possible explanation for the higher degrees of working on tasks independently of these pupils, especially those at positions where no one was sitting next. The mean figures of solitary behaviours of TDP_5 and TDP_4 were respective 0.98 and 0.93 as the greatest values in comparison to other schools.

The obtained results of two groups also revealed that they mostly focused on papers than observing spaces and friends; these features were more significantly observed in older children seated at extended personal distances. With only one window near the teacher's table and in the line of children's sights from their desks, older children mostly concentrated on it. In the case of the grade 4 classroom, children paid less attention to the window behind their desks than another window near the teacher table. This revealed that in classes where rows are the normal seating arrangement, the appropriate position of openings could enhance children's engagement with nature within indoor environments. No significant differences in distributed times regarding social and natural interactions between genders were evident in both cases.

b) In playground area

Through illustrations in Figure 6-18, children of three groups did their tasks within the playground, mostly covered by shade in the mornings. These maps clearly show pupils did not occupy the sunny areas. With large areas of high trees' shade covering on the playground, the boundaries of pupils' activities largely expanded and spread throughout the site.

Most of the oldest group members, TDP_5, heavily concentrated in the central area that is artificial grass-covered almost their entire time during the task. Six of nine pupils remained in their positions from the beginning to the end of the tasks. Children lay down or sat on the ground to explore the surrounding environment. Even within intimate distances, boys and girls were clearly seated in sub-groups of same-gender. A small group including three pupils also joined this group at the beginning until half of the survey period. Then, they moved to the protective wall and climbed the frame while others were still on-task.

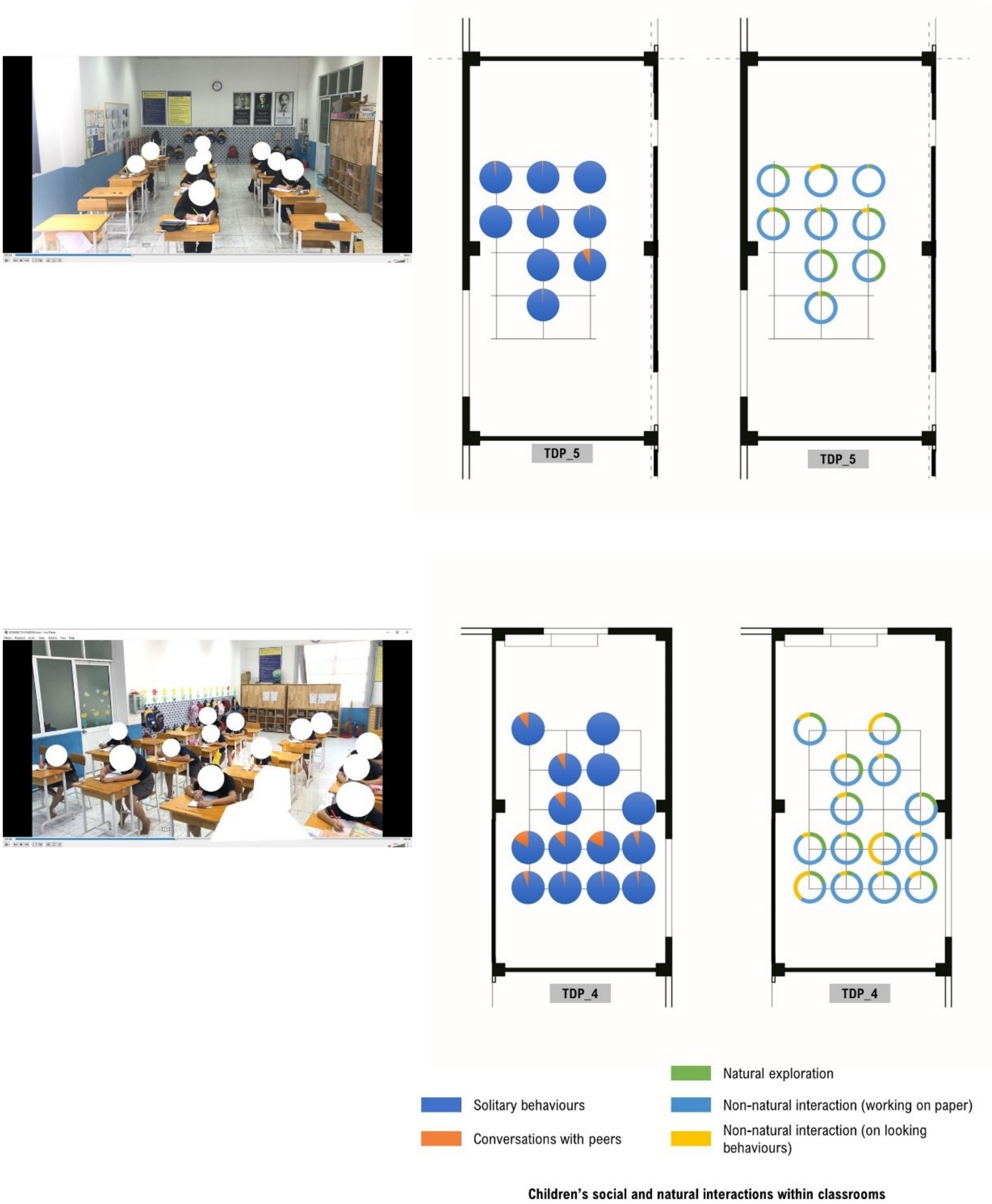


Figure 6-17. Indoor interactions in time on-task of HCMC_TDP pupils groups

Figure 6-18. Maps of children's spatial – social – natural interactions in time on-task of three pupil groups within the HCMC_TDP playground area

In younger groups, behaviour mappings illustrate they preferred gathering at trim-trail, climbing facilities, or tree-houses to explore nature from high positions. Seating in groups within intimate distances was the vast majority of social interaction patterns of these groups. However, they had higher frequencies of traveling throughout the schoolyard compared to TDP_5 groups. Children who were the most frequently walking around likely spent time on-task to work individually and less interacted with other classmates. Within each group, it could be clearly seen that children also gathered according to similar gender concentrations, for example, boys of both grades 4 and 3 heavily concentrated at tree-house places, girls of grade 3 preferred the tree-house at the opposite side while girls of grade 4 mostly occupied the trim-trail at the right side. As seen in the maps, children of TDP generally had a much more intense inclination for observing natural elements from visual distances rather than close-distances. The reason that could explain this result is that the diversity of natural elements was not attracted or encouraged them to come to experience more than visions only. For example, bamboo trees and high trees were pointed out in their papers. However, these behaviour mappings did not illustrate children's positions closed to these elements. These behaviours revealed that their answers regarding natural elements explored by non-visual senses were not completely experienced directly. Children applied their previous knowledge about natural elements to respond to the task requirements.

6.4.3 School HCMC_TXS

The results obtained from the interaction analysis of HCMC_TXS participants in classrooms and schoolyards are set out in Figure 6-19 and Figure 6-20, respectively.

a) In classrooms

Figure 6-19 presents the notable features in the working environments of TXS groups in comparison to other schools. Particularly, younger children seated and lay down on the floor, and the older groups sat at their desks to explore nature. During time on-task, younger pupils frequently move their heads to the window or moved around the room and then turned back to fill on papers. Oppositely, in older pupils' classroom, the frequencies they looked out of these openings to observe outdoor environment were much higher. These findings may be due to the opened front door and window and the seating arrangement as L-shape, all of them had more view fields and were in straightforward postures. The results show that both groups also spent less time observing nature compared to other schools; in particular, the mean figure regarding the natural exploration of grade 5 was 0.09 and of grade 4.3 was 0.04.

The results obtained also illustrate that two groups had higher degrees of working individually than communication with other friends although working within intimate distances compared to other classrooms. Besides, important differences between the two groups were detected. For example, 4 pupils of TXS_4.3 significantly preferred solitary behaviours (M=.93, SD=.05), focussing on paper works (M=.73, SD=.13), or on looking activities (M=0.14, SD=,06). Meanwhile, older children tended to be more discussed with others, spend less time individually (M=.75, SD=.15), and less look onto other people (M=.05, SD=.02) than the above group. These differences in social interactions reveal the increased preferences of older children's interactions with friends in natural explorations. No significant differences in indoor social and natural interactions were found between genders in cases of TXS school.

b) In playground areas

Figure 6-20 maps the activities of two groups at two different playground areas. Firstly, it could be seen the differences in children's spatial interactions between the outdoor class. Older children felt comfortable within their fully-shaded area compared to the football yard where younger pupils heavily concentrated in the partly-shaded area to observe nature. The greater movement frequency of younger than older children, who mostly remained their positions from the beginning to the end of the survey period, was also observed.

Another difference between two groups were related to social and natural interactions. Particularly, TXS_5 children gathered within intimate social distances at the central area where they were comfortably seated to observe nature only from vision distances. Although there were various natural objects to explore by both visual and non-visual senses, they only worked on tasks from the fixed positions. There are several possible explanations for this result. Firstly, it relates to children's familiarities with existing natural elements through daily activities. Secondly, the size of this area is relatively small, that they could be entirely observed without moving. Moreover, the last reason is their previous knowledge that they only need to define the perceived nature through vision and then determine features of natural objects through relative other non-visual senses. Conversely, younger children, at the football playground more often moved thorough the shaded area within personal and social distances. On top of that, they worked more individually and less talked to others. Although the diversity of natural elements is much greater than other school schoolyards, the sand yard was glaringly sunny, and trees were not in the hand-on distances of touching; thus, children of TXS_4.3 could contact these natural elements through a sense of looking only.

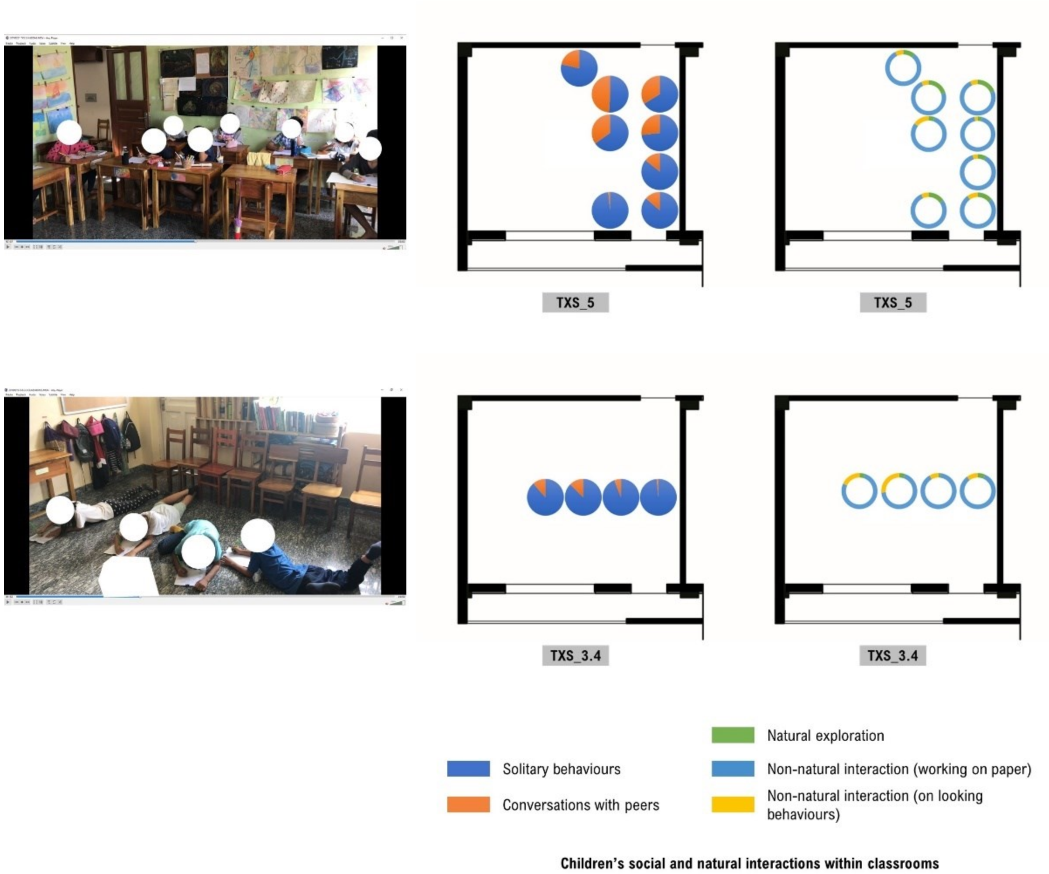
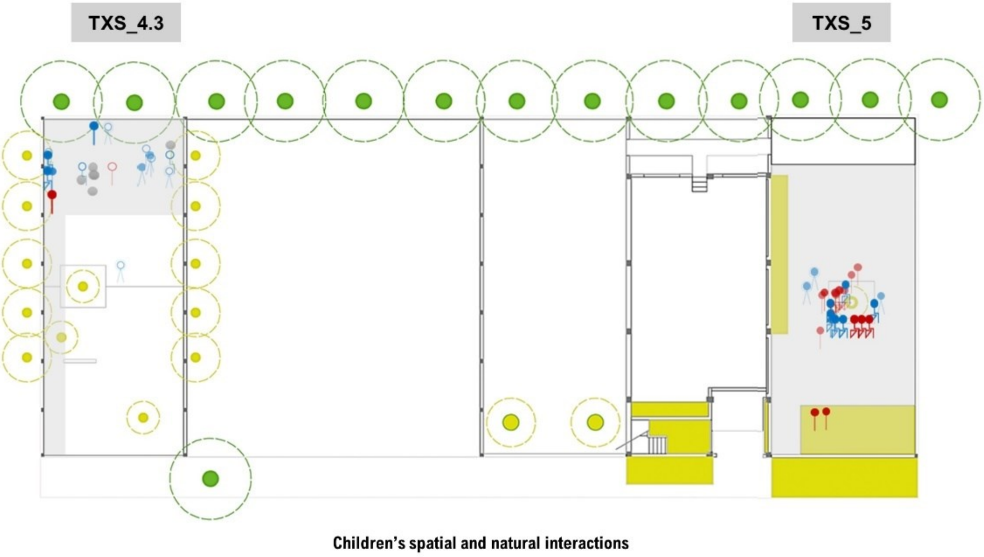


Figure 6-19. Indoor interactions in time on-task of HCMC_TXS pupils groups



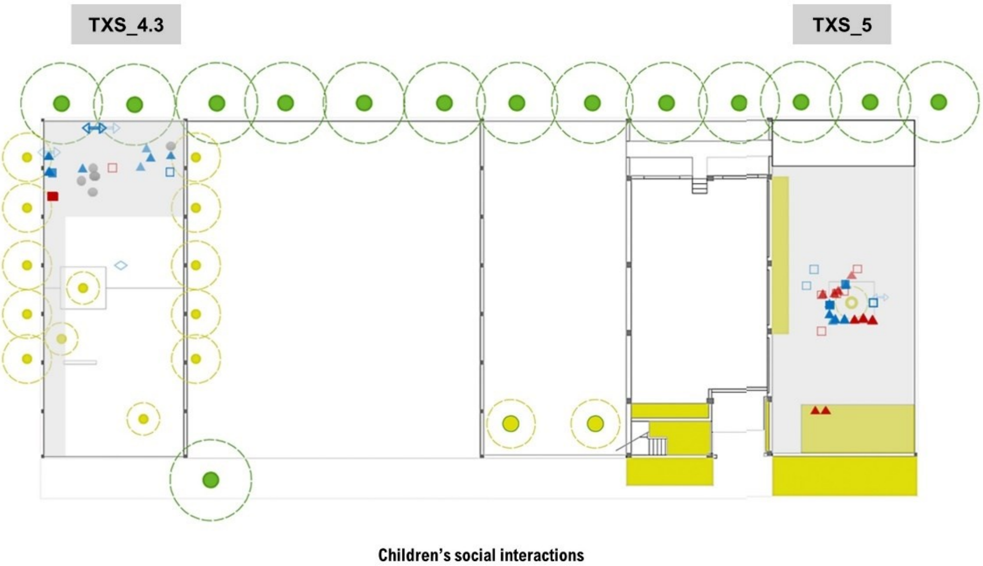


Figure 6-20. Maps of children's spatial – social – natural interactions in time on-task of two pupil groups within different HCMC_TXS playground areas

6.4.4 Synthesized Results and Findings

The analysis revealed multiple activities and interactions of children related to spaces, friends, and nature when exploring nature within different physical characteristics of classrooms and playgrounds in three primary schools in HCMC.

a) Indoor social - natural interactions

Overall, the results of investigated groups found the consequences of physical settings of classrooms on the degrees of social and natural interactions.

The first important finding is the influence of openings' features on leading children's attentions to outdoor environments. For instance, within the TQT classroom, the grade 5 classrooms of TDP and TXS, frequently paid their attention to the large windows at appropriate heights from their desks. In reverse, within the grade 4 classroom of TDP and TXS schools, children less frequently observed outdoor environments through windows at the opposite directions from their sight directions while sitting or lying. Thus, the effects of physical features of openings in considerations of children's positions can be suggested into the frequencies of children's natural observations within indoor environments.

The most striking finding was that intimate distances between children's desks increased their time ratio of discussing with their peers. Conversely, children who sat at personal distances tended to work independently and less interact with others. Interestingly, the statistical analysis results pointed to the significant associations between social and natural interactions, as shown in Table 6-20. Particularly, individual working was positively associated with time proportion of concentration on the task, including working on paper (r= .559, ρ <$.01$) and observing nature (r= .227, ρ <$.05$). In contrast, conversations with peers were negatively associated with focusing on working papers (r= -.574, ρ <$.01$) and natural exploration (r= -.207, ρ <$.05$). Children who preferred working individually spent more time focusing on the task while those who preferred to communicate with friends were the opposite. The time children had off-task behaviours were also significantly associated with social interactions. Children had increased time off-task when they communicated with peers (r= .483, ρ <$.01$), while others who had less time off-task increased individual time during the natural observation process (r= -.474, ρ <$.01$). Furthermore, another slightly significant association was found between children's social interaction features and the amount of indoor perceived natural types (r= .206, ρ <$.05$); this result indicated that children could figure out more natural types when working in groups.

Table 6-20. Associations between social and natural interactions in terms of indoor natural exploration

Spearman's rho		Social Interaction			Natural and Non-natural interactions		Off-task
		Solitary behaviours	Conversations with peers	On looking behaviours	Natural exploration	Working on paper	
Solitary behaviours	*r*	1.000	-.988**	0.016	.227*	.559**	-.474**
	ρ		0.000	0.873	0.026	0.000	0.000
Conversations with peers	*r*	**-.988****	1.000	-0.007	-.207*	-.574**	.483**
	ρ	0.000		0.944	0.042	0.000	0.000
On looking behaviours	*r*	0.016	-0.007	1.000	.256*	-.397**	-0.023
	ρ	0.873	0.944		0.011	0.000	0.820
Natural exploration	*r*	.227*	-.207*	.256*	1.000	-.291**	-0.151
	ρ	0.026	0.042	0.011		0.004	0.139
Working on paper	*r*	**.559****	**-.574****	**-.397****	**-.291****	1.000	-.513**
	ρ	0.000	0.000	0.000	0.004		0.000
Off-task	*r*	**-.474****	**.483****	-0.023	-0.151	**-.513****	1.000
	ρ	0.000	0.000	0.820	0.139	0.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

N=97

These results suggest that social activities influence children's indoor interactions with nature. Therefore, the distance of study desk arrangements could shape the characteristics of both natural and social interactions. When children did tasks individually, they highly paid their intentions to observe the surrounding environment and working on papers. In contrast, when children were seated in groups within intimate distances, they discussed together and also less spent time on papers. This finding indicates how physical settings of studying environments that principally influenced by educational methodologies and philosophies could shape children's behaviours with nature and others.

In relation to gender differences, no significant results were found through results obtained from groups of three schools. Regarding age concerns, although there were differences regarding social and natural interactions between three age groups of the public school TQT within a studied classroom that older pupils spent more time discussing with friends and spent less time to observe surrounding environments. However, the converse trends occurred in cases of TDP groups in which older groups preferred working individually and observing nature. A note of caution is due here since the older groups of TQT were seated at closer distances like the younger group of TDP and vice versa. Furthermore, in the case of TXS schools, no evidence regarding these features was detected in two classrooms with different settings of children's seats. Thus, these results are likely related to consequences of seating arrangements and children's distances rather than influences of age ranges.

Therefore, it can be assumed that the physical settings of classrooms, including characteristics of openings and seating arrangements, could regulate the pupil's social and natural interactions when they explore nature. These findings may help us to promote important implications in organizing various types of activities in correspondences with characteristics of connections with others and with nature to ensure the optimal outcomes of children's developing goals.

b) Outdoor spatial – social - natural interactions

The behaviour mappings of children's activities and interactions when exploring nature within schoolyards of three HCMC primary schools reveal important findings.

Firstly, in relation to spatial aspects, the boundary of children's activities was heavily influenced by weather conditions, especially in sunny and shaded areas. Notably, they heavily gathered at places where offered comfortable thermal satisfaction of shade from trees and buildings to explore nature. These maps also illustrate most concentrations in areas with seating opportunities, especially at centre positions like children of TQT and TXS grade 5. In particular, at hard surfaced covering areas in TQT school and sports playground of TXS school, they mostly preferred to sit down in cases of available seating. In contrast, children comfortably settled down at grass-surfaced areas and lied down on the grass as children of TDP school. Pupils who frequently play with adventurous facilities like younger groups of TDP schools preferred to observe nature from higher positions and larger view-fields, such as from tree houses or trim train facilities. Thus, children's postures when exploring nature varied according to the features of playgrounds.

Examining the behavioural maps, the most outstanding feature was the number of intimate interactions with friends was most concentrated at flower-plants and at suitable areas where they had shade to work in groups. These results then raise the possibility that children mainly behave in a way that preferred to be in pairs or groups when exploring outdoor nature. Generally, older children were seen to group together heavily for visual natural experiences. Meanwhile, aspects of non-visual sensorial modalities for experiences of visible natural elements are linked with higher degrees of personal and distances. These children spent time alone and they most frequently travelled surrounding playground areas.

On the question of child and natural interactions, there were important findings from behavioural mappings. The degree of how the child experienced nature was significantly influenced by weather conditions as followed consequences of spatial interactions in outdoor spaces. Pupils would have less contact with natural elements and environments if these places were sunny, especially in the afternoon times when the temperatures were high and full of glare. Among three schools, the behaviours of TQT pupils show the attractiveness of flower-plants could provoke children's engagement. This engagement was shown in higher concentrations and closer intervals to observe natural objects other than vision distances compared to other schools. These results of vision-distanced connections revealed how children applied their knowledge of nature to complete the questions regarding nature, perceived through non-visual senses instead of direct attestations by senses of touch, taste, and smell visible natural elements.

Another finding was that the size of the space could direct the movements of children and their non-visual interactions with visible natural elements. It could be seen through differences in mappings of children's activities boundaries between the three schools; among them, the TQT pupils had widespread environmental interactions within outdoor spaces except areas covered by sunlight. Conversely, Waldorf school's outdoor classroom area and sports playground were much smaller than other studied playgrounds, pupils least frequently moved within these places. Within a clear visual distance (7.5 meters), children seemed to less change their positions to explore more details and more natural elements and types. And thus, the interactions of close or immediate sense would not be evoked.

Age influences were detected in this study. Younger children showed their higher degrees of movement illustrated through observed active and passive activities within playground areas. Additionally, the distances of non-visual interactions between older children and natural objects were further than youngers' ones who regularly moved within spaces and approached closer to explore natural objects. As a consequence of these highly energetic characteristics of spatial and natural interaction behaviours, younger children had more changes in distances and preferred to explore nature with friends within personal distances. Conversely, older children had a higher tendency to explore nature in same-gender groups within intimate spaces and remained these behaviours during the task. The more children grow, the more social interactions occur among them, and the greater degree of connection with nature via the vision-distance is constructed while the degree of connections with nature within hands-on distances is increasingly limited and vice versa. This finding is in accord with those of Munro & Grierson (2018) who reported that adults had higher tendencies of social interactions to enjoy natural views. In this study, the analysis of children's behavioural interactions of natural experiences provide more broaden understanding of the human-nature relationship and more than the facet of vision connection with nature between age differences. Taken together, these results suggest that spatial, social and natural interactions via senses influence each other and changes according to children's ages.

To summarise concerning architectural features and settings, this section investigated significant influences of shade availability in relation to weather conditions, physical settings, and features of playgrounds (e.g., scale, ground covering, seating opportunities, and facilities). These features curiously affect children's interaction behaviours toward spaces. Additionally, appearances of natural elements that evoke children's interests and favours, such as flower-plants, have important roles in enhancing children's direct interactions with nature. This information should be considered to develop targeted interventions setting up playgrounds and other recreational spaces according to characteristics of pupil groups and their activities.

6.5. Summary of chapter findings

This chapter examined the issues influencing child-nature multi-sensorial connection within the primary school. Drawing on the analysis, notable issues in different school contexts and in the effects of natural exposure diverge from features of children that should be considered in future school design for reconnecting the child and nature. Particularly impacts of urban configurations, architectural features, and spatial settings on pupils' natural exploration, environmental preferences, and interactions in outdoor play spaces and classrooms are summarised.

a) Features of nearby urban configuration

The results of Glasgow and HCMC case studies reveal the significant influences of the urban configurations on the quantitative and qualitative degrees of natural elements and types perceived through visual and non-visual sensory modalities within educational environments. For example, children could explore less natural diversity and lower ranges in high-density urban areas of HCMC_TQT and HCMC_TDP schools. Conversely, the wilderness area of TGA_Milngavie and profound urban nature of TGA_Kelvinbridge that compose greenery, water landscape, and the undeveloped urban area of the Waldorf school in HCMC remarkably provide children diverse natural elements and stimuli for the visual and non-visual explorations according to time of day, weather, and seasonal conditions.

b) Features of school playgrounds

Regarding schoolyards, the richness and diversity of natural environments significantly play key roles in children's direct exposure to nature. In particular, they are advantages of combined natural landscapes, nature-based and/or earthy surfaced grounds, and diverse vegetation settings within school environments. Evidently, these features positively contribute to the degree of natural exploration for children, such as a significant difference in diversity of natural objects between wilderness areas and water landscapes compared to hard-surfaced playgrounds. Specifically, in the case of Glasgow city, seasonal changes and weather conditions could plentifully generate a variety of natural stimuli associated with different elements. Either grassed or earthy playgrounds could also offer various flora and fauna species and/or minerals elements of on- and under-ground layers than hard-surfaced ground places. Children at primary school age given direct physical contacts and discovery that involves multi-sensing nature could develop deeper connections with nature beyond just vision. For example in this study, a child felt happy with a beautiful flower when looking, however, this child also felt tired of its odour when smelling or weird when tasting it. Both pleasant and unpleasant arousal levels were reported toward living and non-living natural elements through discovery of new things. More nature and attributes of nature to be figured out, more various emotional feelings to be evoked in children, including biophilia and biophobia like previously suggested by S. R. Kellert (2002) and Ulrich (1993). In contrast, when the gap between children and nature has been increasing, opportunities for children's non-visual experiences with nature have been diminishing and then, a deprived attraction toward nature has been occurring as a result. Therefore, our findings support a '*re-wilderness of the playground*' as an essential approach to reconnecting children with nature within school contexts.

Furthermore, natural diversity was seen to be an important factor in the social and natural dimensions of children's favoured places. The playground is considered an important social setting (e.g., gender, class, race, and identity) in educational contexts. Gender and age differences are evident here. Commonly, boys are dominant playground users while girls are often excluded from much of the playground (Blatchford et al., 2003; Paechter & Clark, 2007; Thorne, 1993). This might be explained by the typical design of playgrounds, which are primarily concrete or asphalt-covered surfaced supporting games and activities, historically for boys and older groups. Greening is now considered as a purposeful approach to provide equitable and healthy playgrounds (Dyment & Bell, 2008; Lucas & Dyment, 2010; Paechter & Clark, 2007). The results of the current study support this plan, in particular by identifying female pupils' inclination for outdoor activities within soft and nature-based surface areas. We have found that younger girls both in Glasgow and HCMC case studies favour adventurous energetic activities. This finding suggests there are advantages in designing playgrounds with natural-based surface covers to balance the distribution of gender and age ranges.

The significant distributions and influences of flora species were apparent through children's favoured natural elements and their interaction behaviours when exploring nature, especially flower-plants and trees. Flower-plants predominantly attract children due to high aesthetical values whilst pleasant feelings are derived from appearances of trees with various stimuli under impacts of other natural elements and weather changes.

This study further reveals the influence of weather conditions on children's perceptions, feelings, favours, and behaviours toward nature. For example, Glaswegian pupils reflected their pleasant feelings and aesthetical concerns of the psychological aspect, while HCMC pupils had more positive perceptions of thermal comfort. Children's behaviours and activities, including spatial, social, and natural interactions, of natural experiences in HCMC studied schools were significantly shaped by shaded areas or in-between spaces due to hot and sunny conditions. These findings suggest the landscape and architectural features in designing school settings should consider climatic conditions and thermal comfort to enhance the quality of spatial environments and decrease the child-nature distances of non-visual sensorial experiences.

c) Features of classrooms

In general, key features of the classroom influence how the child directly connects with nature through multi-sensorial manners are identified in turns.

The first important finding is about the spatial layout within buildings and school sites that could greatly influence the children's degrees of visual and non-visual experiences. An appropriate classroom location could increase children's exposure to outdoor nature and enhance natural elements and stimuli explored. In reverse, a more adverse location disconnects pupils and outdoor nature like classrooms in TGA_Milngavie and HCMC_TDP schools. These results suggest the limited performances of classrooms within educationally renovated buildings compared to new and original school building design following specific standards, for examples, the TGA_Kelvinbridge grades 4 and 3 or the public school HCMC_TQT classrooms. Furthermore, the consequences of disconnections with outdoors are related to the indoor air quality through the ventilations and open status (Mocová & Mohelníková, 2021). This feature is significantly important not only in the tropical savanna climate zone climate in HCMC but also in the mild climate conditions like the UK to manage indoor air quality both in heating and non-heating seasons (Korsavi et al., 2020).

In an aspect of focusing on the direct experiences of nature, this study explored additional contributions of openings' features (i.e., scale, orientational position, height, and operational status) on the degrees of nature pupils perceived and interacted with outdoor environments through five senses. Within spatial conditions with adequate openings to outside, vision is the strongest and the most efficient connection between children and nature from indoor places compared to non-visual sensorial experiences. Thus, the inclusion of permeable features in building envelopes can considerably enhance the natural experience of a child and their perception and behaviours toward nature.

The roles of opening settings are also important for the child-nature connections in terms of seating arrangements across students' activities and educational methods. In classes in which children seated in groups, like three schools of TGA and the Waldorf school in HCMC, they had more access to openings than classes in which rows and columns are the normal seating arrangements, like HCMC_TQT and HCMC_TDP schools, due to the directional effect. The followed influences of these features on indoor social and natural interactions are shown from observing behaviours of children when they explored nature. The closer distances pupils were seated in pairs or groups, the higher the degree of social interactions that occurred during the tasks. Meanwhile, when children were sitting in rows and columns of single desks at personal distances, they increased individual time on tasks. Tobia et al. (2020) showed that children showed greater logical reasoning when seated at individually at single desks, while higher creativity performances when seated in clusters with given tasks related to non-natural subjects. In this study, the type of given task has combined both capabilities of observation and logical reasoning related to nature. The results showed slightly greater performance in relation to perceived natural types of children who had higher time distributed to communication with others. When exploring nature, logical reasoning thinking was reflected by capabilities of defining natural classifications and linking the relationships between natural elements and stimuli, for example, wind was figured out through movements and sound of leaves, or analysis of parts of trees. With these features, it can thus be suggested that activities connected with nature and natural experiences should be arranged differently from non-natural tasks and/or subjects. Considering the nature of on- and off-task activities, and characteristics of children's behaviours, selecting the proper seating arrangements is substantial to provide studying environments that satisfy learning aims yet ensuring children have natural connections equally and frequently.

Lastly, the most remarkable finding is the children's attention to indoor natural elements. The hands-on and regular learning related to natural elements evoked pupils' awareness through five senses, particularly through senses of look, touch, and smell. Besides providing children's hands-on material for cognitive development as the key purpose (Hachey & Butler, 2012), this study revealed added benefits of indoor natural settings. In places with limited connections with outdoor nature, children's responses demonstrated a higher intensity of focus on indoor natural objects. Children's emotional reactions, especially female pupils, showed greater biophilia feelings toward species with a wide range of natural elements including species considered less liked or disgusting. Besides upgrading the connections with greater natural types, these positive alterations of the children's perception and attitudes are important advantages in indoor natural settings in studying environments.

To sum up, these results provide insights for decision-making on both designating spatial layout within school buildings and sites, the inclusion of permeable features in building envelopes, and considering the appropriate seating arrangements and indoor natural settings that should be explored according to the nature of children's activities.

d) Features of participants: biological characteristics and off-school environments

The first significant finding is distinctions in natural exploration and environmental preferences between the early middle childhood (6-9 years old) and the late middle childhood (9-12 years old). Due to higher growth of cognitive development, the capacity of discovery of nature increases according to children's age in both of TGA and HCMC schools. However, with increased age, children had less arousal feelings toward nature, less contact with nature through multi-sensorial modalities, the increased trend of indoor favours, and the more inclination of socialised interactions. Conversely, younger groups tended to be more energetic, enthusiastic about nature, and more closely in contact with nature through direct experiences. These results of age effects are line with those of previous studies (Aminpour, 2021; Liefländer et al., 2013; Lyons, 1983; Müderrisoğlu & Gültekin, 2013). These evidence revealed the steady changes of preference for non-nature and social needs over nature, the gaps between the child and nature also increasingly expand with age progression (Lyons, 1983). This suggests different strategies need to be adapted to particular groups for enhancing direct natural experiences.

Gender effects were found in TGA case studies. Specifically, girls had higher preferences to express biophilia attitudes toward diverse natural elements and favour adventurous energetic activities. On the contrary, no significant gender difference was evident in results of HCMC case studies. The difference between TGA and HCMC could be explained by the richness of flora species, higher frequencies of natural exposure within studying and playing environments, and nature-based playground areas that support TGA female pupils' inclination for outdoor activities. Furthermore, most playground areas in HCMC case studies are hard-surface ground settings with limited natural types and less attractive natural features like flowers, insects, or small animal species. Limitations of physical and natural settings that have been unable to demonstrate the gender effects in HCMC groups may explain this difference between Glasgow and HCMC case studies.

Regarding children's off-school living environments and activities, no findings were found because the relative distributions of participants were limited. This research focused only on identifying the characteristics of school settings and educational contexts. Thus, a greater number of schools would offer a more variety of children's social contexts, enriching the findings from this study.

In brief, these findings have provided greater support for remaining and nurturing affinity for nature with children's ages and genders at school environments. In order to satisfy various children's desires and activities with their many diverse personal characteristics, spatial variety and included natural settings are seen as appropriate approaches to renovate and design new schools around. However, with brief responses to favoured nature and places at current school contexts, the study at this phase is limited by the lack of information on their desirable characteristics of classrooms and playgrounds to develop implications and proposals for the design of future school projects.

6.6. A summary of chapter

In outline, this chapter has contributed to the growing body of research with many important and positive findings of children's experiences of nature, present in the case study schools in Glasgow and HCMC. The extensiveness of natural exploration through visual and non-visual sensory modalities, affinities for nature and natural environments, and interaction behaviours of children diverge from spatial and natural characteristics in different contextual contexts. In order to suggest implications and design proposals for (re-)connecting the child-nature relationships, it needs to explore further children's perspectives on nature and spaces in school environments. The following chapter investigates characteristics of advantageous classrooms and playgrounds raised by children in comparison to perspectives of architects and educators in making decisions to plan educational environments.

Chapter 7 Bridging Children – Architects and Educators on Primary School Architecture

for Children's Multi-sensorial Experiences of Nature

"Sustainability anticipates a future that is a rupture with the present, a shift away from the new-as-novelty to the new-as-renewal of the built and natural environments, a renewal that depends as much on new ideas and techniques as it does on reinstated ones."

— **Susannah Hagan** (2001, p. 75)

7.1. Introduction

This chapter aims to present and discuss the findings of the interview surveys with pupils at three case studies, architects and educators who are currently working in HCMC. The initial stage of chapter data analysis is to understand the overall preferences of the classrooms and playgrounds through designated images (Figure 7-1 and Figure 7-2) from children compared to adults. The desirable characteristics of studying and playing environments are addressed. Second, suggestions for making studying and playing spaces offering children's natural experiences of architects and educational professionals are shown and discussed.

Besides statistical analysis from the database, the communication with the children helped obtain children's statements explaining why he/she selected a particular option and key themes: evoke children's desire to explore and be creative, stimulate children's positive emotions, offer children's appropriate spatial form (size, shape, and openness) and physical (lighting, thermal, and noise insulation) comforts, fulfil children's functional and aesthetical needs, and provide children with social and natural interactions. Each option's statements and themes from children and professionals are presented and discussed respectively to review and compare the similarities and differences in their perspectives about classroom and playground settings. A list of spatial and natural features of classrooms and playgrounds that children desire and architects consider are outlined to be referred to in developing approaches and final discussions in the following chapters.

Figure 7-1. Classroom options

Figure 7-2. Playground options

7.2. Children's desirable characteristics of classroom and playgrounds

The desirable characteristics of studying and playing environments through responses of children toward designated options are accordingly presented as follows.

7.2.1 Favoured features of classrooms

The four options shown to pupils were to portray different features of classroom settings, including indoor-outdoor boundaries and connectivity, furniture arrangements, and interior surfaces and designs (e.g. shape, colour, and design). Table 7-1 shows the results collected from students, and it highlights that the differences between those from public school TQT and private schools are noteworthy.

Table 7-1. Descriptive statistics of favoured classrooms and playgrounds through focus-group with children

School ID	Favoured classroom				Favoured playgrounds					
	I-1	I-2	I-3	I-4	O-1	O-2	O-3	O-4	O-5	O-6
HCMC_TQT	11 31%	15 43%	4 11%	5 14%	3 8%	9 25%	12 33%	5 14%	0 0%	7 19%
HCMC_TDP	8 29%	4 14%	2 7%	14 50%	0 0%	12 40%	7 23%	1 3%	0 0%	10 33%
HCMC_TXS	5 33%	1 7%	2 13%	7 47%	1 7%	1 7%	5 36%	2 14%	0 0%	5 36%

Around half of pupils in TDP (50%) and TXS (47%) schools selected the natural outdoor environment (I_4) as the place they wish to study. Conversely, the majority of TQT participants (43%) indicated the flexible semi-open and semi-closed space (I_2) as their desirable classrooms while a minor group (14%) selected the I_4. The second most preferred classroom was the I_1 whereas the I_3 classroom was the least favoured by children of three schools. Following is the presentation and discussion of each option to explore why children selected those classrooms.

a) I_1 classroom

Regarding the classrooms, around 31% of total participants, including 18 males and 8 females, preferred I_1.

Table 7-2. Children's statements and themes of favoured features of the I_1 classroom

School	ID	G	I_1 – Children's statements
TQT_5	1.A	F	*… like bright colours. ... looks open, cool, and spacious*
	3.A	M	*… like having air conditioner in classroom. … also like its colour, and tree views.*
	6.D	M	*… the atmosphere is cool because of air conditioner; … looks modern and comfortable.*
	14.L	F	*… has cool temperature; … like air-conditioner.*
	16.M	M	*… has low temperature; … like white colour.*
TQT_4B	4.H	M	*… looks beautiful and modern.*
	6.KH	M	*… looks modern, and has air-conditioner.*
	11.PH	M	*… beautiful with paintings.*
TQT_4C	1.A	F	*… like scientific gadgets. … looks quite beautiful, … there are tree views outside.*
	4.KH	M	*… bright, clean, … lots of furniture.*
	9.TR	M	*… looks bright, clean, and plentiful.*
TQT_3	10.NH	F	*… looks modern and beautiful.*
	14.TH	M	*… spacious and has cool temperature.*
TDP_5	6.NH	M	*… is open; … has balcony to look beautiful outdoor landscape.*
	8.V	F	*… looks beautiful, open, and modern. I want to be a scientist, so I like modern classroom.*
TDP_4	1.C	M	*… open and cool temperature with good lighting, not darkness, not noisy.*
	2.D	F	*… looks modern, … glass windows to look outside views; … like white colour.*
	2.CH	M	*… looks clean and sparkling. The tables and chairs are arranged orderly.*
	3.D	M	*… it's clean and beautiful.*
	4.GI	F	*… like bright colour. … looks like a hotel room.*
TDP_3	12.M	M	*… beautiful, clean, open and cool temperature with lighting.*
TXS_5	1.A	M	*… beautiful and not too much colour.*
TXS_4	1.KH	M	*… looks luxurious and beautiful.*
TXS_3	1.A	M	*… I just like it.*

The themes of physical comforts and aesthetical satisfactions mostly recurred throughout children's opinions (Table 7-2). Colour-related (e.g., "*white*", "*bright*", and "*not too much colour*"), clean, beautiful, and modern appearances of decorations are the most concerns among stated reasons. The physical comforts were related to thermal and lighting conditions. Interestingly, a common view noted by a majority of the participants was that "*air conditioner*" was frequently linked to "*cool* (temperature)" feelings despite having no air conditioner in this photo. Some children also appreciated "*good lighting*", "*not darkness*", and "*not noisy*". Some children also noted "*open*" and "*spacious*" feelings as significant spatial features of this classroom. In concern of focusing on nature, there was a minor ratio (4 of 24 pupils) expressed availability of "*tree view(s)*" outside or "*beautiful outdoor landscape*" through "*glass windows*".

b) I_2 classroom

Approximately 26% of interviewees designated the I_2 option with an equal distribution of gender (11 boys and 10 girls).

Table 7-3. Children's statements and themes of favoured features of the I_2 classroom

School	ID	G	I_2 – Children's statements
TQT_5	2.A	F	*… spacious. … has cool air, … like grass ground.*
	4.B	M	*… has private space for study as well as has fresh outdoor air. … has less risks.*
	5.D	M	*… looks most impressive and close with nature.*
	8.D	F	*… like grass-covered ground and all furniture.*
	21.PH	F	*… like studying outdoor. The air is so cool and fresh.*
	27.TH	F	*… feel open and cool. … is not occupied by many pupils.*
TQT_4B	1.B	M	*… has fresh air and green grass ground.*
	5.KH	F	*… cool and open. … like studying with friend.*
	10.PH	M	*… like grass-covered ground, … large, open and cool. Studying here is interesting.*
	13.TR	F	*… closer with nature than others.*
TQT_4C	3.H	M	*… outdoor environment, cool and open. … like grass.*
	5.KH	M	*… like learning in playing. … has sunlight.*
	7.M	F	*… like studying outdoor, … could see nature.*
TQT_3	1.A	F	*… outdoor and cool.*
	3.CH	F	*… has lots of tree shadow. … looks beautiful, … I could study outdoors.*
	4.D	M	*… spacious, … has grassed ground.*
	5.KH	M	*… grassed ground. … looks open and cool.*
TDP_5	2.CH	F	*… has apart outdoor so it's open, cool and comfortable.*
TDP_3	7.H	F	*When we are studying, we could see and enjoy natural environment.*
	9.H	M	*There are people in this class.*
	14.PH	M	*… like open class and looking outside. … still cool and comfortable without fans.*
TXS_3	2.K	M	*I like it most because the opt.1 and 3 – they are not open enough to feel comfortable, I also don't like opt.4 because there are many mosquitoes here.*

Table 7-3 significantly highlighted the themes of physical comforts and natural concerns. Various natural elements and nature-based features were frequently mentioned, for example, quality of air (e.g., "*fresh (outdoor) air*"), lighting (e.g., "*sunlight*"), trees (e.g., "*lots of tree shadow*"), being connected with nature (e.g. "*impressive and close with nature*", "*outdoor environment*" or "*apart outdoor*", "*could see nature*", "*could see and enjoy natural environment*", and "*could look outside*"), and studying within nature (e.g. "*like studying outdoor*", "*could study outdoor*", and "*an open class*"). Significantly, many pupils argued that they favour grass ground in this design. With these natural concerns, most following statements were descriptions of satisfying thermal comforts (e.g. "*cool air*", "*cool and fresh*", "*cool and comfortable*") without concerns of fans or air-conditioners like the I_1 option. Besides, some children also argued that they liked this classroom because of its "open", "*spacious*", and "*not occupied by many pupils*" setting. Only a few statements appreciated the functional, aesthetical, and social concerns.

c) I_3 classroom

A minority of selected pupils (10%) favoured the I_3 classroom; most of them were girls except one boy in the total sub-group. They all preferred its aesthetical value of decoration with comments like "*beautiful*", "*colourful*", and "*looking good*" as shown in Table 7-4. On the other hand, further themes were less frequently recorded, such as good lighting, a clean and friendly environment, or satisfied thermal comforts from the air-conditioner even though this photo does not display this feature.

Table 7-4. Children's statements and themes of favoured features of the I_3 classroom

School	ID	G	I_3 – Children's statements
TQT_3	8.M	F	*… beautiful, cute, clean, tidy; … has good lighting that help us easily studying.*
	12.PH	M	*… clean and beautiful.*
	15.TH	F	*… beautiful and colourful.*
	17.V	F	*… looks good.*
TDP_3	5.GI	F	*… beautiful and colourful. … like having air-conditioner.*
TXS_5	4.KH	F	*… a friendly classroom.*
TXS_4	2.L	F	*… colourful.*

d) I_4 classroom

Conversely, around 33% of the participants selected the I_4 option as their desirable classroom. The gender distribution of this group was relatively equal, with 14 boys and 12 girls. Specifically, the natural concerns were the greatest widespread amongst interviewees, and then all followed children's positive spatial responses were linked with nature and various natural elements (Table 7-5). Pupils pleasantly demonstrated they could have visual and non-visual connections with "*wind*", "*trees*", "*plants*", "*green leaves*", "*(strange), (dangerous) animals*", "*worm species*", "*lots of natural things surrounding*", "*sounds of the forest*", "*bird*", "f*resh air*", and "*light*". Students highly valued this "*outdoor classroom*" as more "*open*", "*cool*" and "*comfortable*" than indoors.

Interestingly, pupils also provided contradictory opinions within the same space; some individuals stated that studying within outdoor environments, within a forest, and/or within nature is much more "*fun*". On the other hand, others commented that "*quiet*", "*quieter than others*", and "*peaceful*" could help them study better. Another interesting outcome is that children strongly stated they could study, explore nature, and play here even though with "*a little bit scared*" or "*not so fun*" due to possible risks from their perspectives, such as strange, dangerous, or scary animal species or a look of slightly dirty. Also, like other options, except for I_2, children did not mention social interaction concerns within studying environments.

Table 7-5. Children's statements and themes of favoured features of the I_4 classroom

School	ID	G	I_4 – Children's statements
TQT_5	9.H	M	*I feel studying outdoors bring more open, cool, and comfortable than indoors; … green and fresh with cool wind.*
TQT_4C	6.L	M	*… trees are nature, so I really like this classroom.*
TQT_3	3.CH	F	*… has lots of tree shades, beautiful, and I could study outdoor.*
	6.KH	M	*I can see plants, green leaves; … a little bit scared because of dangerous animals.*
	13.S	M	*… studying in forest is much more fun.*
TDP_5	1.B	M	*… like study at outdoor places where have nature.*
	3.D	M	*… like studying outdoors because there are many trees; … has open and cool air.*
	4.GI	F	*… cool.*
	5.M	F	*… I could see worm species.*
	7.NH	F	*… I like studying in natural environment; … comfortable and cool. I could breathe within pure and fresh air.*
	9.V	F	*I feel open and cool, especially when I study about nature and survival skills. I could play here. This is also the place I want to visit.*
TDP_4	3.D	M	*… cool and quiet.*
	5.H	M	*… much more spacious and quieter than others.*
	6.L	F	*… it's nature; … lots of natural things surrounding.*
	8.M	F	*… it's outdoor classroom; we could contact with nature; we could hear sounds of forest.*
	12.TH	F	*… like studying in natural landscapes; … very comfortable and peaceful. … help us studying better.*
	13.TR	M	*… a kind of outdoor classroom. … very open, cool, and comfortable to study here. Natural environment and with bird singing sound will help us study better.*
TDP_3	6.H	M	*… feel cool, fresh air that makes me very comfortable.*
	13.PH	F	*… fresh air to breath and it's cool.*
TXS_5	3.CH	F	*I like studying outdoor.*
	5.KH	M	*… lots of trees; … looks cool and open.*
	6.M	M	*… looks not to fun. … cool and fresh. …might have many strange animal species and looks slight dirty.*
	7.NG	F	*… very nature.*
	8.PH	M	*… because it's nature.*
	9.PH	M	*… really fun here*
	10.TH	F	*… I really like forest; there are trees, air, and light.*

7.2.2 Favoured features of playgrounds

As Table 7-1 shows, when being asked which playground they like most, it is apparent that O_2, O_3, and O_6 options were mostly selected while O_1, O_4, and especially O_5, were less and even completely unfavoured respectively by participants of three schools. However, there are relative differences in preferred playground distributions between schools' pupils. The greatest demands of TQT pupils are options O_3 and O_2 with 33% and 25%, respectively. Meanwhile, the playground O_2 leads the figures of TDP pupils with 40%, followed ranges are O_6 (33%) and O_3 (23%) options; conversely, O_5 and O_1 alternatives were entirely excluded. In regard to Waldorf school, although its number of interviewees was smaller (15 pupils), children shared their greatest preferences on O_6 and O_3 with 5 responses (36%) of each option. In order to understand why they are favoured, children's statements and themes regarding playground preferences are described as follows.

a) O_1 playground

A minority of children (4 responses that accounted for 5.1% of total interviewees) expressed their favours in the playground O_1. As Table 7-6 shows, the "*open*" and "*spacious*" features were the most impressive by who chose it. On the other hand, they also commented two other important features, including the availability of "*sitting areas*" and "*trees*," which was the only natural concern within this playground.

Table 7-6. Children's statements and themes of favoured features of the O_1 school playground

School	ID	G	O_1 - Children's statements
TQT_5	27.TH	F	*… open and spacious.*
TQT_4B	5.KH	F	*… spacious. … lots of sitting areas.*
TQT_4C	9.TR	M	*… spacious. … many sitting areas and trees.*
TXS_4	1.KH	M	*I could sit here to enjoy the views.*

b) O_2 playground

In the aspect of the O_2 playground, there were 24 respondents (about 30% of total interviewees), comprising 8 boys and 16 girls. Especially, the highest gender difference occurred in TDP groups in which female pupils highly favoured this playground setting (10 girls and one boy), as shown in Table 7-7.

Table 7-7. Children's statements and themes of favoured features of the O_2 school playground

School	ID	G	O_2 - Children's statements
TQT_5	2.A	F	*… has slides and large area to play.*
	9.H	M	*… very open, cool, and comfortable. … many interesting games here.*
	14.L	F	*… has many different playing areas, … could play more with my friends.*
	21.PH	F	*… like playing these games.*
TQT_4C	3.H	M	*… there are many games.*
	7.M	F	*… there are various games … so colourful.*
TQT_3	6.KH	M	*… there are places for playing football, many activities and facilities, such as swings, slides, and adventurous games.*
	12.PH	M	*… has many places to play various activities, such as, area for playing football as well as basketball.*
	15.TH	F	*I used to play at the playground where looks like it before. … could have different playing activities here; … colourful.*
	17.V	F	*… there are many games here.*
TDP_5	2CH	F	*… there are many different games for many pupils and my friends.*
	8.V	F	*… there are many pupils playing here; … beautiful, comfortable and fun.*
	9.V	F	*… there are many interesting playing games. I could play alone here.*
TDP_4	2.D	F	*… much more spacious than others; … beautiful and colourful. … also has space for playing football.*
	8.M	F	*… there are many different games for many pupils. I like sitting in shelter because it's cool with sunshades.*
	14.U	F	*… spacious, … different things for many pupils. I like the climbing games mostly.*
TDP_3	4.GI	F	*… there are many games with colourful squares, and teachers guiding how to play here.*
	5.GI	F	*… there are many playing activities. I like climbing games.*
	7.H	F	*… there are many games. There are words in square paintings.*
	13.PH	F	*… there are many adventurous games. I like climbing games which are located in the center area most.*
	14.PH	M	*… there are many different games for many pupils. I could play football at grass yard.*
TXS_3	1A	M	*… I could play many games.*

The students preferred the playground setting with diverse functional areas and with a variety of facilities for their playing activities. The majority commented their functional satisfaction regarding various game types (e.g. "*slides*", "*games*", "*football*", "*activities and facilities*", "*sitting in shelter*", "*climbing*", "*adventurous game*", and "*square paintings*") through comments with emphasized words describing features, such as "*interesting*", "*different*", "*many*", and "*various*". Following, some children like seeing various colours when reported "*colourful*" and evaluated this school as "*beautiful*". The spatial setting was also important for pupils when they indicated that this school playground is open and spacious with different/many areas to play with friends or alone. Interestingly, one child commented: "*although there is a lack of trees*". This comment matches our prior statements of its specific features in the photo selection process as presented in Chapter 3. However, children's responses showed that they significantly focused on the particular features in concerns of playing activities.

c) O_3 playground

About the playground O_3, which is specified by grasses ground and a simple landscape setting for playing sports and football activities, about 30% of the participants preferred it.

Table 7-8. Children's statements and themes of favoured features of the O_3 school playground

School	ID	G	O_3 - Children's statements
TQT_5	3.A	M	*… spacious. I like playing football, the grass-covered ground will not be slippery for my running.*
	6.D	M	*… spacious; I could play football and run.*
	16.M	M	*I like playing football.*
TQT_4B	1.B	M	*I like grass-covered ground for running without slippered risks. I like playing football.*
	4.H	M	*… I like playing football.*
	6.KH	M	*I like playing football, I like walking on grass.*
	10.PH	M	*… for many pupils playing together; the more people, the happier.*
	11.PH	M	*… spacious, … has goals to play football with friends*
TQT_4C	6.L	M	*… I like spacious space and I could run here.*
TQT_3	4.D	M	*… has grass ground and many trees.*
	5.KH	M	*… has grass, … and to play football.*
	13.S	M	*… there is space for playing football.*
	14.TH	M	*… has grass ground; … spacious, fun, … I could play football.*
TDP_5	6.NH	M	*… there is space for playing football because I often play this. I also like spacious playground for many pupil groups playing different games.*
TDP_4	1.C	M	*… I could play many games here, such as playing football or running competition. I like football. However, I like artificial grass because it would not have ants and worms.*
TDP_3	3.D	M	*… I like playing football.*
	6.H	M	*… my passion is football, so I like it most.*
	9.H	M	*… because they're fun.*
TXS_5	1.A	M	*… I like playing football.*
	6.M	M	*… I like playing football.*
	8.PH	M	*… because I like football.*
	9.PH	M	*… I like playing football.*
TXS_3	2.K	M	*… I like playing football.*

The most surprising aspect of the data is this playground setting was entirely inclined by male pupils, as shown in Table 7-8. The major reason for liking is due to children's significant pleasure derived from opportunities of "*playing*", "*running*", and "*walking*", especially "*football*" (the frequency of playing football is 19 of 24 interviewees). Moreover, what is striking about this playground setting is the "*grassed-covered ground*" that contributes to children's highly energetic movements and activities with greater risk prevention. This was a shared view amongst children who chose it with similar statements, such as *"…will not be slippery for my running"* and *"…without slippered risks"*. Some interviewees argued their positive emotional feelings (e.g., "*happiness*" and "*fun*") when playing with friends and were satisfied with this open and spacious playground.

Interestingly, in one case, one 10-year-old pupil of the TDP school thought that "*I like football. However, I like artificial grass because it would not have ants and worms*". These reflected his dislikes (or biophobia feelings) toward ants and worms and then followed greater favour for plastic-material grass over the natural grass environments. Although there is one response collected in this study, one may wonder if this would have increasingly occurred because artificial grass ground is practically adopted into the playground area for sporty activities in TDP school and many other school environments as a familiar setting.

d) O_4 playground

Approximately 10% of the interviewees liked the O_4 playground, which is set up as a garden with many different plants and flowers. Specifically, female pupils tend to rate this outdoor environment higher than male pupils, as shown in Table 7-9.

Table 7-9. Children's statements and themes of favoured features of the O_4 school playground

School	ID	G	O_4 - Children's statements
TQT_5	8.D	F	*… there are many flowers and spaces for sitting and chatting with my friends.*
TQT_4C	1.A	F	*… peaceful. … lots of trees, they are lovely.*
	5.KH	M	*… there are many flowers.*
TQT_3	1.A	F	*… because there are many flowers and plants. … looks cool.*
	7.M	F	*… open and cool. There are many flowers and sitting areas to relax.*
TDP_3	2.CH	M	*… sparkling, clean and beautiful.*
TXS_5	4.KH	F	*… looks cool and fresh. I could stay here to read books.*
TXS_4	2.L	F	*… like flowers and sunshades.*

The most significant features of this playground, "*flowers*" and "*plants*", were reflected through children's responses regarding natural elements they found attractive. Besides highly aesthetical values (e.g., "*beautiful*", "*lovely*", and "*sparkling*"), this place was also greatly evaluated for comfortable satisfaction when they described "*cool*", "*fresh*", and "*open*" for their low energetic activities, such as "*sitting and chatting*", "*to read books*", and "*to relax*". These reported activities appeared to be completely contradictory to the previous playgrounds of O_2 and O_3 options.

e) O_6 playground

About 28% of participants from three schools favoured the wilderness area as their school playground, including 9 boys and 13 girls.

Table 7-10. Children's statements and themes of favoured features of the O_6 school playground

School	ID	G	O_6 - Children's statements
TQT_5	1.A	F	*… it's nature. … looks adventurous … there are many things to explore.*
	4.B	M	*… could have many physical activities here; the atmosphere is fresh and open. I could explore many animal species; and I feel more friendly with nature.*
	5.D	M	*… I never go to forest, but I would like to have experiences with nature.*
TQT_4B	13.TR	F	*… interesting and fun here.*
TQT_4C	4.KH	M	*… there are lots of trees, I could have many experiences here. I could climb and breathe pure and fresh air.*
TQT_3	3.CH	F	*… outdoor with a stream and many plants to explore.*
	10.NH	F	*… there are lots of plants; the blowing wind is cool.*
TDP_5	2.CH	F	*I chose this place for matching with the classroom option on which I preferer. (Opt.I2 - It has part outdoor so it's open, cool and comfortable)*
	33.D	M	*… I am a person who like to explore and play at outdoor places. I also like stream.*
	4.GI	F	*… I like climbing, and it's cool here.*
	5.M	F	*… there are water and many types of leaves.*
	7.NH	F	*… I like visiting forests; I could wash my face by stream water and drink it; I also like climbing.*
TDP_4	5.H	M	*… I like to explore and have adventurous things in forest.*
	12.TH	F	*… I could have adventurous and interesting feelings when crossing stream. I like playgrounds where completely are nature like this.*
	13.TR	M	*… I think when we are playing in forest, we could gain direct knowledge which are taught at the same time, for example studying about animal species. Sounds of birds and waving leaves will help us to have more relieved feelings, and to study better. The atmosphere is greenery, fresh and cool. … is very spacious, so we could play many different things here.*
TDP_3	12.M	M	*… gains my strength to climb trees, across the stream. I also become a better person for helping my friends' climbing trees. I also gain knowledge to cut down the trees to across the stream.*
TXS_5	2.A	F	*… it's cool. There is a stream, so I could hear the funny sound of water running.*
	3.CH	F	*… I like to explore dragons and climb trees.*
	5.KH	M	*… has trees and a stream.*
	7.NG	F	*… I like to explore.*
	10.TH	F	*… I like trees in forest.*

As shown in Table 7-10, amongst their responses, the theme related to nature had the highest frequency of comments with 18 times. Pupils indicated that they selected because "*it's nature*",

"*... with nature*", "*forest*", and "*completely are nature*". They additionally reported various natural elements with their relative features existing in the given photo, such as "*animal species*", "*trees/plants*", "*many types of leaves*", "*stream*", "*water*", and even "*dragon*". Interestingly, they also described their experiences of nature more than vision here, for example, breath pure and fresh air, washing their face with water and drinking it, having sounds of birds and waving leaves, hearing the funny sound of water running, and climbing trees. The themes of positive emotional feelings and physical comforts emerged as follows through comments like "*interesting*", "*fun*", "*open*", "*cool*", "*fresh*", and "*comfortable*".

The most striking results are children's perspectives on which types of activities they could do within the wilderness playground. Completely different from other options, the theme of exploration was only detected here because "*there are many things to explore*". Various energetic and adventurous activities in the connections with trees and a stream as playing facilities were highly reported. Besides satisfying children's playing desires, natural elements also play as facilities and benefits for studying from their perspectives, as shown in statements of two female pupils of TDP school [TDP_4.13.TR and TDP_3.12.M]. Importantly, one child [TQT_5.4. B] expressed concern about the child-nature relationship when she indicated that "*I feel more friendly with nature*".

7.3. Perspectives of architects and educators on classrooms and playgrounds

Architects and educators were asked two different questions to understand how they favour classrooms and playgrounds with and without considering his or her responsibility for users and society. Table 7-11 showed that '*favoured*' classifications are results of the first question: "*Which classroom and playground do you like to study and play if you were a child?*". In contrast, '*recommended*' ones are outcomes of the second question regarding their viewpoints as an expert in architecture or a primary-school educator in creating the most suitable educational environments for children and purposes of the child-nature reconnection. Through in-depth interviews, participants also provided the advantages and disadvantages of each option. Lastly, important attributes in designing studying and playing environments are synthesized to evaluate the importance of children's multi-sensorial experiences with nature from the professionals' perspectives, among other significant factors. Outcomes of this part are presented following the route of their perspectives, which establishes from personal favourites to professional recommendations and finally, more expandingly considerations in design further than given options of this study. Additionally, the differences between age ranges and genders of interviewees in favoured and recommended preferences are summarized in Table 7-12 and Table 7-13, respectively.

Table 7-11. Frequencies and ratios of favoured and recommended classrooms and playgrounds of architects and educations

	Favoured classroom				Favoured playgrounds					
	I-1	I-2	I-3	I-4	O-1	O-2	O-3	O-4	O-5	O-6
Architects (N=42)	5 11.1%	21 46.7%	4 8.9%	15 37.8%	3 7.1%	12 31.0%	9 21.4%	1 4.8%	1 4.8%	16 42.9%
Educators (N=3)	0	1	0	2	0	1	0	1	1	2
	Recommended classroom				**Recommended playgrounds**					
	I-1	I-2	I-3	I-4	O-1	O-2	O-3	O-4	O-5	O-6
Architects (N=42)	8 13.6%	33 55.9%	10 16.9%	8 13.6%	4 5.3%	28 37.3%	18 24.0%	5 6.7%	10 13.3%	10 13.3%
Educators (N=3)	0	3	0	1	0	1	2	0	0	2

Table 7-12. Ratios of favoured classrooms and playgrounds according to age ranges and genders of architects and educators

	Favoured classroom				Favoured playgrounds					
Age ranges	I_1	I_2	I_3	I_4	O_1	O_2	O_3	O_4	O_5	O_6
40-50 (N=14)	.21	.43	.14	.29	.21	-	.36	.07	.07	.36
30-40 (N=21)	.05	.57	-	.43	-	.43	.14	.05	.05	.38
18-30 (N=10)	.10	.40	.20	.40	-	.40	.10	-	-	.50
Genders										
Female (N=21)	.10	.57	-	.43	-	.33	.24	.10	.05	.38
Male (N=24)	.13	.42	.17	.33	.13	.25	.17	-	.04	.42

Table 7-13. Ratios of recommended classrooms and playgrounds according to age ranges and genders of architects and educators

	Recommended classroom				Recommended playgrounds					
Age ranges	I_1	I_2	I_3	I_4	O_1	O_2	O_3	O_4	O_5	O_6
40-50 (N=14)	.36	.71	.14	.07	.29	.50	.64	.07	.14	.21
30-40 (N=21)	.05	.76	.14	.19	-	.71	.33	.14	.19	.19
18-30 (N=10)	.20	.70	.50	.30	-	.60	.20	.10	.40	.30
Genders										
Female (N=21)	.10	.76	.19	.29	-	.57	.43	.10	.19	.24
Male (N=24)	.25	.71	.25	.08	.17	.67	.38	.13	.25	.21

7.3.1 Different perspectives on classroom settings: favoured – recommended – considered features

a) Favoured classroom

As Table 7-12 shows, the I_2 and I_4 are the most favoured classrooms by architects and teachers (from TDP and Waldorf schools). According to Table 7-12, the results of I_2 and I_4 classrooms also head the figures of preferences while classroom designs of I_1 and I_3 attracted the least favoured from architects of all ages and genders.

b) Recommended classroom

In the matter of suggested classrooms, there were significant changes in architects' opinions regarding alternatives from the data in Table 7-13 compared to Table 7-12. In particular, over half of the interviewees (56%) picked the I_2 classroom - an increase of 9.2%; the ratio of the I_3 classroom also raised 8%. In contrast, the greatest decrease occurred in the I_4 option's ratio by 24.2%; this led to the I_4 and I_1 options being the lowest considered settings up of classrooms for children. These figures convey that the wilderness areas were much favoured by most adults' interests without responsibilities than those with responsibility considerations for the end-users. Among three educators, only a Waldorf teacher reported that *"… it would become more successful"* if a school could set up both environments of I_2 and I_4 for children's studying activities rather than only performances I_2 like suggestions of two other teachers.

According to age ranges and gender aspects, as displayed in Table 7 13, besides the most appropriate setting of the I_2 classroom by those interviewed, slight differences in other options were detected. For example, the youngest groups indicated that the I_3 classroom offers appropriate features whereas the oldest interviewees from 40-50 years old highly suggested the setting up of the I_1 classroom. Concerning female participants, the wilderness area of the I_4 classroom was more greatly considered. By contrast, the least concerned males whose reported I_1 and I_3 classrooms are more appropriate environments for children.

Turning now to the underlying statements and themes that offer an in-depth understanding of why they encouraged or discouraged given alternatives of classroom designs through the details of their in-depth interviews are presented below.

I_1 classroom

Firstly, Table 7-14 provides the results from professionals' perspectives on the I_1 classroom. The majority of positive comments, especially those between 40 and 50 years old, are related to themes of satisfaction of spatial form, functional, and physical comforts for children.

Particularly, they agreed that this dedicated classroom meets standard features for primary-school children's studying, included fully equipped, safety, utility, good thermal and lighting conditions. They also commented on the room's modern looks, orderly, and flexibility. One interviewee suggested this formal classroom is *"… efficient and well integrated with the current condition of Vietnam…"* [17.C]. Another architect considered that the classroom *"… must look for potential solutions to enhance the connection between indoor and outdoor environments."* [15.B] and indicated that the setting of the I_1 option satisfies this requirement.

Table 7-14. Statements and themes of the I_1 classroom's features according to professionals

Age	ID	G	I_1 Statements – Positive responses
40-50	4.D	F	*… has bright colour. The appropriate furniture that looks modern is fully and flexibly arranged. The lighting is properly designed.*
	10.C	M	*… well-performance because the educational environments need good safety, utility, thermal and lighting controls.*
	13.Q	M	*… most orderly classroom that could nurture children's self-discipline;*
	14.Q	M	*… remains standard features of a conventional classroom setting.*
	15.B	M	*I think children need opening spaces even though they could be distracted a little bit. Thus, designers must look for potential solutions to enhance the connection between indoor and outdoor environments.*
30-40	28.H	F	*… looks like a modern learning space.*
20-30	17.C	M	*… efficient and well integrated with the current condition of Vietnam. … a formal educational environment with orderly organization and management.*
	33.H	M	*… suitable for the studying of primary-school children*
			I_1 Statements – Negative responses
40-50	36.L	M	*… looks too narrow, inefficient functional setting, very boring and constrained.*
	10.C	M	*… However, the levels of opening and connection to the outdoor are relatively limited.*
	13.Q	M	*… however it looks too disconsolate.*
	44.L	F	*… a limited environment for children's activities.*
30-40	8.TH	F	*… too orderly organised that could not offer group activities.*
	16.A	M	*… too formal for children*
	29.V	F	*Everything looks thorough orderly and not lively.*
	30.PH	M	*… looks like excessively industrial projects, probably more properly fit for high schools.*
	31.PH	M	*… too constrained to study and play*
	37.C	F	*… looks excessively modern that is intended for high schools.*
	38.D	M	*… improper because children's boundaries are limited and constrained.*
	39.S	M	*… looks like an industrial project.*
20-30	32.TH	M	*… seems appropriate with the secondary and high schools where the studying specifies higher concentration and solemn manners.*
	40.Q	M	*I don't think it's suitable for children because the colour decoration is not exciting to children.*
	42.A	M	*… looks like industrial environments or working spaces.*

However, the number of architects who discouraged this classroom design was greater than those agreed above, especially the group of architects between 30 and 40 years old. A common view was related to its adverse aesthetical aspect, for example, "*very boring*", "*too disconsolate*", "*too formal*", and "*not lively*". Additionally, some interviewees evaluated this setting as "*industrial environments/projects*" or "*working spaces*" when the furniture is too orderly and constrained, limiting boundaries and flexibility for children to study and play. Thus, they indicated that it is not appropriate for primary-school children, both in physical and psychological aspects; it would be probably more appropriate for above high school students. One architect claimed that "*the levels of opening and connection to the outdoor is relatively limited*" [10.C] due to its fixed window system. However, he previously appreciated the classroom's spatial, physical, and functional features.

To summarise, this classroom setting is principally appreciated by architects with standard needs for formal and conventional studying activities of children as well as good quality of thermal and lighting comforts. However, there are diverse perspectives in spatial settings and aesthetical evaluations. In particular, one group of architects suggested the orderly arrangement. On the other hand, the discouragements of this kind of setting are because of the unsuitable characteristics for primary-school children's studying and other activities that require more open, flexible, and free environments along with their psychological aspects in concern of aesthetics. These negative comments were mostly reported by architects below 40 years old.

I_2 classroom

Receiving the most significant consideration, Table 7-15 presents a range of positive appraisals for the semi-open and semi-closed setting of the I_2 classroom. The majority of those who responded to this item highly appreciated how designated design solutions of the setting contribute to appropriate spatial form, satisfy functional needs, provide connections with nature, and create an open and high creativity environment for children at primary-school ages.

Firstly, on the theme of spatial form, half of those who recommended this classroom appreciated its significant advantages of a semi-open and semi-closed spatial layout which is greater for pupils' connections with outdoor nature. It was considered as "*open*", "*spacious*", and "*comfortable*" with "*proper (natural) lighting*" and furniture that satisfy not only spatial and physical comforts but also pupils' multi-functional demands. A common view amongst architects and educators was that children would have the limit in forms of activities, degrees of "*freedom*" and "*flexibility*" that are considered significant to the development of their "*creative thinking*" or "*nourish children's thought-provoking and freedom*" [23.NG]. One architect stated that:

> *"… This classroom is an appropriate solution in Vietnam where education environments have a severe shortage of developing children's creativity…" [28.H].*

Furthermore, social interactions between pupils and between pupil and teacher could be enhanced in their diverse activities and manners of classroom management. Some architects appreciated the remarkable features of decoration in moderation and modern style as well as adapting soft materials of flooring for children's safety.

Similar to architects, educators indicated positive evaluative comments on this classroom. In particular, the teacher of TDP school commented that:

> *"…well equipped. Children have highly concentrated levels and freely creative. The open design offer children's natural connection with greenery to make children's emotional feelings better that could help them learn about happiness. Children also have social interactions with their classmates." [45.NG]*

Waldorf teachers [43.PH and 44.L] also indicated that "*natural connection*", "*open and spacious*", "*considerable (flexible) spatial organization*", and "*pupils are not limited to move around*" are important features that make this classroom to be selected as the most appropriate classroom for primary-school children.

In contrast, only three architects discouraged this classroom setting due to inappropriate features. When a place was suggested for other activities instead of its original function, this meant three fundamental aspects, including spatial form and functional satisfaction, were ranged as inappropriate. Here, this type of classroom was considered as only *"…suitable for extracurricular activities/events."* by two architects. They then selected the classrooms of I_1 and I_3 as the most appropriate options for young children. Conversely, one architect who also disagreed with the I_2 classroom commented:

> *"This is an example of how adults created a space for children according to adults' perspectives only on spatial form and functional layouts as well as their perceptions of aesthetics rather than according to understand and satisfy what children truly desire for." [39.S]*

Then, he selected the classroom in the wilderness area as the most appropriate learning environment for children. Although these architects disagreed with I_2 classroom, their perspectives on setting up a classroom were on contrary movements.

Table 7-15. Statements and themes of the I_2 classroom's features according to professionals

Age	ID	G	I_2 Statements – Positive responses
40-50	6.NG	F	*… as the in-between environment… no division between indoor and outdoor environments. Children could both study and play within here.*
	10.C	M	*… creatively designed with good openings and connections with outdoor nature.*
	11.A	M	*… an open environment, pupils have direct connection with nature.*
	13.Q	M	*… more freedom for children could both study and play.*
	14.Q	M	*… enhances the quality of studying environments for children…, the flexibility of open-closed management, or setting buffer-zones between indoors and outdoors.*
	35.H	F	*… the best appropriate environment where children could have both freedom and essential protection. … advantages of semi-open/semi-closed spatial layout, flexible amenities and arrangement for various types of children's activities.*
	36.L	M	*… the most proper to study with these features: not excessive static, functional and fulfilled setting, moderate decoration, proper lighting, spacious enough for children's comfort studying and other activities.*
	41.D	M	*… most proper classroom. Children could look at nature outside. … spacious enough for all activities of children. … feel comfortable and free without excessively immense sense that could be provoked within outdoor environments.*
	43.PH	F	*… has natural connection, open and spacious, and considerable spatial organization. … has natural lighting.*
	44.L	F	*Open and spacious, and natural connection; pupils are not limited to move around; … a flexible setting;*
30-40	1.V	F	*…has suitable spacious area for pupils' playing activities … ensure teachers manage and interact with all pupils.*
	3.H	M	*… proper for grouping arrangement with soft ground, and flexibility.*
	12.TH	M	*… provides a comfortable and free environment … excitement for children's studying and playing.*
	16.A	M	*… a blurred boundary between primary (e.g., tables, chairs, and board) and secondary (e.g., constellations bulbs for lighting and decoration) functional utilization, and between indoor and outdoor spatial environments. … presents children with high levels of freedom of their interactions and creative thinking.*
	18.L	M	*… clears the separation between indoor and outdoor environments has both natural elements and a filled completion with all the modern and safe amenities.*
	21.H	F	*… looks modern and safe. The connection between indoor and outdoor environments offers more natural experiences for children. The open and flexible setting could both afford their studying and playing activities.*
	27.N	F	*… looks fresh, and children could feel connected with nature. … fulfilled amenities for children's activities …. advance children's higher levels of flexibility and freedom.*
	28.H	F	*… an appropriate solution in Vietnam where educational environments have a severe shortage of developing children's creativity.*
	29.V	F	*Children have close connections with outdoor environments … satisfy both studying and playing activities here.*
	30.PH	M	*… the most proper classroom that children could have a closed connection with the outdoor natural environment.*
	31.PH	M	*Children would be unlimited and have various forms of interactions within this semi-open/semi-closed space. They also have more space than normal classrooms for playing activities.*

	34.M	M	*The semi-open/semi-closed spatial features could provide a direct connection with nature for children. … proper natural lighting and covering features yield comfortable and friendly feelings to users. … has a fulfilled amenity for children's study and play activities.*
	37.C	F	*… appropriate with primary school children and educational method.*
	38.D	M	*… more freedom and a close connection with natural environment when children study.*
	45.NG		*… well equipped. Children have highly concentrated levels and freely creative. The open design offer children's natural connection with greenery to make children's emotional feelings better that could help them learn about happiness. Children also have social interactions with their classmates.*
20-30	24.D	F	*… open space that could evoke children's creativity. The grass-covered surface could enhance children's direct experiences with nature.*
	40.Q	M	*It is a flexible space.*
	25.V	F	*… provoke children's energetic or practical motions.*
	42.A	M	*Looks open and fresh feelings that brings comfort of studying than other options.*
	17.C	M	*… an in-between space, its setting provides freedom and flexibility for children's studying and creative thinking.*
	22.NG	F	*… looks flexible that could provide diverse forms of interaction between pupils and teachers. Besides, children could have direct experiences with nature.*
	23.NG	F	*… nourish children's thought-provoking and freedom…*
			I_2 Statements – Negative responses
30-40	20.K	F	*… suitable to study extracurricular activities.*
	39.S	M	*This is an example of how adults created a space for children according to adults' perspectives only on spatial form and functional layouts as well as their perceptions of aesthetics rather than according to understand and satisfy what children truly desire for.*
25-30	33.H	M	*… should be applied for extracurricular events only.*

I_3 classroom

A minority of architects (17%) suggested this classroom setting, while three teachers did not approve. As shown in Table 7-16, they highly indicated that this place offers appropriate features of functional satisfaction through "*properly*", "*friendly*", and "*well-organised*" setting up of furniture as well as children's physical comforts (e.g. "*cool and comfortable*", "*natural lighting*", and "*concentration … not be distracted*"). Besides, the interior decoration of this classroom was highly appreciated, for example, "*attractive*", "*vivid*", or "*warm and friendly*" colour adaptation. This seating arrangement is suitable for pupils' "*group work*" and "*high levels of social interactions*". Meanwhile, the theme of nature was least reported except for the "*natural lighting*" by one architect.

Regarding negative responses toward this classroom, a common view was that the spatial setting and decoration are not appropriate for children and their activities at primary-school ages. The space was considered as "*closed*", "*constrained*", "*narrowly and orderly*", and "*too formal*" which limits the children's activities due to a lack of flexibility. The interior was over-decorated with colours; thus, they suggested this classroom is more "*appropriate with kindergarten children only*". Nature connections of this setting were completely "*limited*" through the TDP teacher's comment.

Table 7-16. Statements and themes of the I_3 classroom's features according to professionals

Age	ID	G	I_3 Statements – Positive responses
40-50	5.H	M	*The colour is attractive … The ceiling is well designed to have natural lighting. The furniture is well and properly set up for studying.*
	9.H	M	*… an approach to satisfy children's needs according to their nature, for example, utilization of fundamental colours and materials, friendly and moderate organisation, not too tough or orderly setting. … appropriate and moderate balance between using natural and artificial materials to comply with the requirements and standards of educational environments.*
30-40	7.L	M	*… orderly and well organised…. full of necessary facilities…. helps children concentrate and not be distracted. …high aesthetical values with a vivid colour decoration.*
	8.TH	F	*The setting of furniture is very good for children's group work.*
	20.K	F	*… has all the necessary and modern amenities, cool and comfortable environment for children's studying.*
20-30	17.C	M	*… still remains the features of conventional indoor classroom design. … also reflects the social orders; thus, this could shape the child's behaviours and attitudes towards the social interactions. … could be broadly applied to many schools in Vietnam.*
	24.D	F	*… has full of studying amenities, vivid colour decoration. … also efficient for children's concentration.*
	25.V	F	*Although this classroom looks low lighting, it still reflects high levels of social interactions between classmates and between pupils with teachers.*
	33.H	M	*… suitable for the studying of primary-school children.*
	40.Q	M	*… warm and friendly colour decoration.*
			I_3 Statements – Negative responses
40-50	35.H	F	*… excessively decorated with colours, and completely closed.*
	36.L	M	*… poor aesthetical values and looks constrained.*
	41.D	M	*… represents a conventional classroom design that is narrowly and orderly set up. However, I feel the concept of ceiling design for lighting is interesting.*
	44.L	F	*… limited environment.*
30-40	16.A	M	*… too formal for children.*
	28.H	F	*… seems more suitably fit kindergarten children only.*
	29.V	F	*… more appropriate with children under 6 years of age.*
	30.PH	M	*… too colouful decoration.*
	37.C	F	*… a conventional classroom of kindergarten children. The setting of study desks and chairs is too narrow and cramped for children's activities.*
	38.D	M	*… improper because children's boundaries are limited and constrained.*
	39.S	M	*… has an improper lighting quality.*
	45.NG	F	*… lots of artificial factors, this space is limited to connect with outdoors.*
20-30	42.A	M	*Although it looks like a friendly classroom, its environment lacks comforts and flexibility.*

I_4 classroom

As Table 7-17 shows, the theme of natural concerns recurred throughout the responses of those who selected the natural environment as a classroom. They both indicated that this place, where nature and its beauty are unaltered profoundly by humans, plays as "*… the most appropriate design for children's natural connection*" and contributes "*… unlimited spatial and natural features*" that children would have higher degrees of "*freedom*" and "*creativity*".

Table 7-17. Statements and themes of the I_4 classroom's features according to professionals

Age	ID	G	I_4 Statements – Positive responses
40-50	44.L	F	*… has a diverse flora system; … comfortable and functional satisfaction for children's activities;*
30-40	1.V	F	*… the most appropriate design for children's interaction with nature.*
	2.D	F	*… the most appropriate option for children who need higher degree of natural connection.*
	26.L	F	*… reflects the complete freedom and unlimited spatial and natural features.*
	39.S	M	*… follows the patterns of some Western schools where children's activities have mostly occurred in outdoor environments. Nature and its beauty are the most unique and essential features children could experience with.*
20-30	19.L	F	*… everything is natural and made from nature. Thus, children should be provided with these elements that reflect the essential connection between human and the natural world.*
	23.NG	F	*… suitable to raise children's creativity, proper natural lighting, and efficient adults' observations of children's activities.*
			I_4 Statements – Negative responses
40-50	10.C	M	*… not suitable for children's health*
	35.H	F	*… completely improper.*
	36.L	M	*… the most appropriate environment to play, not to study. … it does not regard the architectural definition.*
	41.D	M	*… could be adopted in some particular weather conditions and events only.*
30-40	16.A	M	*… the safety concerns are not appropriate for children.*
	28.H	F	*… not a proper design for the practical condition of Vietnam.*
	29.V	F	*… seems overly wilderness for an educational environment.*
	30.PH	M	*… could be used as a place for children's outdoor events only because children would have no notion this is a class. Furthermore, I suggest we should have some places with canopies to ensure the comforts of their activities when it rains or has too much sun.*
	31.PH	M	*… rather exclusive and unsafe. I think many children would not favour it to study.*
	34.M	M	*… only suitable for extracurricular events.*
	37.C	M	*… a completely outdoor environment, I could not define the functional setting for study.*
	45.NG	F	*… only proper for some particular classes.*
20-30	17.C	M	*… only suitable for outdoor trips, extracurricular activities.*
	32.TH	M	*… only suitable for extracurricular activities.*
	33.H	M	*… the application of this concept into the Vietnam's particular condition seems unrealistic. Instead, school could hold extracurricular events here.*
	40.Q	M	*… lacks the necessary amenities for children's studying.*
	42.A	M	*… only suitable for play activities only*

One of the most important concerns is that the Waldorf teacher argued that this natural environment provides *"… comfortable and functional satisfaction"* for children's studying activities. Unfortunately, her judgement was contrary to what many architects who discouraged this place indicated that it *"…lacks the necessary amenities"*.

The most common view of architects is that nature is a completely inappropriate environment for studying, especially in the particular condition of Vietnam, as noted by one architect:

> *"… the application of this concept into Vietnam's particular condition seems unrealistic. Instead, schools could hold extracurricular events here." [33.H]*

Many concerns in children's health and safety are major barriers to organising daily studying activities. They were more likely to suggest this for extracurricular and occasional activities. Contrasts were seen to be related to our discourse and conceptions of nature and architecture - the intervention and product of human and human design for human's basic needs, including protection and welfare, as one architect significantly commented:

> *"… Especially, it does not regard the architectural definition." [36.L]*

c) Considered features in setting up classroom environment

After selecting the most appropriate option, participants were asked to provide important features needed in setting up a classroom for primary school pupils to further optimise future designs. Thematic analysis was used to identify the themes of requested features, including natural- and non-natural aspects, and the frequencies of these themes were presented in Table 7-18. The majority of responses were non-natural considerable features (around 69%). However, the natural lighting and children's direct connection with nature were the most frequently mentioned features (n=16 and n=15, respectively). Among responses related to nature, followed important features were available natural ventilation and fresh air for children's comfort within indoor environments. Besides, some professionals suggested the appearance of a diversity of vegetation with shady trees and animals surrounding classroom's openings while the grassed ground and more natural elements should be installed within indoor spaces.

With higher frequencies in total responses, many non-natural features were suggested. Among them, the principal request was ensuring all studying activities occur efficiently, including fulfilled amenities (n=13), flexibility (n=11), spaciousness (n=10), transformability (n=3), users' comforts (n=8), and excitedly engagements (n=8) for various indoor activities.

Meanwhile, pupils' safety and social interactions were less requested when designing a classroom.

Table 7-18. Frequencies of considerable features of classroom design from professionals' perspectives

Classroom - considerable features	F	Classroom - considerable features	F
Natural concerns	**53**	**Non natural-concerns**	**113**
Natural lighting	16	Proper facilities for children's studying	13
Children's connections with nature	15	Flexibility	11
Natural ventilation (wind)	7	For development of children's creativity	10
Fresh air	3	Spacious	10
Diversity of vegetations	2	Suitable for children's studying	9
Natural outdoor views	1	For children's comfort	8
Animals	1	For children's excitement	8
Grassed floor surface	1	Multi-function	6
Tree shades	1	Open	6
Natural indoor setting	1	For children's safety	4
		For children's freedom	4
		For development of children's interests and potentials	4
		Transformability	3
		For child-teacher interactions	2
		For child-child interactions	2
		Suitable for children's psychological features	2
		For children's concentration (quiet)	2
		Vivid colours	2
		Proper lighting (artificial)	2
		For development of children's love and kindness	1
		For development of children's self-disciplines	1
		Suitable for children's physical features	1
		For development of children's natural knowledge	1
		For children's physical-cognitive-psychological development	1

A noteworthy issue is architects and educators highly urged the need for children's creativity and imagination (n=10) rather than other aspects of children's development (for example, reaching their interests and potentials, enhancing natural knowledge, or nurturing love and human kindness). There is only one architect who indicated the need for the overall development of a primary-school aged child:

> *"The objectives of education of education of primary school children that directly influence and standardize educational architecture are an entire development in physical – cognitive – psychological aspects, life skills, and core values (e.g. responsibility and love) of children." [35.H]*

7.3.2 Different perspectives on playground settings: favoured – recommended – considered features

a) Favoured playground

As shown in Table 7-11, the wilderness area (O_6) heads the figures of liking by architects and teachers at Waldorf schools with approximately 43%. Architects under 30 and over 40 years old accounted for the highest ratio among those who favoured it. Following that are O_2 and O_3 playgrounds which accounted for 37.3% and 24%, respectively. Meanwhile, both architects and teachers showed their much favoured towards O_1, O_4, and O_5. Besides, there was no significant difference in a gender aspect, as covered in Table 7 12. Both male and female interviewees similarly reported their most liking to O_6 and O_2 and least favourite to O_1, O_4, and O_5.

b) Recommended playground

Similar to the obtained results of the classroom investigation, there were also significant changes in architects' perspectives in schoolyard settings. From the results in Table 7-11, a considerably decreased trend of the wilderness playground was by 30%. The O_2 option was the most considered playground setting for children with its frequency accounting for around 37% of total architects' responses. In particular, nearly a third of architects suggested that the O_2 option entirely satisfies all requirements of a proper playground. At the same time, two-thirds felt that it would be more thorough for children if we combined O_2 with other alternatives. For example, the most frequent suggestions were the combination of O_2 and O_3 (8 responses), O_2 and O_1 or O_4 followed, every three responses. Meanwhile, the results showed that the O_1 (5.3%) and O_4 (6.7%) were the lowest considered settings up of playing environments for children. According to educators, Waldorf teachers suggested that primary-school-age children need both the sporting playground (O_3) and wilderness (O_6) while the teacher of TDP highly commented the O_2 as the most suitable playground.

Turning now to the underlying statements and themes that offer an in-depth understanding of why they suggested or discouraged given alternatives of playing environments for primary-school children.

O_1 playground

According to Table 7-19, there were only three architects (both over 40 years old) who agreed that it is a "*spacious*" setting with shady trees; these features were considered as amenities to children's "*energetic activities in various forms*".

In contrast, some interviewees argued that this playground setting is more appropriate for children over 12 years of age instead of for primary-school ages. The improper spatial layout and aesthetical quality were dominant comments. It was seen as an immoderately "*boring*", "*blocky*", and "*dryly*" landscape with a lack of natural features; this was a result of "*the over-*

constructed of designers' perspectives" or accordingly to "*adults' favours*" only. As one architect stated: "*It reflects over-urbanized*." [35.H]. These features were also considered negative influences on the degree of evoking children's creativity and cognitive development in their playing activities.

Although the concerns related to the natural environment were less reported, the negative statements regarding a high ratio of hard-surface ground and the lack of greenery space, especially high trees and structures providing shadow, according to interviewees, demonstrated an insufficient natural setting in this primary schoolyard.

Table 7-19. Statements and themes of the O_1 playground's feature according to professionals

Age	ID	G	O_1 Statements – Positive responses
40-50	13.Q	M	*… is spacious. … many trees and shades as well as many activities that children could play here.*
	14.Q	M	*… be spacious for children's activities as well as have suitable natural elements.*
	15.B	M	*… could provoke children's energetic activities in various forms.*
			O_1 Statements – Negative responses
40-50	35.H	F	*… reflects over-urbanized*
	36.L	M	*… too boring.*
	41.D	M	*I don't think it's suitable for children. The landscape setting looks blocky, dryly, and lacks natural features because of the over-constructed of designers' perspectives.*
	44.L	F	*… too complex and messy according to primary-school children's physiological and psychology;*
30-40	12.TH	M	*… lack creativity.*
	27.N	F	*… does not bring any features to raise children's creativity or cognitive thinking because the setting is too clear and organized.*
	28.H	F	*… is more suitable for children over 12 years of age.*
	31.PH	M	*… too dry and pretty blocky.*
20-30	24.D	F	*… appropriate for children over 12 years old.*
	32.TH	M	*… more appropriate with high school pupils*
	42.A	M	*… looks like a park and for adults' favours.*

O_2 playground

With the highest number of recommendations, this playground was evaluated as an advantageous setting with greater positive evaluations than negative ones. As seen in Table 7-20, common views amongst interviewees who suggested it were the functional and spatial satisfactions. In particular, this playground could provide children with a "*spacious*" and "*safety*" environment and amenities for many forms of playing. As the teacher of HCMC_TDP argued that:

> "*… spacious with many different kinds of games or activities for children.*" [45.NG]

Besides enhancing pupils' physical development through "*energetic activities*", their "*knowledge*" and "*creativity*" competencies also be built up through informative utilisations of colour and graphic decorations according to designated subjects, such as geography and nature. As one architect described:

> *"This provides spacious spaces and safety for children's running and other physical activities. Besides, there are many spaces for different forms of activities with high levels of creativity and imagination." [34.M]*

Furthermore, it was also seen as offering children many forms of social interactions, both individual and grouping play, and they could experience within here besides its well-setting up for teachers' observations to ensure children's safety [21.H].

However, two interviewees showed opposite opinions on this issue. One architect commented:

> *"… it comprises various particular features to regulate how children play as well as their imagination" [23.NG].*

With a relatively similar and a broad perspective, the Waldorf teacher significantly outlines that:

> *"… too complex and messy according to primary-school children's physiological and psychology." [44.L].*

Interestingly, they both then selected the wilderness area (O_6) as the most appropriate outdoor environment for pupils in the primary school contexts.

Significantly, interviewees mostly brought up the lack of "*shades*" or/from "*high trees*" for the particular condition of Vietnam. That explains why almost two-thirds of interviewees preferred to combine this playground setting with the O_3 option to achieve an inclusive outdoor environment. On the other hand, some architects argued that this playground has inappropriate features regarding a high proportion of hard surface ground [5.H] and an over-artificial adaption [30.PH]. It could be seen that although this playground was recommended, it still required additional natural features, especially shaded trees and greenery ground, to adapt to the climate condition of Vietnam properly.

Table 7-20. Statements and themes of the O_2 playground's feature according to professionals

Age	ID	G	O_2 Statements – Positive responses
40-50	10.C	M	*… has a substandard utility.*
	11.A	M	*… includes both kinetic activities and knowledge through setting. … somewhat nature …*
	15.B	M	*… could provoke children's energetic activities in various forms.*
	35.H	F	*… many forms of playing activities and children could gain knowledge through play.*
	36.L	M	*… has a high degree of interaction, and a suitability of culture and weather conditions.*
	41.D	M	*… children could learn climbing or other skills.*
30-40	1.V	F	*… because children are energetic, therefore, this option has spacious area, open and cool environment, and different kinds of play facilities;*
	7.L	M	*… many information and details that children could interact with. … provides many different kinds of games or activities for children.*
	12.TH	M	*… is novel design that could enhance children's creativity thinking.*
	18.L	M	*… has various facilities for children's playing activities.*
	20.K	F	*… has all the necessary amenities for playing activities that evoke children's keens on colour perceptions and their energetic development.*
	21.H	F	*… easy to observe children's activities to make sure they are safe. The open space provides many different types of playing activities.*
	26.L	F	*… many forms of playing activities and children interact with others (e.g., individual or group play).*
	27.N	F	*… looks dynamic and energetic involvements. … also contributes knowledge to children through graphic and playing activities, for example, geography and natural elements.*
	28.H	F	*… is the most applicable design because there are many forms of interactions and playing activities at different surfaced areas (e.g., soft and hard materials).*
	29.V	F	*… looks highly interesting with many features for children to explore within it. … many playing forms and particular areas that could satisfy different needs and desires of children.*
	31.PH	M	*… significantly enhance children's creativity and exploration, especially in the aspect of natural science.*
	34.M	M	*… provides spacious spaces and safety for children's running and other physical activities. … many spaces for different forms of activities with high levels of creativity and imagination.*
	37.C	F	*… many forms of activities for children …*
	38.D	M	*… spacious enough for various forms of play activities.*
	45.NG	F	*… spacious with many different kinds of games or activities for children.*
20-30	17.C	M	*… both have hard-soft landscape layouts with many abstract features. … show the designers' attention on children's visual experiences within playgrounds. For natural landscape settings, children could have multi-sensorial experiences with designated nature.*
	22.NG	F	*… looks flexible with various types of playing activities.*
	24.D	F	*… setting appropriately to lead children's activities because primary-school children have passed the developmental stage of free play.*
	32.TH	M	*… has a spacious feature that children could play together.*
	33.H	M	*…provides many kinds of play activities for children*
	40.Q	M	*… could be applied to practical conditions. …various forms of play activities that could satisfy all age-groups.*

			O_2 Statements – Negative responses
40-50	5.H	M	*… the ratio of the hard surface ground is high; the colour of surface ground is too dark;*
	10.C	M	*… lacks shade …*
	11.A	M	*… should have more trees.*
	13.Q	M	*… lacks greenery*
	44.L	F	*… too complex and messy according to primary-school children's physiological and psychology.*
30-40	8.TH	F	*… has too much sunlight in the condition of HCMC.*
	18.L	M	*… lacks high trees.*
	30.PH	M	*… looks too formal, artificial and blocky like modern amusement parks.*
	37.C	F	*… lacks high trees and other plants.*
20-30	23.NG	F	*… comprises various particular features to regulate how children play as well as their imagination.*
	32.TH	M	*… more shade from high trees is provided.*

O_3 playground

This sporty playground was recommended by 24% of total interviews; among them, only five architects (25%) indicated it as the most proper schoolyard while the rest suggested it should be integrated with other alternatives, especially with O_2, for a comprehensive outdoor environment for children. The themes regarding the O_3 playground are presented in Table 7-21.

Notably, architects over 30 years old drew closer attention to the natural environment with positive comments than O_1 and O_2 schoolyards. Particularly, tall trees with available shades and grass-covered ground not only provide a "*fresh and cool*" and "*safe*" environment while playing and running:

> *"… suitable for children's running and energetic activities. The grass covering and high trees could bring pleasant and comfortable feelings, children could stay cool and fresh" [29.V]*

but also contributed to children's closer connections with nature:

> *"… a dynamic space and close to nature … Children are not limited or bounded within defined areas … a creative environment for children…" [9.H]*

The "*spacious*" spatial setting in which children could "*flexibly*" play and "*actively*" interact was appreciably evaluated as one of the advantageous features here. However, some architects disagreed with the above opinions. They reported that with only an area for sports and running, it is inadequate for children's needs of various playing activities, for instance:

> *"I do not think this option is suitable for children because they were over-designed… shows the greater dominance of adults' perspectives than attentiveness to children's needs and desires … is too cleared up, and not many choices or playing forms for children's varied desires." [16.A]*

With the same view, this schoolyard setting was considered "*normal*" and "*… a conventional design that stands behind trendy educational aspects.*" [12.TH]. Meanwhile, the consideration of nature was less mentioned here, except one architect commented that "*… its natural setting is over-constrained…*" [33.H].

Table 7-21. Statements and themes of the O_3 playground's feature according to professionals

Age	ID	G	O_3 Statements – Positive responses
40-50	4.D	F	*… safe for children … greener. … flexibility and it could set up many activities for children.*
	6.NG	F	*… many high trees and vegetation surface ground.*
	9.H	M	*… a dynamic space and close to nature … Children are not limited or bounded within defined areas…. a creative environment for children.*
	10.C	M	*… has a substandard utility.*
	13.Q	M	*… fresh and cool;*
	35.H	F	*… children could flexibly and freely interact with nature; … spacious enough for children to actively move within this playground.*
	41.D	M	*… essential to have football or sport yards in school environments.*
	43.PH	F	*… an appropriate space for children's running and playing;*
	44.L	F	*… proper environments for children's activities;*
30-40	1.V	F	*… the extensive natural environment that could satisfy the child-nature interactions.*
	3.H	M	*… has shade; grassy ground; diverse activities for children; soft and elastic materials for children's safety.*
	8.TH	F	*… enough spaces for children's playing, running as well as other kinetic activities.*
	29.V	F	*… suitable for children's running and energetic activities. Grass covering and high trees could bring pleasant and comfortable feelings, children could stay cool and freshness.*
	30.PH	M	*… could satisfy children who like sport and energetic movements; besides, children's teamwork and cooperation could be formed through these activities.*
	37.C	F	*… many trees are available.*
	38.D	M	*… spacious enough for various forms of play activities.*
20-30	23.NG	F	*… provides children flexible playing activities, stirs their creativities, and children could freely play according to their favours and interests.*
	33.H	M	*The shade of trees is really good for children's comfort;*
			O_3 Statements – Negative responses
40-50	13.Q	M	*… because the design of playground with only an area for sports, this affects other needs of children.*
	5.H	M	*… needs more grassy area.*
30-40	12.TH	M	*… a conventional designs that stand behind trendy educational aspects.*
	16.A	M	*… do not think this option is suitable for children because they were over-designed. … shows the greater dominance of adults' perspectives than attentiveness to children's needs and desires. … is too cleared up, and not many choices or playing forms for children's varied desires.*

	18.L	M	*… should have more facilities for children's various playing types.*
	27.N	F	*… looks normal*
	28.H	F	*… is more suitable for children over 12 years of age and … a part of the overall playground that only satisfies some particular needs.*
20-30	32.TH	M	*The multi forms of playing activities and spatial settings are limited.*
	33.H	M	*… its natural setting is over constrained.*
	42.A	M	*… only supplies for children's running and sport activities only.*

O_4 playground

Similar to the O_1 option, a minority of architects and teachers (about 7%) made positive comments (Table 7-22); however, all of them suggested it as an additional part of the outdoor environment for pupils at school, as one stated:

> *"…this vegetable garden is considered as a small area for specific activities" [37.C]*

Table 7-22. Statements and themes of the O_4 playground's feature according to professionals

Age	ID	G	O_4 Statements – Positive responses
40-50	41.D	M	*… interesting for children to take care and get knowledge about nature.*
30-40	27.N	F	*…children could relax as well as study nature here.*
	31.PH	M	*…children would have opportunities to interact with nature, and to have feelings about nature and life.*
			O_4 Statements – Negative responses
40-50	9.H	M	*… has a highly spatial constraint and flavourlessness.*
	13.Q	M	*… too cramped for children's playing activities.*
	36.L	M	*… too detailed setting, … should be used only for some specific courses.*
	44.L	F	*… too complex and messy according to primary-school children's physiological and psychology;*
30-40	26.L	F	*… only satisfies children who like personal activities.*
	28.H	F	*… only a part of the overall playground that satisfies some particular needs.*
	37.C	F	*… this vegetable garden is considered as a small area for specific activities.*
	39.S	M	*… a kind of outdoor classroom and only appropriate for weekly or monthly activities at school.*
20-30	24.D	F	*… should have more trees for thermal comfort.*
	32.TH	M	*… this vegetable garden is necessary for teaching children about nature only.*
	42.A	M	*… a vegetable garden is not enough.*

According to interviewees, this place could provide hands-on experiences with nature and learn about nature. Despite that, a vegetable garden that is a "*too cramped*" and "*highly spatial constraint*" environment is not enough for children's playing activities. Functional and spatial aspects were improperly designated here, although children could have a higher degree of multi-sensorial natural experiences. Furthermore, this type of natural setting was impressively disapproved by one architect who described as “*flavourlessness*” [9.H] and a Waldorf teacher significantly stressed:

> *“… too complex and messy according to primary-school children’s physiological and psychology;” [44.L]*

O_5 playground

The O_5 playground was initially concerned as a complex landscape setting with uneven terrains and various natural elements, such as sandy areas, rocks, water, and small plants by researchers. According to interviewees’ statements (as shown in Table 7-23), natural features were highly rated by those who suggested this playground. Most of them indicated that children could have hands-on experiences with various natural elements through playing and studying:

> *“… obtains many natural materials for children’s play activities and their creative thinking. Other options seem to clearly shape how children play and interact with; then, children could feel boring.” [42.A]*

The designated nature was positively commented as “*tranquil*” and “*good with many trees and plants*”. Furthermore, this kind of landscape terrain was considered as “*proper*” for pupils’ activities. Importantly, children’s safety became a major issue when considering this playground. On the one hand, those who suggested it indicated that it is safe for children and easy for observing children playing. As one reported:

> *“… looks safer than the entire natural environment (O_6) and adults could observe how children play within this.” [25.V]*

On the other hand, one architect had an opposite opinion:

> *“Children at primary-school ages are specified with the highest levels of energetic motions. Thus, it's not appropriate because of risk potentials of unconsidered settings, for example, sharp edges and obstacles that could easily cause injuries.” [27.N]*

Likewise, the diverse trends in spatial and natural settings occurred when some participants discouraged it due to “*over-designed*, “*over-utilized artificial*”, and “*over-segregated*” features. It somewhat represents the

> *“greater dominance of adults’ perspectives than attentiveness to children’s needs and desires.” [16.A]*

as well as to their "*physiological and psychology*" [44.L], according to those who selected the wilderness area as the most appropriate playground for primary-school-age children.

Table 7-23. Statements and themes of the O_5 playground's feature according to professionals

Age	ID	G	O_5 Statements – Positive responses
40-50	41.D	M	*… fascinating due to handy experiences with sand, soil, and other natural elements. Safety is not the most important concern.*
30-40	2.D	F	*… safer and easier to observe children.*
	28.H	F	*… there is a connection between children and various natural elements (e.g., water, sand field, and diverse plants)*
	37.C	F	*… the landscape setting looks good with many trees and plants.*
	39.S	M	*… a friendly playground with an appropriate terrain setting and a tranquil landscape.* *… quite suitable for daily play activities of children.*
20-30	17.C	M	*… has hard-soft landscape layouts with many abstract features. … also shows the focus of designers on children's visual experiences within playgrounds. For natural landscape settings, children could have multi-sensorial experiences with designated nature.*
	25.V	F	*… could arouse children's energetic motions. … also looks safer than the entire natural environment (opt.6) and adults could observe how children play within this. Besides, children could study nature from this setting as well.*
	33.H	M	*… the landscape setting creates paths and defined areas to lead children's acts.*
	42.A	M	*… obtains many natural materials for children's play activities and their creative thinking. Other options seem to clearly shape how children play and interact with; then, children could feel boring.*
			O_5 Statements – Negative responses
40-50	36.L	M	*… an overdesigned, and over-utilized artificial setting.*
	44.L	F	*… is too complex and messy according to primary-school children's physiological and psychology;*
30-40	16.A	M	*I do not think it is suitable for children because they were over-designed. … shows the greater dominance of adults' perspectives than attentiveness to children's needs and desires.*
	27.N	F	*Children at primary-school ages are specified with the highest levels of energetic motions. Thus, it's not appropriate because of risk potentials of unconsidered settings, for example, sharp edges and obstacles that could easily cause injuries.*
20-30	32.TH	M	*… the playground is over-segregated that children would not have enough large areas for group activities.*

O_6 playground

Here, a wild forest with a stream and a variety of natural elements is a children's playground at their school. Through statements of interviewees as represented in Table 7-24, all those who suggested nature as children's playing environment mentioned children could study, play, and explore nature through direct experiences – as "*the most profound*" and "*the closest*" natural interactions due to "*it's Nature*". As one architect stated:

"… children could study and play by themselves, according to their interests as their nature. Nature, then, becomes their educational environment, and children could be nurtured as The Scout movement." [16.A]

or another architect described his desire for it:

"… I want to have an educational environment like this where children could have experiences with the forest, the stream, and all-natural species." [39.S]

Two Waldorf teachers also provided similar perspectives when the child-nature connections were appreciated within a wilderness area as a children's daily playing environment. Concerns on other themes, especially children's safety, were less or even not reported by supporters of wilderness playgrounds. For those who discouraged it, these issues were quite the opposite. Safety became a significant problem of a wilderness area as indicated by most architects, such as "*too dangerous*", "*risky*", "(*full of) unforeseen risk potentials*", and teachers could not observe children's activities due to "*lacks a defined boundary*" [42.A]. Therefore, most interviewees suggested that it would be more suitable for pupils' extracurricular events rather than daily activities in school environments.

Table 7-24. Statements and themes of the O_6 playground's feature according to professionals

Age	**ID**	**G**	**O_6 Statements – Positive responses**
40-50	41.D	M	*… really good for children to have skills, exploration, and knowledge through direct experiences with nature.*
	43.PH	F	*… children could discover nature within it.*
	44.L	F	*… proper environments for children's activities;*
30-40	16.A	M	*… children could study and play by themselves, according to their individual interests as their nature. Nature, then, becomes their educational environment, and children could be nurtured as The Scout movement.*
	18.L	F	*… When a child is surrounded within an entirely natural environment, they could discover and figure out which elements are appropriate with them and with their desires to interact with.*
	20.K	F	*… provides natural experiences to develop children's senses.*
	30.PH	M	*… children could have the most profound and closed interactions with nature.*
	39.S	M	*… I want to have an educational environment like this where children could have experiences with the forest, the stream, and all natural species.*
20-30	23.NG	F	*… has the most appropriate spatial and natural features for children's development.*
	40.Q	M	*… the best place for children because it's Nature.* *Diverse and profound natural elements could raise children's creative thinking and energetic activities.*

			O_6 Statements – Negative responses
40-50	10.C	M	*… only appropriate with off-school extracurricular activities.*
	15.B	M	*…have limitations of children's activities.*
	35.H	F	*Natural environment is too wilderness; … too dangerous for children. Instead, children could visit here for extracurricular events.*
	36.L	M	*… the Nature of God/of Creation; thus, it could not be compared or defined as an architectural object.*
30-40	12.TH	M	*… stands behind trendy educational aspects.*
	26.L	F	*… looks rather risky. … also too difficult for adults to observe children.*
	27.N	F	*… looks rather risky (e.g., rivers or water landscape).*
	28.H	F	*… not for daily activities at school, children would rather visit here for extracurricular events.*
	31.PH	M	*… hardly adopted in practical condition of HCMC. … not appropriate for children because of unforeseen risk potentials, especially for those who have not been taught or experienced with nature before.*
	39.S	M	*… it's only appropriate for weekly or monthly activities at school.*
20-30	24.D	F	*… only suitable for extracurricular activities.*
	32.TH	M	*… only appropriate with extracurricular activities under high controls of adults … too wilderness with full of unforeseeable risks.*
	33.H	M	*although it's the best natural environment for children, …not suitable for children due to unsafe concerns.*
	42.A	M	*… involves many risks, lacks a defined boundary that adults could observe children's activities.*

c) Considerable features in setting up playground environment

The themes and frequencies of important features for the school ground of architects and educators are presented in Table 7-25. The majority of requested features by architects was non-natural responses with approximately 80% in total.

Table 7-25. Frequencies of considerable features of playground design from professionals' perspectives

Playground - considerable features	F	Playground - considerable features	F
Natural concerns	**36**	**Non natural-concerns**	**116**
Children's natural connections	10	Children's safety	26
Tree shading	9	Diverse playing activities	19
Natural-based covering ground	4	For development of children's creativity	11
Nature-based playing facilities	3	For development of children's kinetic activities	11
For child's natural knowledge	3	Spacious	10
Domesticated nature by human	2	Flexibility	7
Greenery areas	2	For children's cognitive development	5
Fresh and cool air	2	Fulfilled amenities	5
Proper animals	1	For children's excitement	4
		For children's diverse social interactions	4
		Multi-sensorial evoking activities	3
		Adults' observations	3
		For nurturing children's love and kindness	3
		Suitable for child's physical development	3
		Available shading (artificial)	2

Several non-natural issues of designing schoolyards were expressed; among them, children's safety (n=26), including efficient space for adults' observations, have been notably proposed. The physical characteristics of a school playground were considered not only for various playing activities (n=19) that positively influence on children's physical growth through kinetic and energetic activities (n=11) but also for other developmental aspects. For example, concerns were highly expressed about needs for children's creative abilities, cognitive, love, and kindness. To achieve these educational aims, many professionals suggested a principled playground must be spacious and flexible setting with fulfilled amenities. Moreover, two architects proposed artificial shading appearances in the specific weather condition of HCMC.

On the contrary, by covering nature in design schoolyard, architects and educators expressed their high considerations for providing children's direct experiences with nature (n=10) and for nurturing natural knowledge (n=3). The natural settings of playgrounds were urged to provide shaded-trees (n=9) and should utilize nature as the main materials or facilities for children's play (n=3). Two other architects indicated the importance of children's interaction with domestic natural settings for low risk potentials. Meanwhile, there was only one response related to letting pupils have contacts with proper animals within school sites.

7.4. Insights from perspectives of children and professionals

This chapter is to discern if professionals share similar favours and perspectives of design following the environmental needs of pupils in primary schools. Firstly, in section 7.4.1, the obtained results discussed similarities and divergences in views between pupils and professionals to features of setting classrooms and playgrounds as well as to the degrees of children's natural experiences within these places. The next sections, 7.4.2, 7.4.3, and 7.4.4 presented important findings.

7.4.1 Favourable, appropriate, and inappropriate features of classroom and playground alternatives: a summary

a) Studying environments

Table 7-26 summarized favourable, appropriate, and inappropriate features of studying environments according to perspectives of children and professionals.

Table 7-26. Considerable features of classroom alternatives from perspectives of children and professors

Children's liking responses	Professors' responses	
	Appropriate	**Inappropriate**
 – Aesthetical satisfaction – Artificial thermal comfort – An open and spacious spatial setting – Visual natural experiences: (trees) views outside	– A modern and well-equipped environment for children's studying; – Appropriate spatial settings; – Good lighting (artificial and natural) settings.	– Inappropriate spatial setting for children's activities and their freedom as well as their creative thinking; – Unsuitable decoration for young children.
 – Close and rich visual and non-visual connections with natural environments; – Natural thermal comfort: open and cool environment.	– An appropriate spatial setting for connecting children with nature in the condition of HCMC; – A flexible and appropriate functional setting for various forms of children's activities, interactions, and intellectual development.	– Inappropriate spatial and functional settings for children's mainstream curriculum.
 – An impressive classroom for female pupils with a colourful decoration.	– An orderly and well-organized spatial and functional setting for children's studying; – A colourful decoration style.	– An over-constrained and limited studying environment; – An over decoration with many colours and artificial furniture.
 – Where pupils could contact with nature, explore, and study about nature through multi-sensorial experiences; – A comfortable and cool environment to study and play.	– The most appropriate environment for children's interactions with nature; – A comfortable physical comforts and all-inclusive functional setting for children's study; – Efficiently ensuring the management and observing pupils of teachers.	– Insufficient amenities for children's study; – Negative influences on children's health and safety; – An impractical option for the particular condition of HCMC.

In particular description, these features are:

From pupils: regarding environmental settings for studying, the results showed that pupils were highly concerned about their connections with nature, from the general concept of '*nature*' to detailed natural elements and stimuli. Moreover, the experiences of nature increasingly assemble from vision-only to multi-sensorial connections. For example, in the I_3 classroom, which was least favoured by children, natural concern was not mentioned by any of the respondents. Natural sights were described in I_1 (with 16% of responses). Whereas, both classrooms I_2 and I_4 had the greatest natural concerns at approximately 77% of total responses. However, through pupils' imaginations and descriptions, the difference between two spaces was the more diverse manifestation of nature that children could explore and experience as learning materials in I_4 (e.g. (lots of) trees, plants, leaves, wind, animals, worm species, air, and light) rather than only appreciations and satisfactions regarding spatial and thermal comforts in the I_2 classroom with fewer natural elements (e.g. air, grass, sunlight, and trees).

Besides natural concerns for natural experiences and physical comforts, children clearly showed their attentions to physical and spatial characteristics of the classroom. Having physical comforts, including lighting, temperature, and air qualities were significantly important for them. They also desired for open and spacious spaces that could occupy various activities as well as positively contribute to their feelings as evidence from the previous investigation (Langhout, 2004). Moreover, according to pupils who favoured more '*built*' classrooms, they had higher desires for aesthetical performances which include decorated features of bright colours, clean and tidy arrangements with fulfilled modern equipment. With arguments from pupils of three schools, we can infer that there are restrictions and shortages, both in aspects for pupils' studying demands as well as for their sensorial connections with nature, of investigated classrooms of case studies in HCMC.

From architects: their opinions were divided into two opposite groups. According to those who appreciated natural connections for children, they had comparable perspectives to pupils in the case of I_4 in which nature was considered as the most appropriate place and rich resource materials for studying activities. However, the number of architects who promoted this wild classroom accounted for the least ratio amongst interviewees. From opinions of architects who disagreed the I_4 classroom, it is inappropriate for daily studying activities because of the lack the necessary amenities and the high risks to children's health and safety. Instead of I_4 setting, architects highly recommended the semi-open/semi-close spatial layout of I_2 as the most proper approach for children, especially in the condition of HCMC. Rather than children's studying about nature in its diverse manifestation through multi-sensorial connections, architects selected the safer environment where adults could both easily manage pupils' activities and has less negative influence by nature on children's health. Here, architects suggested that they focused more on children's cognitive and creative thinking developments while the aspects regarding natural connections or natural knowledge were infrequently dis-concerned. This issue was once again significantly illustrated through their considered features of designing classrooms. They also highlighted natural lighting, ventilation, and an open spatial setting as the essential features for physical comforts of pupils within classrooms.

From educators: they also shared similar perspectives with architects. Particularly, the semi-open/semi-close spatial layout of I_2 is the most appropriate approach because it could ensure teaching and studying activities occur efficiently as well as children's natural connections. They also indicated that natural lighting, natural ventilation for cool and fresh air, and a spacious- and flexible- classroom as the important features.

b) Playing environments

Table 7-27 summarized favourable, appropriate, and inappropriate features of playing environments according to perspectives of children and professionals.

Table 7-27. Considerable features of playground alternatives from perspectives of children and professors

Children's liking responses to playground alternatives	Professors' responses	
	Appropriate	Inappropriate
 – An open and spacious environment; – Available sitting areas with trees.	– An open and spacious spatial setting for children's energetic activities; – Available shady trees.	– An appropriate spatial and functional setting for primary-school age children; – An over-constructed and over-artificial design; – Lack natural features.

 – An open and spacious environment; – Satisfying various children's needs and desires for playing activities and social interactions; – A beautiful and colourful playground.	– An open and spacious environment; – Various types of activities and social interactions for children; – An efficient physical setting with decoration information that could enhance children's creativity thinking and knowledge.	– Lack of greenery and shaded trees, especially in HCMC's weather condition; – A formal, over-designed, and over-constructed setting with high ratios of hard surface and artificial objects; – Lacks children's freely thinking, imagination and creativity in playing.
 – Availabilities of high energetic activities for male pupils only, especially playing football and running, without risks due to grass-covered ground; – A highly appreciated greenery of shade trees and grass ground for children's thermal comfort satisfactions.	– A spacious environment for various types of children's activities without risk potentials due to the grass-covered ground; – A freedom and flexible spatial setting in which children's activities are not limited or constructed by adults' perceptions; – A highly appreciated greenery with shade trees and grass-covered ground for children's physical comfort and pleasant feelings; – An appropriate environment for child-nature connections.	– An old-fashioned style design of playground that stand behind the trendy educational strategies; – An over-designed and over-constrained that could not satisfy children's needs and desires for various types of play.
 – Flowers as the most impressive natural elements; – An open and cool outdoor environment that evokes children's pleasant thermal comfort.	– Offering hands-on experiences with nature for children; then, they could take care and get knowledge about nature.	– An inappropriate spatial and functional setting because this small space only satisfies some particular activities regarding studying about plants.
 Completely disregarded by pupils.	– A proper spatial and functional setting that could both arouses children's energetic motions and creative thinking in playing; – Where teachers could easily observe children's activities; – Offering hands-on experiences with various types of natural elements.	– An over-designed and over-constructed spatial and natural setting that shows the dominance of adults' perspectives; – Lack considerations of children's group activities; – High risk potentials.

 – Where pupils have direct experiences with and explore various types of natural elements and stimuli; – Various natural-based activities; – Satisfactions of physical comforts and pleasant feelings.	– The most profound and rich hands-on experiences of the true nature; – Where children could play, explore, and develop skills, knowledge, and creativity.	– An inappropriate environment for daily play at the primary school; – Unsafety and unhealthy for children because it's too wilderness and involve many risk potentials.

In particular description, these features are:

From pupils: the results indicated that pupils (relatively equally distributed to girls and boys) had the strongest connections with nature at the wilderness area O_6 where nature could satisfy various ranges of activities and emotional feelings. A profound natural manifestation was illustrated through how children read and described natural elements and stimuli linking to their actions and feelings. Meanwhile, although being second most favoured by children, the degree of natural connection within the playground O_2 was the least mentioned. Pupils who favoured it mainly focused on the physical features while nature was completely dis-concerned. With much greater child-nature connections than O_2, natural comforts and pleasant emotional feelings were detected by pupils within the sport grassed playground O_3 and vegetation garden O_4. Here, the results illustrated differences between genders; particularly, boys preferred O_3 playground for kinetic activities while girls liked O_4 garden for aesthetical appreciations and pleasant feelings from various plants and available sitting areas.

From pupils' non-natural concerns, affordances of a playground are the most significant factor. Varieties of playing activities and interactions are needed. Thus, a spacious schoolyard with rich playing materials is required as followed to satisfy pupils' needs. Through their perspectives, we can infer that the conventional playground setting of the public school TQT fails to meet the essential demands of participants. Furthermore, except for the Waldorf schoolyard with three different outdoor areas, the degrees of pupils' sensorial natural experiences within the TQT and TDP schoolyards are unsatisfactory.

From architects: their perspectives regarding the wilderness area as an approach of playing environment give a similar result of studying environment for children. Architects had opposing views toward the child-nature connection and children's safety aspects. Architects who disapproved of a wild nature indicated the requirements of safety and various children's activities as principal factors whereas offering hands-on experiences of nature for pupils was a secondary attentiveness. Following, to reduce risky potentials of '*wild*' nature, some architects suggested '*dominated*' natural environments as the potential approach for practical implications. Meanwhile, there was a small ratio of architects who recommended wild nature for children's daily playing environment as well as indicated the need to enhance pupils' connections with nature in school contexts.

From educators: in correspondence with architects, three teachers also took the affordance of a place for children's various kinds of playing activities and safety as the priorities over all other matters.

7.4.2 Findings of children's and professionals' affinities to nature

One of the most important findings of this chapter is both children and adults showed their affinities with studying and playing in the wilder areas from the standpoints of main users through the question of favourable spaces. However, on the question regarding the roles of decision-makers for children as the main users, the wilder areas have become less suitable and suggested by architects. These findings, on the one hand, corroborate the biophilia theory (Wilson, 1984b) when innate tendencies forwarding nature and natural environments still exist in children and adults' childhoods. On the other hand, the obtained results also suggest a shift from more '*wild*' nature to more '*domesticated*' nature and '*built*' environmental approaches between their childhoods' desires and their professional authorities, which be assembled from an individual experience in the context of shared responsibilities (Robinson, 2009), in making decisions for children. Adults' affinities to nature and natural environments have been decreased with professional roles and responsibilities. Many previous studies explored the positive associations between the scope of natural experiences during childhood and adults' natural connections (Cleary et al., 2020; Fretwell & Greig, 2019; Pensini et al., 2016). However, although the factor regarding childhoods' natural experiences of architects and educators was not investigated here as previous studies – and it could be an important question for future research, instead – the hypothetical question '*… if you were a child?*' was raised to explore how differently or similarly they make decisions in the roles as users and as designers/managers of a space. These findings may help us to understand the differences in human-nature connections between *without professional responsibilities* and *with professional* *responsibilities* – make decisions for practical tasks and actions - forwarding approaches for younger generations having experiences with nature for sustainability.

7.4.3 Findings of the child-nature-connection according to perspectives of children and professionals

Important findings were detected through: -how children read and describe information linking to their activities and feelings toward given classroom and playground settings, and -how architects and educators evaluated and suggested considerable features for practical applications in the future.

Firstly, the obtained results highlight the urban pupils' strong desires for more '*wild*' and more intense connections with nature in their desirable learning and playing environments than the suggested threshold of natural experiences by architects and educators. This finding is contrary to that of Meidenbauer et al. (2019) who found that urban children from various geographic locations have greater preferences for urban than natural environments and than adults. A possible explanation for this is that the image sets used in the experiment and the request given to children were too general and not linked to particular concerns. They rated the most favoured images mainly according to the first aesthetical attractions rather than read and linked information of an environment with how and what they expect to have and to do within this place. In this study, it is found that the ways children read information of given environments could illustrate the differences between natural and man-made features. Like Sebba (1991), there are similarities in this study when more built environments were supposed to provide man-made functional and physical satisfaction while natural environments were appreciated by experiences of natural elements and stimuli through senses for pupils' desires and comforts. This study found that children favour natural environments not only due to the potentials of desired activities like previous studies (Aminpour, 2021; Laaksoharju et al., 2012; Simmons, 1994) regarding the theory of affordance of Gibson (2014) but also for pleasant feelings and thermal comforts for studying and playing activities in case of the hot weather condition like HCMC. If wilderness areas are where they could study and play:

> *"It's a kind of outdoor classroom. It's very open, cool, and comfortable to study here. The natural environment and with birds singing sound will help us study better."*
> *[TDP.4.13]*

or

> *"… because it gains my strength to climb trees, to cross the stream. I also become a better person for helping my friends' climbing trees. I also gain knowledge to cut down the trees to cross the stream." [TDP.3.12]*

Children expressed their desire to explore nature. Thus, to remain and nurture their biophilia towards nature, we need to innovate approaches for primary school contexts. The results of children's responses also indicated that they highly seek challenging and risky play that was priorly figured out (Little & Eager, 2010). And it is argued that children would gain skills and push their capacities in familiarities with surrounding environments rather than be hampered by lack of experiences (Brussoni et al., 2015; Sandseter & Kennair, 2011). Whereas architects and educators suggested a less extensive degree of child-nature connections than pupils due to safety concerns and risk potentials for children's health outcomes in wilder nature. Less diverse natural environments could reduce many possible harms to children. These results are consistent with previous studies which also considered these considerations as major barriers to providing children opportunities to spend more time outdoors (Ross et al., 2007; Wyver et al., 2010). The perception and management of children's safety within school environments are strictly influenced and increasingly required by societal norms, parental standpoints, educators, and government responsibilities through policies and standards in school settings. It would seem that in the drive for children's safety, schools' convenient constructions and maintenance, as well as teachers' easier management and observations, wilderness approaches seem absolutely impossible to be approved. Thus, in order to avoid a wild nature with many risk potentials, a more '*domesticated*' natural environment is argued as a healthier approach for children. Moreover, the results also indicated that architects tended to prefer structured user-activity spaces with fulfilled facilities where children have less freedom in playing by themselves, few opportunities to develop creative thinking and try new things or skills. As Peter Heseltine has evaluated playgrounds for an urban area in the UK:

> *"… – the playgrounds were excellent on safety, construction and maintenance. They met all the relevant standards – and were almost totally useless in terms of play and child development."*(Heseltine, 1995, pp. 91–95)

The influences of the risk and structured society declined the opportunities for children's studying and playing in a wilder natural environment in school contexts were addressed. Therefore, in order to push children closer to nature, perhaps, the most important of all, is to allow them access to nature from changes of adults' perspectives. To do this, a demanded accompanying shift through innovative approaches should be investigated for keeping children "*as safe as necessary*" instead of "*as safe as possible*" (Brussoni et al., 2012).

Furthermore, when considering statements of architects and educators on classroom and playground options, it is found that inappropriate features they stated could be resolved by existing characteristics of wild natural environments. For example, the wilder playground O_6: - is not an over-constructed setting (regarding the O_1 and O_5); - could develop children's imagination and creative thinking in playing (for the O_2); - could offer diverse play forms and activities with fulfilled studying and playing facilities from nature instead of artificial materials (for the O_2, O_3, O_4, and O_5); - is an open and spacious area (for O_4); - provides a richness degree of natural elements and stimuli they could interact with (for O_1 and O_2). Thus, it provides further support for promoting wilder school environments as well as a call for renewals of nature in minds of designers, architects, educators, and policy makers.

7.4.4 Findings of influences of educational contexts

Again, the obtained results between three schools showed the influences of children's educational contexts on their environmental preferences. In particular, pupils of the Waldorf school who adopted a nature-based educational curriculum showed their stronger desires for the '*wilder*' natural classroom and playground. Similarly, pupils of TDP school who are encouraged to develop physical and social skills through energetic and adventurous activities showed the highest characteristics of challenge seeking and exploration within a wilder environment. In contrast, pupils of the public school TQT tended to favour the more '*built*' classroom and less natural settings. These results, once again, supported the influences of low risk and structured society and educational approaches for children. If pupils are encouraged and equipped with skills through educational philosophy and curriculums that frequently and repeatedly offer pupils hands-on experiences with nature both in physical, cognitive, and spiritual developments, their affinities to nature and natural environments would be enriched as well as the wilderness areas would become safer as positive consequences. This finding is consistent with those of other studies confirming the contributions of forest schools for fostering children's engagement with nature (Harris, 2021; Smith et al., 2018). It can thus be suggested that in order to push children to interact closely with nature, the educational approach for enhancing the more frequent and repeated direct experiences should be increasingly adopted. Therefore, the philosophy and principles in primary school architecture must follow and satisfy this request. And vice versa, along with a school designated with a rich natural environment and easily accessible setting to those within the pupils' sensorial experience distances, the higher opportunities for adapting more natural-based curriculums would be a far-reaching accomplishment as Sharon Danks believes:

"An educational shift toward hands-on lessons, project-based learning, and teaching to "multiple intelligences" has made the school ground an appealing location for academic studies. Interdisciplinary outdoor lessons lend themselves to blending topics that had previously been taught separately."(Danks, 2010, p. 3)

7.5. A summary of chapter

This chapter has explored the features of studying and playing environments in prospects of child-nature connection between pupils and professionals. The results led to the general conclusion that the perceptions of nature and natural environments are much more '*wild*' and more desired to be hands-on experienced by pupils at schools than views of architects and educators. Pupils prefer and appreciate nature which would provide them with a variety of activities and interactions, positive feelings, and physical comforts. Pupils also prefer the challenge and adventurous activities from nature, they could learn skills through experiences that would positively enrich their affinities toward natural environments. It is important to consider and satisfy the pupils' views, needs, and preferences about school environments. If we want to create the school environments that are best for children and child-nature connection, we should involve children in school design; however, the barrier to children's participation is the attitudes of adults. These findings are important evidence for designers, architects, educators, and policy makers to make decisions to (re-)create better-suited spaces with more wild nature in school contexts for children who are the main users. Furthermore, the findings also have indicated that it becomes essentials to develop children-centred design guidelines and proposals for school projects in the future.

Following, the next chapter will provide a synthesis drawing together the key themes from findings of previous chapters and a broad view of approaches in primary school architecture for (re)connecting pupils and nature within their learning and playing spaces.

Chapter 8 Towards Design Approaches for Primary School Architecture

for Fostering Children-Nature Connection

"I can think of no more important way to apply the naturalistic approach to human behavior than in the design of the places in which we live and work. The evidence is overwhelming that, given a choice, people wish to bring the beauty and harmony of nature within sight. When possible, they like to blend these qualities into the details of their daily existence, because in so doing, they add to their own sense of worth and security. If architecture and design are ever to become science as well as art, it will be through scholarship of the kind exemplified by the contributions to Biophilic Design."

— **Edward O. Wilson** (2011)

8.1. Introduction

This chapter brings together all key findings of previous sections to understand how architectural features and school environments within various urban-, socio-, cultural-, and pedagogical- contexts construct the extent of children's direct experiences of nature. Chapter 5 firstly examined the relationships between the level of child-nature direct connection via sensorial modalities – the '*external*' nature the child exposure to and school spaces within the context of urban and architectural decision-making across the case study schools. The results revealed the features of urban configuration significantly influence the Child-Nature-Distance ranges 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. Subsequently, chapter 6 investigated the child's '*internal*' nature through their extensiveness of natural explorations, affinities for nature and natural environments, and interaction behaviours diverging from spatial and natural settings. The results of this chapter also pointed out significant influences of nearby urban configurations, landscape and architectural design of playgrounds and classrooms, on the quantitative and qualitative degrees of natural elements and types perceived and through visual and non-visual sensory modalities within educational environments. Their affinities for nature and interaction behaviours diverge from spatial and natural characteristics in different climatic, socio, and pedagogical contexts. The combination of findings from chapters 5 and 6 provided support for remaining and nurturing children's affinity for nature in school contexts as well as potential strategies to bring nature closer to children and encourage them to explore nature. Next, in order to suggest implications and design proposals for children's multi-sensorial natural experiences, similarities and differences in prospects of child-nature connections within school environments were compared between pupils, architects, and educators and presented in chapter 7. The results led to the significant finding that children desire to have much more '*wild*' and multi-sensorial natural experiences than their current school environments, and than perspectives and considerations of architects and educators. Following these findings, this chapter attempts to propose the potential design approaches, in the context of the urban and architectural design of primary school architecture, for enriching primary-school children's direct experiences of nature within their studying and playing spaces. Then, motivated by the desire to consider the possible contributions of primary schools in the future, a reflection on the research investigated questions: *How to bring nature closer to children?* and *How to encourage children to explore nature?* are also presented and discussed in a broader view for children's sustainable development.

8.2. Children's visual and non-visual connections with nature: Key findings

Initially, it is necessary to have an overall picture of the relationship between children and nature according to natural features of learning and playing environments. The synthesis of obtained results showed that the connectedness ranges vary according to the naturalness degrees of space as well as features of natural attributes from children's sensorial experiences. These findings have important suggestions for developing subsequent design approaches.

8.2.1 Child – Nature – Connection across the Built-Nature Spectrum

Drawing on measurements and evaluations of investigated classrooms and playgrounds, the schemas of children's experiences of nature relies on a spectrum of built and natural environments that reflect the naturalness values of vision and non-visions children expose themselves to (Figure 8-1). The highest value of '*built*' is when the child stays within a fully indoor place where its spatial enclosure (vertical and horizontal interfaces) is completely disconnected from nature and without indoor natural settings; the highest value of nature is when the child exposes his/her body and senses within an untouched wilderness area. The in-between space-type ranges according to the permeable features of built envelopes, while the distance ranges between the child, nature, and properties of the natural environment within and surrounding that space.

The first subject of the schema is an increased tendency of natural elements and stimuli children could explore through visual and non-visual sensorial modals according to the more permeable connectivity of spatial enclosure, the closer distances, and the more wilderness and richness of natural environments.

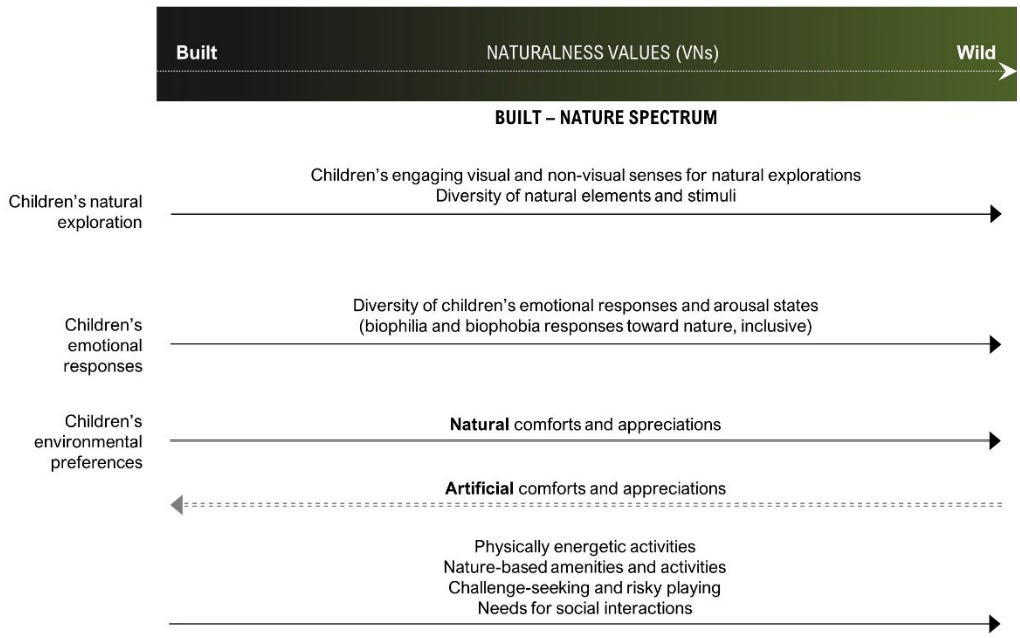


Figure 8-1. Schemas of the Child–Nature–Connection across the Built-Nature Spectrum

Following the more powerful sensorial evoking, children could gain more diversified and intense emotions toward explored nature, both pleasant and unpleasant feelings ranging from low to high arousal levels, inclusively.

According to the differences in children's spatial perceptions between built and natural environments, there are two opposing trends in choosing their favourite places for studying and playing activities. More built environments were supposed to offer man-made functional and physical satisfactions whereas natural comforts and appreciations increasingly come from more profound natural elements and stimuli children could experience directly. Similarly, higher physical and energetic undertakings, reinforcements of creativity and imaginative thinking, levels of challenging and risky seeking, and various social interaction types of studying and playing activities occur in wilderness spaces in compared to developed spaces; the former addressed that nature is playing facilities while the artificial settings are related to the latter.

8.2.2 How natural attributes are experienced and considered by children

Following the schemas of Child-Nature connection according to the overall Built-Nature spectrum, in correspondence with ascertained features of natural attributes in senses of connections with children, Figure 8-2 presented a summary of related spatial figures influencing children's experiences with nature within classroom and playground environments.

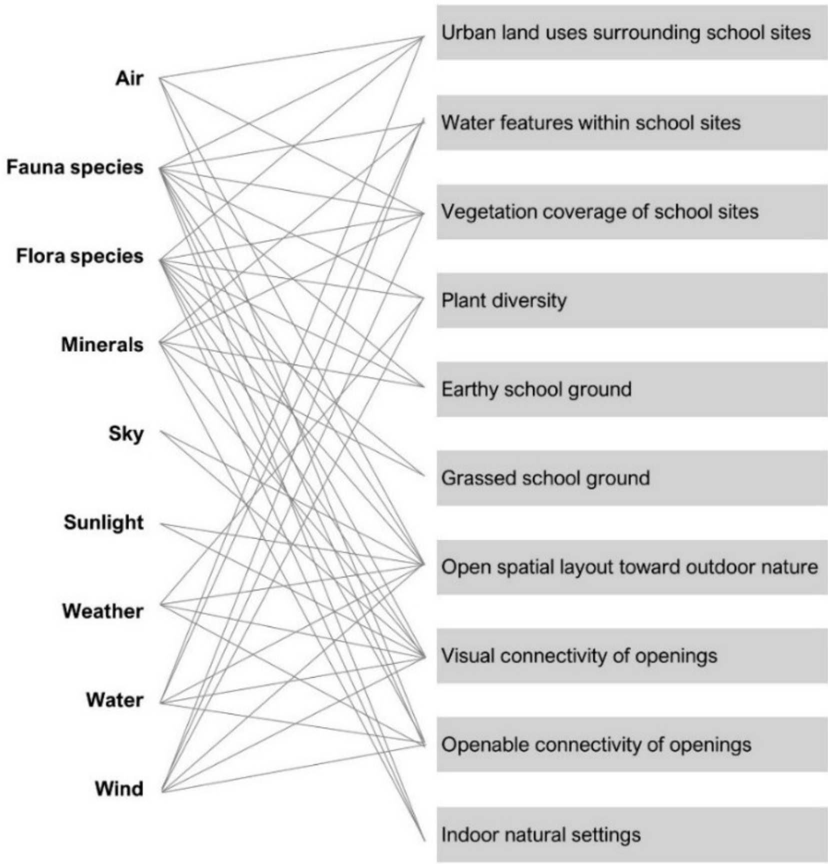


Figure 8-2. Summary of relevant spatial features influencing on children's multi-sensorial experiences with natural attributes

These particular characteristics of natural attributes through children's experiences and perspectives have been identified as the following.

	How children experience
Air	Children could frequently point out the existence of the surrounding air through all senses except hearing, especially at school sites with green and water areas around the boundaries and richness of plantations within. Besides appreciating the contribution of fresh air as an essential factor for human beings through education, fresh and cool air was also highly valued and desired for children's thermal comfort satisfaction in the particular condition of HCMC.

Fauna species

They are the second most explored natural features within school environments through multiple senses, especially connections from distances (e.g. looking and hearing). The diversity of vegetation, earthy ground, and indoor settings for studying activities are principal factors that could enhance the appearances of animal species, especially birds (for senses of looking and hearing) and insects (for senses of looking, touching, and smelling) within school environments.

The generous connections with animals and insects activate greater emotional feelings including biophilic and biophobia responses, varying from high to low arousal levels. The more familiarities and greater frequencies of experiences of insects and disgusting animals could be considered as the constructive manners to nurture the child's biophilia feelings toward nature.

Flora species

Elements and stimuli of the flora group are the most significant experienced natural features at school sites. Among these, looking and touching are the most intense senses of experiences.

Of these elements and stimuli, most children highly favoured trees, leafy plants, flowers, and grass-based grounds for particular reasons. Flowers are the most appealing feature that could attract children's attention and earnest engagements in multiple senses of connections. Children in HCMC appreciated and desired trees and leafy-plants more because of the thermal comfort satisfaction due to hot weather conditions, while Glasgow pupils promoted the aesthetical pleasantness of trees and coloured leaves according to seasonal changes. Appearances of these features play an important role in enhancing children's direct interactions with nature in both cases of Glasgow and HCMC. Meanwhile, grounds with grass-covering are highly suitable for pupils' energetic activities.

Minerals

Children could experience mineral elements through vision and closed-distance senses, such as touch, taste, and smell. They mainly were found at earthy ground areas, flowerbed areas and potted plants, outdoor and indoor inclusively. When directly contacting nature through non-visual sensorial modals, children had pleasant feelings with visual experiences while responding unpleasantly toward soil, rocks, and stone.

Sky Children explored the sky through vision only and mostly had positive feelings. The visual connections with the sky could have occurred when children directly exposed themselves to the outdoor environment and in classrooms where there were views to outdoor through openings.

Sunlight Children could have senses of looking with sunlight. Their feelings toward sunlight differ depending on the light intensity levels and the climate conditions. For example, the sun glares caused uncomfortable feelings according to HCMC pupils, and they also avoid sunny areas, whereas Glaswegians appreciated the warmth of the sunlight within outdoor environments.

Within classrooms, natural lighting is an important factor in design according to the viewpoints of children, architects, and educators of HCMC. The features of openings (including position, size, height, and style) determine the quality of natural lighting.

Weather Children could figure out conditions and changes of weather through looking (from classrooms) and smelling (when moving to outdoor spaces). This element has an intense influence on how children interact within the playground and with other natural elements. If the weather condition is unfavourable, for example, too sunny in hot climate regions like HCMC, children tended to occupy shaded areas and avoid exploring natural objects in sunny areas.

Water Only pupils of schools where water landscapes were surrounded or as a part of school sites could have experiences with water elements and stimuli. With various elements of water bodies and states of water under the impacts of weather conditions, children could see, hear, touch, taste, and smell them. Among them, looking from a distance and hearing sounds of water were the majority of manners of experiences due to a distance limitation and restricted access.

Accordingly, how children felt about perceived water elements and stimuli range from high to low arousal levels, including pleasant and unpleasant emotions. However, these water-related experiences significantly evoked positive emotional feelings with low arousal levels, such as comfortable, relaxation, and tranquillity.

Besides, by investigations of pupils in HCMC who did not have opportunities to explore water elements and stimuli at their schools, they showed their desires for water features as parts of school environments for studying and playing activities. Meanwhile, architects did not recommend water features and multi-sensory water experiences in school contexts due to safety concerns.

Wind The wind is an invisible element that could be figured out through sounds and other ones. Among them, the impacts of plants and water features were the major contributors to experiences of wind through vision and hearing, such as scenes and sounds of leaves and water movements. The emotional responses regarding wind could cover from low to high arousal levels of pleasant and unpleasant feelings. Besides various types of stimuli that could provoke different emotions, children from cold and hot climate regions would have opposing reactions due to thermal comforts.

In classrooms, the connectivity of spatial enclosure and the position within school buildings are principal factors to provide a connection with wind for natural ventilation as well as sounds and images of wind's stimuli. According to the viewpoints of children, architects, and educators, natural ventilation is one of the most important requests in an indoor studying environment in the condition of HCMC.

8.2.3 How spatial features affect children's experiences of nature

Under the umbrella of proposed main aims of this study: – to investigate and understand how architectural features and school environments within various urban-, socio-, cultural-, and pedagogical- contexts construct the extent of children's direct experiences of nature, and – to inform design approaches and future decision-making in educational architecture, the study achieved these aims (as shown in Figure 8-3).

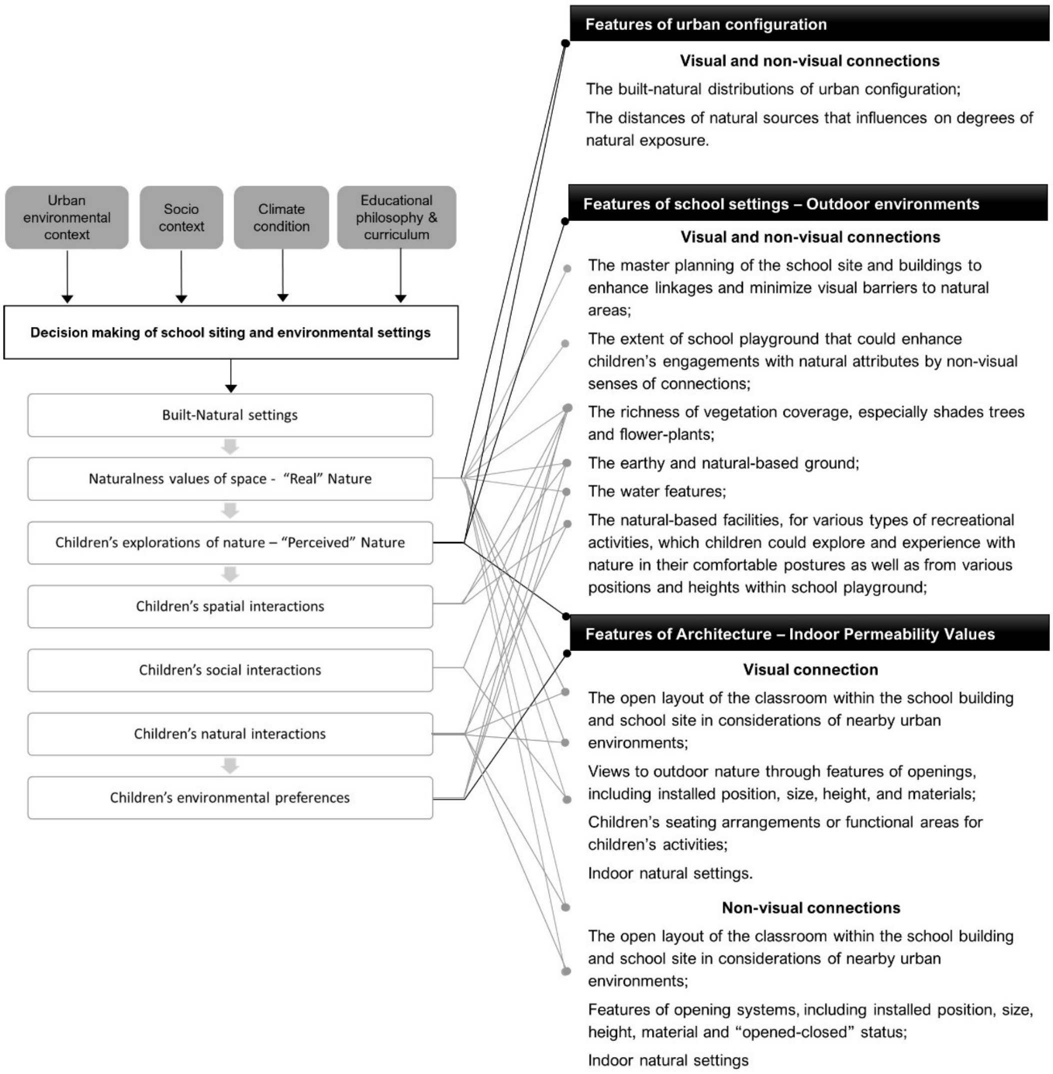


Figure 8-3. Findings of primary school architecture for children's visual and non-visual experiences with nature

Generally, the manners in which the holistic school environments can shape children's senses of connections with nature are influenced by built-natural settings that were designated under the impacts of urban environmental context, climate conditions, and educational philosophy (as presented and discussed in chapter 4). Following this, presented identified influential features of urban configuration, school settings, and architectural features. Through these findings, corresponding proposals would be developed for designing and improving primary school architectural environments.

8.3. Implications of primary school architecture for children's direct experiences of nature

Following the above-presented obtained spatial features affecting the threshold of natural connection of children, this section discusses recommendations for primary school buildings and environments to respond to the main research question:

What are appropriate design strategies for primary school architecture to enrich children's direct experiences of nature?

Specific aspects included urban configuration surrounding school sites and the schools' external and internal environments. Accordingly, these suggested approaches built upon findings set side by side with Biophilic design principles and patterns to figure out the additions of this study to the biophilic design knowledge. The literature review introduced and discussed Biophilic design as a potential direction in educational settings to upgrade the environmental qualities for pupils' activities and enrich the child-nature connection. Among three fundamental manners that people experience nature, patterns of "*Nature in the Space*" of biophilic design and benefits to human's well-being (see Table 8-1) that take into account direct physical experiences with nature are associated with this study's particular focus.

Table 8-1. "*Nature in the Space*" patterns of Biophilic design - adapted from B Design (n.d.)

No.	"Nature in the Space" patterns	Attributes (B Design, n.d.)	Benefits (Ghaziani et al., 2021; Park & Lee, 2019)		
			Stress reduction	**Cognitive skills**	**Emotions and preferences**
(1)	Visual connection with Nature	Views to natural elements and stimuli	Decrease: *Blood pressure* *Heart rate*	Increase: *Work engagement* *Concentration*	Positively effect: *Attitude* *Spatial preference*
(2)	Non-visual connection with Nature	Auditory, olfactory, tactile, and taste experiences with natural elements and stimuli that cause intended and positive reference toward nature	Decrease: *Systolic blood pressure* *Stress hormones*	Positively effect: *Cognitive performances*	Positive effect: *Mental health* *Tranquillity*
(3)	Non-Rhythmic Sensory Stimuli	Experiencing with nature randomly and temporarily that may be analysed but not predicted precisely	Positively effect: *Heart rate* *Systolic blood pressure* *Sympathetic nervous system activity*	Increase: *Attention* *Exploration*	-
(4)	Thermal/Airflow Variability	Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments	Positively effect: *Comfort* *Well-being* *Productivity*	Positively effect: *Concentration*	Enhance: *Temporal and spatial pleasant feelings*

(5)	Presence of Water	Experiences of a place through senses of looking, hearing, or touching water and water's stimuli	Decrease: *Stress* *Heart rate* *Blood pressures* *Increase: tranquillity feelings*	Enhance: *Concentration* *Memory restoration*	Positively effect: *Emotional responses* *Natural preferences*
(6)	Dynamic and Diffused Light	Provide varying intensities of light and shadow changing according to time to create conditions of nature	Increase: *Comfort* *Happiness* *Productivity*	Increase: *Concentration*	Positive effect: *Spatial preference and perception*
(7)	Connection with natural systems	Consciousness of changes of natural process and characteristics of natural elements according to seasonal and temporal changes	Reduce *stress*	-	Positive effect: *Perception about nature* *Health responses*

As a result, the suggested design strategies with associated purposes and biophilic design patterns are as follows:

8.3.1 Urban configuration - Built-Natural distributions and Child-Nature-Distance ranges

	Decision making process to select appropriate locations for future schools and/or urban regeneration should take these priorities:	*Benefits*	*Associated "Nature in the Space" patterns*
1.1	the prosperous natural environments (green and blue areas) of potential urban areas exist nearby and within schools	• to offer the richness of natural elements and stimuli surrounding school environment,	(1)(2)(3) (4)(5)(7)
1.2	the closet distances of nature, the strongest connections with nature children could exposure and experience more frequently	• to enhance the frequencies of visiting and having visual and non-visual natural connections,	(2)(7)
1.3	the outmost distances between school sites and sources of air and noise pollutions (for example, transportation, industrial, infrastructure land uses, and urban sprawls)	• to connect with natural process, especially seasonal and temporal changes of the local ecosystem, and • to improve the air quality and reduce negative impacts to noise pollution of school environments (Watchman et al., 2020).	(4)
1.4	available (walking) pathways/trails that pupils could directly access to (local) natural environments surrounding from their schools		(2)(7)

Assessment tool: Apply the methodology developed to measure visual and non-visual sensorial experiences of nature (in Chapter 5) to evaluate the naturalness values of the school environments and to make decision in selecting school sites.

According to suggested priorities in planning new schools, the initial strategy (1.1) satisfies almost entirely Biophilic patterns that will provide more prospects for children multiple-sensorial and frequent natural experiences because a nearby green space surrounding the school site covers the following priorities (1.2, 1.3, and 1.4). Thus, this vision of the future school estates should be taken into the strategic and local development plans.

In particular contexts of Glasgow and HCMC, the disparities in urban green spaces between two cities have been discussed and the results of naturalness values have proven the negative influences of the greater urban density of HCMC, especially in the city centre and highly developing areas. Consequently, regarding suggested approaches in the macro context of planning schools, authorities of HCMC would face more challenges than those of Glasgow city due to urban restraints and the growth rates of primary schools and students. These factors thoroughly restrict the proportion of appropriate sites for future schools in HCMC. And in order to deal with school sites within the compactness and density of urban areas that make them fewer naturalness values, the design-making process and design approaches in micro scales, that regard external and internal spaces of a school, must be put in more prominence and comprehensive applications.

8.3.2 School's outdoor environments – spatial layout, natural diversity, and nature-based affordances

Decision-making process and design of school architecture should consider and offer:		*Benefits*	*Associated "Nature in the Space" patterns*
2.1	the master plan of the school site and buildings which precludes visual barriers or accessible preventions to natural environments for children's daily activities within the spaces	• to increase naturalness values of visions and non-visual senses, and • to increase the frequency of visiting natural environments for pupils.	(1)(2)(3) (4)(5)(6) (7)

2.2	the size and dimensions should be greater than a clear visual distance by 7.5 meters	• to enhance children's movements and engagements with natural attributes by non-visual connections with nature rather than exploring nature from distances only, and • to ensure diverse activities for various pupil groups (e.g. age, gender, and personal favour).	(2)
2.3	the large scale of abundant natural environments within school sites. In particular,	• to broaden and deepen children's daily hands-on natural experiences through intertwined auditory, olfactory, tactile, taste, and visual senses, and • to evoke various emotional states and arousal levels, pleasant and unpleasant feelings inclusive.	(1)(2)(3) (4)(5)(6) (7)
	(a) the earthy surfaced or natural-based ground	• to enhance the diversity of natural elements, • to nurture children's biophilic feelings toward unfamiliar natural species, • to offer adequate spaces and diverse activities for different pupil groups (e.g. age, gender, and personal favour), and • to increase children's safety for their kinetic activities.	(1)(2)(3) (4)(7)
	(b) the greening school playground with a richness of flora species, especially - shaded trees, - flower-plants, and - edible plants and fruiting trees	• to enhance the appearances of other natural elements and stimuli of healthy ecosystem, especially under impacts of seasonal and temporal changes, • to increase children's pleasant feelings, • to attract children's interests and direct engagement with natural elements, • to become an ecological classroom where pupils could learn about nature and gardening skills, and could have opportunities to taste edible plants and fruits within school contexts, and	(1)(2)(3) (4)(6)(7)

	• to provide children's thermal comfort in hot climate region due to shading (Attia & Duchhart, 2011; Gaitani et al., 2007).	
(c) presences of water features, for example, water surfaces, fountains, ponds, or streams (Ito et al., 2010)	• to have visual and non-visual senses of experience with water, water stimuli, and appearances of other natural elements, such as water plants, animal species (e.g. birds, insects and fish), and minerals of inland, • to increase children's pleasant feelings of tranquillity and calmness, • to offer various activities for children (Ito et al., 2010) to satisfy their environmental desires, • to become an outdoor studying area where they could learn about nature and advanced skills, and • to improve the microclimate of environment due to humidity, air quality and thermal comfort inclusive, in hot climate regions (Attia & Duchhart, 2011; Gaitani et al., 2007).	(1)(2)(3) (4)(5)(7)
(d) adventurous challenges from natural elements	• to evoke engagement with nature of pupils, • to offer various types of activities for different groups of pupils, and • to encourage and raise children's adventure skills or experiential activities.	(1)(2)

Assessment tool:

Apply the methodology developed to measure visual and non-visual sensorial experiences of nature (in Chapter 5) to explore the 'real' natural values children exposure to within outdoor spaces, especially the natural values of looking.

Among the suggested considerations above, the first and foremost concern in setting outdoor spaces is establishing accessible manners that will contribute to multi-sensorial natural experiences and associate with comprehensive patterns of biophilic design. Along with unrestricted linkages between natural resources and children's bodies and senses, the emphasis should be on nature-based settings in which natural diversity must be yielded. These strategies will matter powerfully for school sites where there are adverse conditions and degraded urban green spaces of the urbanisation process, similar to the existential circumstance of HCMC in this study.

8.3.3 School's indoor environments – spatial layout, permeability values of enclosures, and interior settings

	Decision-making process and climatic-based design of schools' indoor environments should consider:	*Benefits*	*Associated "Nature in the Space" patterns*
3.1	the 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).	(1)(2)(3) (4)(7)
3.2	the degrees of spatial enclosures (related to permeability values): (a) Direct exposure to outdoor environment (b) Open spaces or semi-open and semi-closed spatial layout (c) Transitional spaces for buildings in hot and cold climate regions (Watchman et al., 2020)	• to increase the connections with higher naturalness environments (that means windows are possibly opened more frequently), and • to provide thermal comfort satisfactions while avoiding adverse weather conditions.	(1)(2)(3) (4)(6)(7)
3.3	the installation and renovation of opening systems (position, size, height, and materials) for: (a) Natural lighting (b) Natural ventilation (c) Views to nature	• to enhance the permeability values and view areas toward natural environments, • to ensure indoor air quality, physical and thermal comforts for children as well as • to avoid adverse weather conditions.	(1)(2)(3) (4)(5)(6) (7)
3.4	the interior setting up of children's study desks and furniture	• to ensure every child could have views of nature, and • to shape children's behaviours with nature and others; in particular, the social interactions and activities influence	(1)(3) (6)(7)

		children's indoor interactions with nature.	
3.5	applications of indoor natural settings, for example: (a) indoor plants, flowers and green walls (b) pets, birds, and/or insects (c) aquariums or indoor pool (Ghaziani et al., 2021)	• to enhance children's hands-on experiences with nature as well as • to nurture children's biophilic feelings toward unfamiliar natural species.	(1)(2)
3.6	a functional 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	• to ensure the indoor environmental quality and demands of direct experiences with outdoor nature for children's daily activities (except specific and extra-curriculum activities).	(1)(2)(3) (4)(6)(7)
Assessment tool: Apply the methodology developed to measure visual and non-visual sensorial experiences of nature (in Chapter 5) to explore the "real" natural values children exposure to within indoor spaces.			

With regard to internal spaces, the architectural attributes stand as the principal role in the thresholds of children's direct natural experiences. Adopting the climatic-based design approaches mentioned above will not only generate children's pleasant spatial experiences but also allow patterns of biophilic architecture to be comprehensively enhanced. Therefore, these design strategies for primary school architecture should be encouraged in both Glasgow and HCMC conditions.

In summary, this study provides an overall understanding of the child-nature connections through multi-senses of experiences with the key findings and adds important knowledge – a comprehensive approach to primary school architecture for children's direct experiences of nature – to the biophilic design knowledge and practical applications. The literature review argued that the limitation of biophilic design is the lack of clear descriptions of design principles and patterns as well as how these categories were determined in relation to the particular population groups. Recently, more and more researchers have drawn attention to biophilic design in the field of educational architecture. For example, Ghaziani et al. (2021) conducted case studies of primary schools in many countries to explore the evidence of 10 patterns of "*Nature in the Space*" and "*Natural Analogues*" through a listing of existing associated characteristics of school settings. Similarly, Watchman et al. (2020, 2021) also provided biophilic design strategies and schemas in relation to school architecture in cold climate conditions through listing and summary of associated characteristics. The key difference between these publications and this study is derived from engaged research methods and the depth scope of examinations. Here, architectural features are provided through evidence with particular benefits for enriching extinctions of experiences and associated natural elements and stimuli children are exposed to, experience with, and desire for in various educational contexts. The results explored how particularly each natural elements and stimuli deliver impacts and benefits children and their activities in school environments. Thus, this study contributes to the current gap in biophilic design knowledge that was argued by Richardson & Butler (2021). In another important aspect, the multi-dimensional integration of promoted efficient measurement tool and selective methods of this study, including an open-questionnaire survey, observations of children's behavioural interactions, and undertaking participatory studies with children, yield a comprehensive picture of the child-nature relationship rather than from separate single aspects, such as intellectual knowledge or emotional concepts of children or from brief evaluations of designers only. These approaches help to determine related factors and consequences of experiences associated with connectedness levels to provide practical implications for future sustainability science and primary school architecture, as suggested by many researchers (Ives et al., 2017, 2018; Klaniecki et al., 2018; Wijesooriya & Brambilla, 2021).

8.4. The holistic approach to the enrichment of Child-Nature Connection in primary school context

It imposes that there can be no easy, single, and direct manner to afford children's direct natural experiences in urban school contexts. In the previous section 8.3, the urban and architectural approaches of primary school designs were provided – as the principal research objective - to bridge the increasingly-broadened gap between urban children and nature within school environments - that was set out at the beginning of this study:

How to bring nature closer to children within school environments? and How to encourage children to explore nature?

Proposed architectural implications could offer a richness of natural experiences, accessible pathways to connect indoor and outdoor, and environmental settings that could positively fascinate children and directly promote engagement with nature through multi-senses rather than vision only. However, it could be only thoroughly successful if important and demanded accompanying shifts of decision-makers, including designers, architects, educators, and policymakers, are constructed and forwarded to child-centred approaches, as was discussed in Chapter 7.

Initially and generally, the importance of the child-nature connection as a fundamental part of childhood in selecting school sites and promoting wilder school environments needs thorough consideration. Besides the restrained nature due to the current rate of population growth and urbanity, the main reason for this requirement is the decrease in adults' affinities to nature and the extinction of natural experiences with professional roles and responsibilities, as well as the influences of increased risk and structured society.

The next consideration is regarding children's participation and inclusion in school design. Based on their expressions through the child-centred methods, they showed a strong desire for '*wilder*' and more intense connections with nature within learning and playing environments. They also actively seek more nature-based challenging activities in school environments instead of the architects' suggested threshold for natural experiences. Children would then gain skills and push their capacities in familiarities of natural environments, learning through physical and hands-on experiences with the natural environment through bodies and senses. This approach not only fosters children's affinity toward nature but also shapes the relationship between them and places (Björklid & Nordström, 2010; Rigolon, 2011).

The last consideration is children's participation and inclusion in nature-based activities and pedagogy of schools, such as greening schoolyards and classrooms, re-naturing and outdoor curricula. For example, in particular, Jansson et al. (2014, 2018) provided significant pieces of evidence that promoting the participation of children in school greening projects over time will increase positive relationships and attitudes towards the natural environment. The results of Waldorf pupils who adopted a nature-based educational curriculum with many outdoor activities in this study also have higher affinities to nature and natural environments. In addition, these activities of daily life at schools could also be equipped with advanced skills for other aspects of daily life as discussed in Chapter 7.

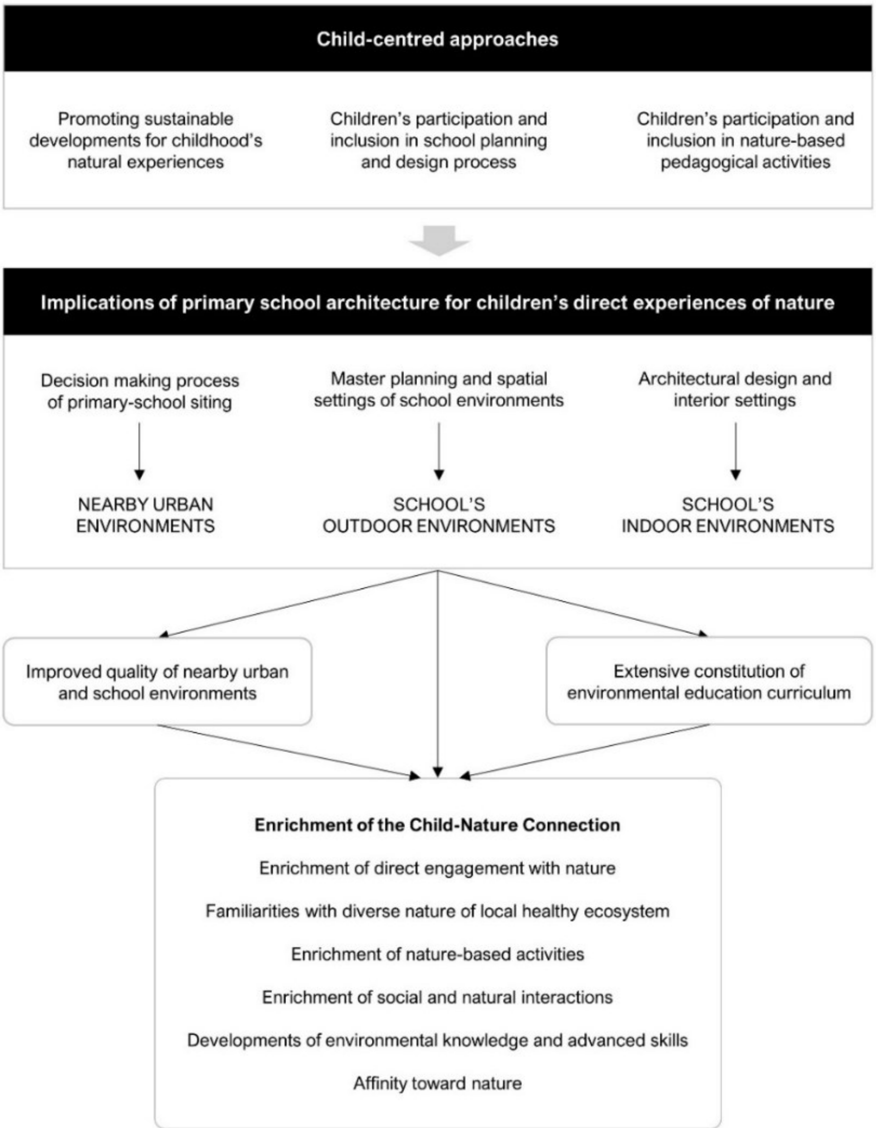


Figure 8-4. A holistic approaches and outcomes of the primary school architecture proceeding to the enrichment of Child-Nature Connection

In conclusion, the comprehensive approaches and outcomes of the primary school architecture for childhood's direct experiences with nature and developing affinity toward nature are summarized and illustrated in Figure 8-4. The need to develop child-centred proposals and guidelines in every step of the process, from planning and (re-) designing school environments as well as developing schools' pedagogical curricula, is suggested.

Chapter 9 Conclusions and Considerations

"When our designs are succinct statements of purpose, easy to understand, use, maintain and repair, long-lasting, recyclable and benign to the environment, we inform.

If we design with harmony and balance in mind, working for the good of the weaker members of our society, we reform.

Being willing to face the consequences of our design interventions, and accepting our social and moral responsibilities, we give form."

— Victor J. Papanek (1995, p. 53)

9.1. Introduction

This thesis aimed to support primary school design decision-makers to enhance children's sensorial experiences of nature. It explored and identified key issues that influence child-nature multi-sensorial connections within indoor and outdoor environments of various urban-, socio-, cultural-, educational-, and pedagogical- contexts. It also investigated the features of studying and playing environments in prospects of child-nature connection as important evidence to make the decision to (re-) create better-suited spaces with more natural enrichment to provide an enhanced, diverse, and equitable access to nature for all pupils in their daily activities at schools. To conclude the thesis, this final chapter responds to the research questions and objectives, reviews the contributions of the thesis, and considers possible directions for future research in this field.

9.2. Responding to the research questions

In Chapter 1 of this thesis, the research questions and objectives, including the management and sub-research questions, are set out to advance and enrich the existing knowledge in children's connectedness to nature within school environments. A summary of findings align with the research questions has been identified as the following.

RQ1 – How much Nature exists in the limited distances of a child's visual and non-visual experiences in both internal and external spaces with particular spatial attributes of the educational environments?

This question relates to the naturalness values of children's visual and non-visual natural experiences according to the conceptual framework of this research that is founded upon the model of Linzmayer et al.(2014). In previous chapters, it has been proposed that former tools for natural environment evaluation have focused less on the existent values of naturalness which directly impacts the human body via multiple sensory modalities within spaces, including indoor and outdoor. As stated, there is a need to expand further investigations by exploring the qualification of naturalness in a particular place to more holistic visual and non-visual sensorial experiences. Similarly, it is acknowledged that the varying value of nature in relation to distance features has not been sufficiently investigated. In particular, it attempts to support a proximity hypothesis – that closer connections bring greater benefits to children; and that the proximity of nature at distances where a child has direct and meaningful sensory exposure is a vital requirement for the primary-school children group selected.

In these respects, one of the major objectives of this research is to establish a methodology for measuring children's multi-sensorial experiences with nature. In chapter 5, the investigated methodology provides an in-depth understanding of the association between children's multiple layers of sensory modalities with particular attributes of the spatial environment, in turn, determining the level of naturalness that children experience. Through particular contexts of case studies in both Glasgow and HCMC, the outcomes indicated that all sensorial modalities are significantly associated with attributes of nearby natural environments, depending on the Child-Nature-Distance ranges, and governed by features of building envelopes, building layouts, and interior settings. Three major indicators altered the sensorial connections between a child and nature: the permeability values of spatial settings that refer to accessibility of children and nature, the distance between the natural resource and a child, and the properties of nature following the land coverage plan. These features act directly on the relationship between the child and nature within a space, indoor and outdoor exclusively. These findings not only broadly support the proximity hypothesis and the influences of nearby urban areas but also further indicate the influences of architectural features varying the extensive levels of children's natural experiences through particular senses. This method, in the exclusion of disciplines regarding the human's perceived environmental ranges and how the natural environment contributes to human's physical, psychological and interactional aspects, specifically provides evidence-based design approaches for refurbishing schools and planning for new schools.

RQ2 - What are the differences in the children's experiences of nature through visual- and non-visual senses, including their discovery of nature – feelings towards nature and environmental preferences according to various spatial features, educational, and social contexts?

The outcomes of this question, in Chapter 6, are the core of this research. Evidence from previous studies has indicated multiple advantages of greening approaches in school design, for example, naturalized schoolyards, classrooms with visual access to nature, and indoor natural settings. As stated, there is a need for more evidence and understanding of how spatial and non-spatial factors affect the relationship between children and nature to successfully promote approaches of sustainable design for educational architecture. This study responds with a combination of different methods and mixed approaches to explore relative major research objectives, including children's perceived nature through multiple sensorial experiences, and environmental preferences at school environments. In relation to contextual differences according to urban, social, and pedagogical aspects, six primary schools in Glasgow and HCMC have been identified as case studies that involve appropriate features for the research questions (as presented in Chapter 4). This helps advance children's explanations of their perceptions, emotions, and preferences toward nature within different spatial scales and non-spatial contexts responding to a need for further analysis from aspects of socio-cultural bias and temporal changes in children's lives.

Firstly, regarding how children discover nature, the results of this research demonstrate that the perceived intensity of each and total sensorial experience of pupils increased when moving from indoors to outdoors and from high built environment to more wilderness. Vision remains to be the most substantial sense through which children experience nature in comparison to non-visual senses. Flora species (especially trees and flowers) and fauna species (especially birds) were the two most principal natural groups pupils discovered at schools. Through observations and perspectives of Glaswegian and HCMC pupils, it might be deduced that sensorial emotions vary with greater natural diversity. Pleasant and unpleasant feelings, ranging from low to high arousal levels, are evoked when their explorations are unlimited, illustrating how vivid features of nature exist through children's observation and perspectives. Among them, positive feelings (biophilia responses) are similarly distributed regardless of children's culture and educational contexts. Although some children had disgust or fear when encountering unfamiliar natural features, others showed their interest and affection. These divergent responses reveal the constructive contributions of experiencing nature for human benefit pleasures.

Concerning spatial features, this study revealed significant influences of the nearby urban configuration, spatial and natural settings of classrooms and playgrounds, on pupils' natural explorations and perceptions. Particularly, the quantitative and qualitative degrees of natural elements and stimuli of nearby urban areas could manipulate the extensive level of nature explored by children, varying by time of day, weather, and seasonal conditions. Children could experience less natural diversity and lower ranges in high-density urban areas. Following, within outdoor environments of schools, the more wilderness and richness of natural diversity prevail, the greater numbers of natural objects pupils can explore. For example, the earthy ground, water landscapes, and plentiful vegetations that could involve a rich natural diversity and improved air quality of school environments compared to hard-surfaced playgrounds. The diversity of vegetations is the principal factor to enhance the appearances of animal species, especially birds, within school environments that were most preferred due to their outward forms and pleasant sounds. The valuable contribution of vegetation richness, thus, is suggested for awakening emotions toward various classifications of nature. The earthy ground sites offer an abundance of underground flora and fauna species and minerals not found on hard-surface grounds. Through the discovery of new things, both pleasant and unpleasant arousal levels were reported toward living and non-living natural elements. Likewise, water landscapes are a rich source for children's discovery, providing aquatic ecosystems, abiotic components, and a more diverse soundscape. Therefore, a significant difference between natural land typologies and hard-surfaced playgrounds relates to the increased diversity of natural objects. These features, in another aspect regarding children's environmental preferences, have shown that the greater wilderness is preferred by children, the more natural concern is given by their description. The need for social interactions, energic and physical activities, with various arousing emotional degrees, are increased according to the expanding naturalness of outdoor recreational areas. These findings broadly support the importance of naturalized schoolyards to children's direct experiences with nature in school contexts beyond other significant advantages that were found in previous studies (discussed in Chapter 2.2.2). Regarding indoor environments, appropriate decision-making on the master planning of school's sites and layout settings within buildings, and the inclusion of permeable features in building envelopes, can enhance children's perceived nature rather than visual access to outdoor nature. Another important finding is that pupils' higher intensity of focus on indoor plants and insect boxes. The hands-on and regular experiences could evoke pupils' awareness through five senses, mainly through look, touch, and smell. Children's emotional reactions, especially female pupils showed greater biophilia feelings toward species that are commonly considered to be disgusting or less liked. The results suggest that there are advantages in reconsidering indoor natural settings to upgrade pupils' direct experiences and nurture their biophilia feelings toward a wide range of natural elements.

In company with influences of nearby urban areas and architectural features of schools, the investigation of Glasgow and HCMC case studies has shown that the region and climate conditions affect the differences in the natural diversity which are evident in the responses from children between Glasgow and HCMC. Due to seasonal changes, Glaswegian pupils had greater numbers of natural elements, especially seasonal planting, as reported by Paddle & Gilliland (2016), in school sites in comparison to those in HCMC schools. Another important finding of this study is that weather conditions remarkably affect how children evaluate their feelings toward some corresponding natural types and stimuli, such as wind, sunlight, and trees. Remarkably, the difference regarding weather and climate influences between these pupil groups are divergent trends of favouring spaces: while HCMC pupils indicated greater relaxation and thermal comfort within their desired places, children of TGA schools valued the affordable playgrounds where they could have fun and enjoyment. From these findings, it is tempting to suggest that adopting a climate-based design approach considering the microclimate of natural settings can enhance the child-nature connections.

Regarding non-spatial considerations, firstly, the degree of children's natural exploration increases according to age due to the augmented levels of cognition, understanding, and knowledge of their education. On the contrary, high arousal levels of feelings toward nature decreased according to children's increased ages. They felt less excitement and had increased inclinations and desires for built environments instead of the natural environment as they grow up. The older children were, the more they favour built environment, the more they were inclined to social interactions, and the less they preferred outdoor spaces. Regarding gender differences, the results have shown that female pupils not only had the greater intensively attractions and high emotional positive attitudes toward high aesthetical natural elements, such as colourful flower plants, but also towards species with less aesthetical appealing or impressive animal species. Furthermore, younger female pupils showed their favour for adventurous, energetic, and high-risk activities with natural-based surfaces and natural-based playing equipment. The familiarities could explain this positive alteration of the female children's perceptions toward nature and environmental preferences within the studying environments. Therefore, this study strongly supported the positive advantages of pedagogical curricula and activities which offer many opportunities for hands-on experiences with diverse natural species and natural-based advanced skills. There was no finding regarding children's off-school living environments and activities because the relative distribution of participants was limited. According to the consideration of educational philosophy, the most prominent issue is the definition of the nature of Waldorf pupils compared to those from other schools. The majority of participants shared the statement that their classmates, as humans are parts of nature, thus, causing the ratio of accepted answers to account for about a third of their total responses although the researcher shared similar introduction and guidelines as other schools' participants. This result reflected the consequence of educational philosophy on how children define nature – and therefore, this is an important matter for future research and further progress in determining more appropriate approaches and methods for specialized groups of children.

Concisely, this research section has identified and described key issues influencing children's multi-sensorial natural explorations, and their environmental preferences at primary schools. The extensiveness of natural experiences through visual and non-visual sensory modalities and affinities toward nature and natural environments of children diverge from spatial and non-spatial characteristics.

RQ3 - How do children experience nature through visual- and non-visual senses when comprehensively considering spatial- social- natural interactions?

The research objective of this question is children's spatial-social-natural interactions when they explore nature within studying and playing environments. In Chapter 2, it has been addressed that the child's nature connection within a spatial environment is a combination of three kinds of interactions: with *nature*, with *space*, and with *other people*. Consequently, it is important to investigate the relationship between the child-nature connectedness degrees - three forms of interactions rather than only features of individuals with nature, and features of spatial environments.

Responding to this question, the study adopted observations and mappings of HCMC participants when they explored nature within the classrooms and playgrounds to understand how they interacted with the spaces, natural landscapes, and other peoples.

In the indoor investigations, the overall results found that the consequences of seating arrangements could concurrently shape the characteristics of both natural and social interaction while physical features of openings mainly act on children's natural interactions. It has been found that social activities influence the behaviours of children's indoor interactions with nature. For example, higher concentration and more self-individual working on tasks when the child seat at a personal distance, while children who seat in groups within intimate distances tend to discuss together and figure out more natural elements. These pieces of evidence help us to promote important implications in an organisation's various types of activities in correspondence with children's characteristics of connections with others and with nature to ensure the optimal outcomes of children's developing goals.

Within schoolyards, the behaviour mappings of children's activities and interactions reveal important findings concerning architectural features and settings, including significant influences of shade availability concerning weather conditions, physical settings, and features of playgrounds (e.g., scale, ground covering, seating opportunities, and facilities). These features affect children's interaction with spaces. Moreover, appearances of natural elements that evoke children's interests and favours, such as flower plants, have important roles in enhancing children's direct interactions with nature. This information should be considered to develop targeted interventions when setting up playgrounds and other recreational spaces depending on the characteristics of pupil groups and their activities.

In relation to gender differences, no significant results from the group of three schools were found but age differences were detected. The more children grow, the more social interactions occur among them, and the greater degree of connection with nature via the vision-distance constructed while degrees of connections with nature within hands-on distances are increasingly limited and vice versa. These results indicated that spatial, social, and natural interactions via senses influence each other and change according to children's ages.

To conclude, these findings of this research question are important to be considered in developing targeted interventions in designing spaces according to characteristics of pupil groups and their activities for enhancing their multi-sensorial experiences of nature at schools.

RQ4 - How are children's perspectives about ideal nature-built environments for their daily school activities?

In order to encourage children positively explore and engage with nature, a need to apprehend children's perceptions of the ideal environmental school according to their needs and desires is stated to push them move in nature. This is one of the central issues of environmental psychology for understanding how different characteristics of spaces and natural attributes provoking affective states in various types of individuals. Children need to be given opportunities to express their perspectives and interests regarding their subjective well-being concerns (Mustapa et al., 2015). Further and most importantly, the discrepancy between children's and adults' perceptions about a beneficial school environment has been proposed. In these compulsory respects, the study specially investigates further HCMC children's activities, thinking processes, and desires for their ideal classrooms and playgrounds at schools through structured interviews (as presented in Chapter 7). It provides a broad overall picture with desirable spatial and natural features to serve as references in developing approaches rather than their existing classrooms and playgrounds as analyzed in Chapter 6.

Generally, from the arguments of all three schools' pupils, we can infer that there are restrictions and shortages, both in aspects of pupils' studying and playing demands as well as for their sensorial connections with nature, of investigated classrooms and playgrounds of case studies in HCMC.

The obtained results highlight the urban pupils' strong desires for '*wilder*' and more intense connections with nature in their ideal learning and playing environments. They favour natural environments not only for the potential to facilitate desired activities regarding affordances of places but also for pleasant feelings and physical comfort. Children also seek challenging and risky activities more than architects and educators anticipated. This unmatched anticipation is due to safety concerns and considerations of potential risks for children's health outcomes in wilder nature. The influences of the risk interventions and structured society declined the opportunities for children's studying and playing in a wilder natural environment in school contexts were addressed. However, children could gain relevant skills and capacities in familiarities with surrounding environments through appropriate educational methods rather than be hampered by a lack of experiences – of nature inclusively, as previous arguments and evidence from this study. Thus, it provides further support for promoting more wild school environments as well as a call for renewals of nature in minds of architects, designers, school administrators, and educators.

RQm. The synthesised research question – What are appropriate design approaches for primary school architecture to enrich children's direct experiences with nature?

In order to respond to this research question, all key findings of previous sub-questions have been synthesized to comprehend how school environments within various urban, socio-cultural, and pedagogical contexts construct the threshold of children's multiple-sensorial experiences of nature. Following, the thesis has proposed potential design approaches in the context of urban and architectural design in particular, and a holistic approach in the respect to the study of children's nature connection as a broader view for children's sustainable development.

The findings included the schemas of children's experiences of nature relying on a spectrum of built and natural environments that reflect the naturalness values of vision and non-vision children expose themselves to, the particular characteristics of natural attributes, and in accordance with related spatial figures affecting children's visual and non-visual experiences of nature. These findings became evidence to propose potential approaches for designing primary schools in the urban and architectural contexts and a holistic view for promoting children's health and well-being development.

In regards to urban and architectural approaches of primary school design, the first concern is related to the decision-making process to select appropriate locations for future schools or urban regeneration strategies. At school's outdoor environments, an appropriate master plan of the school site and buildings with -views to nearby urban green and blue areas, - accessible pathways for children's daily activities, - natural diversity, and - nature-based affordances of playgrounds, is considered as an essential condition to increase the naturalness values of vision and non-vision senses as well as to enrich children's engagement with the diversity of nature. Regarding approaches for indoor environments, the appropriate layout within buildings in considerations of outdoor environments, the features of spatial enclosures related to permeability values, and interior settings of children's study desks and furniture are important considerations. The application of the developed methodology is suggested to measure visual and non-visual sensorial experiences of nature children exposure to within children's learning and leisure spaces (in Chapter 5) to confirm the effective and rational decisions in designing schools.

Broadening to a holistic approach to the enrichment of Child-Nature Connection in primary school, a need to develop child-centered proposals and guidelines is suggested based on the obtained results regarding perspectives of children for their favourite places at their schools and ideal environmental preferences in Chapters 6 and 7, and various perspectives of architectures and educators in Chapter 7. The initial and fundamental proposition is a thorough consideration of the importance of offering children's multi-sensorial experiences of a range of natural elements in daily school environments. In every step of school designing, children's participation and inclusion not only provide better-suited spaces for them as the main users but also foster their close bonds with schools. Lastly, children should have active involvements in nature-based activities and pedagogy in daily school times, in both learning and playing environments for sensorial experiences of nature, for improvements in their health and well-being, and for nurturing their affinity toward the natural world - biophilia. In order to succeed, accompanying shifts of decision-makers, including designers, architects, educators, policy-makers are significantly demanded to create future schools with "*nature in mind*" (Duncan, 2018).

9.3. Contributions to existing knowledge

Following the summary of the findings responding to the research questions, this section confirmed the contribution to the existing knowledge of this study. This research has relied on and worked out on the current extent of the research field as presented in Chapter 2 to provide relevant contributions to knowledge regarding primary school design, methodology and approaches of children's natural connection study.

a) Theoretical contributions: Biophilia and Human/Children-Nature Connection

The exploration in perceptions and preferences on nature of children in Glasgow and HCMC primary schools, architects, and educators presented in Chapters 6 and 7 once again support the Biophilia hypothesis that innate love for nature and inclinations for the natural environment still exist in urban children, regardless of their culture and educational contexts, and adults' childhoods. However, with an investigation in various contexts in Glasgow and HCMC, this study found natural favours diverse according to local weather conditions and educational approaches for children. Within an educational environment where children are frequently encouraged and offered hands-on experiences with nature for developments in physical, cognitive, and spiritual fundamentals, the more enrichment of affinities and positive engagement with nature from children. In another aspect, findings of this study have indicated a shift of affinity towards nature - from more '*wild*' nature to more '*domesticated*' nature and '*built*' environmental preferences in accordance with an increased age ranges in general, and a similar shift between adults with and without professional authorities in a particular aspect. These findings help us explore the changes in human-nature connections, in a tendency of degraded environmental experiences with nature, according to temporal changes and human-social magnitudes. And if this inclination continues, the foreseen aftereffects would be the same problems of "*environmental generational amnesia*"(Kahn Jr., 2002). Therefore, this study identically indicates the importance of early natural experiences and supports the re-wilderness of the school environment as a critical plan of action in the generational institution of sustainable futures.

b) Practical contributions: Biophilic design, Primary school architecture, and the Child-centred approach in the primary school context

The outcomes of this study have provided practical contributions to knowledge. The findings, presented in Chapters 5 to 7, have identified key issues influencing child-nature multi-sensorial connections within indoor and outdoor environments. They include broadening understanding of how particular characteristics of spatial and natural settings impact the extent to which children's -bodies and multiple-senses exposure to, -exploration and knowledge about nature, -emotional responses, and -environmental preferences, in varying social and environmental contexts. The connection between children and nature and relevant key issues at school contexts have become clarified through an all-embracing approach that brings spatial, psychological, and behaviour dimensions in the methodological framework, rather than an exclusive focus on children's intellectual and emotional responses. Subsequentially, Chapter 8 has synthesized and provided potential design approaches in a codification of Biophilic design patterns for refurbishing schools and in planning for new schools. The recommended features in selecting school sites and setting school environments have added detailed descriptions and associated purposes of patterns in an evidence base to the research area of Biophilic design principles for direct natural experiences. We believe these findings and suggestions for primary school design could support future policies and guidelines. Furthermore, we suggest the child-centred scheme in every phase of setting school environments and organizing school activities to advance the children and nature movement and help to address a widening disconnection with nature worldwide.

c) Methodological contributions: Child-Nature-Distance (C-N-D) methodology

One of the significant outcomes of this study is to develop the methodology for measuring visual and non-visual experiences of nature children exposure to. Relevant literature on the existent value of naturalness which directly impacts the human body via sensorial modalities, particularly non-visual senses are remaining scopes that should be further investigated. The methodology developed in this study, which was presented in Chapter 5, has contributed to the above. It is intended to help understand '*real*' natural value – in a quantitative aspect – across varying C-N-D ranges and consider the impacts of spatial environmental properties within urban settings. This thesis argues that the application of this method can support design decision-making for refurbishing schools at the micro-level, and in planning urban development involving proposals for new schools at the macro levels. In a more widespread perspective, the application of this methodology could be practically expanded to other architectural typologies and other spaces' occupants.

The next advanced impact of this study is the research methodology of children's HNC study areas. In chapter 2, the lack of understanding about the relationship between connection indicators is presented – forms of behaviours and activities – features of the spatial environment and a need to look at mixed approaches within different contexts and spatial scales in the research area of children's natural connection. In order to overcome these limitations, an investigation of place-based components and mixed approaches that bring spatial, psychological, and behavioural dimensions, in various social and environmental contexts to investigate three principal components (e.g. cognitive, affective, and behaviour) constructing children's natural connectedness is adopted. The synthesized findings in Chapter 8 have provided the answers responding to questions - *where*, *how*, and *why* an educational environment enriches a child's connectedness to nature while others could not. These theoretical and methodological aspects have been considered as important contributions to sustainability science and architectural research in the field of Human-Nature Connection.

9.4. Future research avenues

This research with existing limitations has provoked many further questions and directions for future study. Below, I explain the ones I believe are the most intriguing and requisite.

The initial issue that needs to involve is to develop a parameter system of naturalness value ranges as a rating system, specifically for the regional and local built environment. The aim of this action is establishing criteria and benchmarks towards more visual and non-visual natural experiences children could have within school environments and more efficient practices, like criteria of green building rating systems (for example, LEED and BREEAM of international system, and LOTUS of Vietnamese rating system). This study has obtained naturalness values of six primary schools, as case studies to explore the influences of spatial features. However, some questions remain: *Are these naturalness values acceptable to ensure children have enough sensorial natural experiences at the lowest threshold allowed?* or *How are aesthetical values of these works of landscape and architectural design in sustainability discourse?* (Meyer, 2008). It requires experimental investigations in many different directions, including sustainable architectural and landscape design, to clarify the benchmarks of naturalness values and correlative outcomes of direct natural experiences of children in both quantitative and qualitative concerns. Among them, with the suggested approaches of this study in Chapter 8, the method of a before and after study would be a worthy investigation to evaluate the practical efficiency and reasonable supports for establishing criteria and benchmarks. Accordingly, design guidelines and approaches would be successfully adapted in actions and policies. These are, therefore, requisite issues for future research in primary school architecture.

Besides, other aspects are related to the existing limitations of this research. In Chapter 6, it was suggested that further research is required to design appropriate methods for engaging with the number of various school environments and social contexts because there was no finding regarding children’s off-school living environments and activities. As noted in criteria selection, this research focused only on identifying the characteristics of school settings and educational contexts. Thus, a greater number and diversity of schools in urban environments and educational systems would offer a more variety of children’s social contexts.

Furthermore, due to finite access permissions and time restrictions, the researcher only investigated the designated classrooms and playgrounds within 45-60 minutes according to the allowable time for each pupil group. Regarding spatial issues, other indoor and outdoor spaces within school environments, with fewer frequencies of children’s occupying, have not been explored yet. In order to create more accessible manners for enriching the child-nature connection in a whole building and a school site, more studies of various architectural forms and spaces are needed.

With an issue related to the timeframe of the methodology for research, two main aspects need consideration. Firstly, this study exclusively observed children’s natural – spatial – social interactions to establish how children interact with the spaces, natural landscapes, and other people when they explored nature in classrooms and playgrounds. Further work with more focus on when children do not explore nature to figure out the characteristics of their spatial-natural-social interactions when they are not actively engaging with nature. This direction would yield different insights in terms of comparison between the active and passive engagements with nature and following, particularly whether there are potential findings in settings of schools’ environments, and organizing children’s curricula. Another aspect that needs further investigation is the temporal and seasonal changes because how children perceive, feel, and interact with nature might differ. In this study, Glaswegian pupils did surveys in springtime, and HCMC pupils did in the highest temperature and highest solar radiation months of the dry season. Thus, other seasonal investigations would be necessary to consider in terms of timescales for a wilder context of children’s direct experiences of nature and school designs.

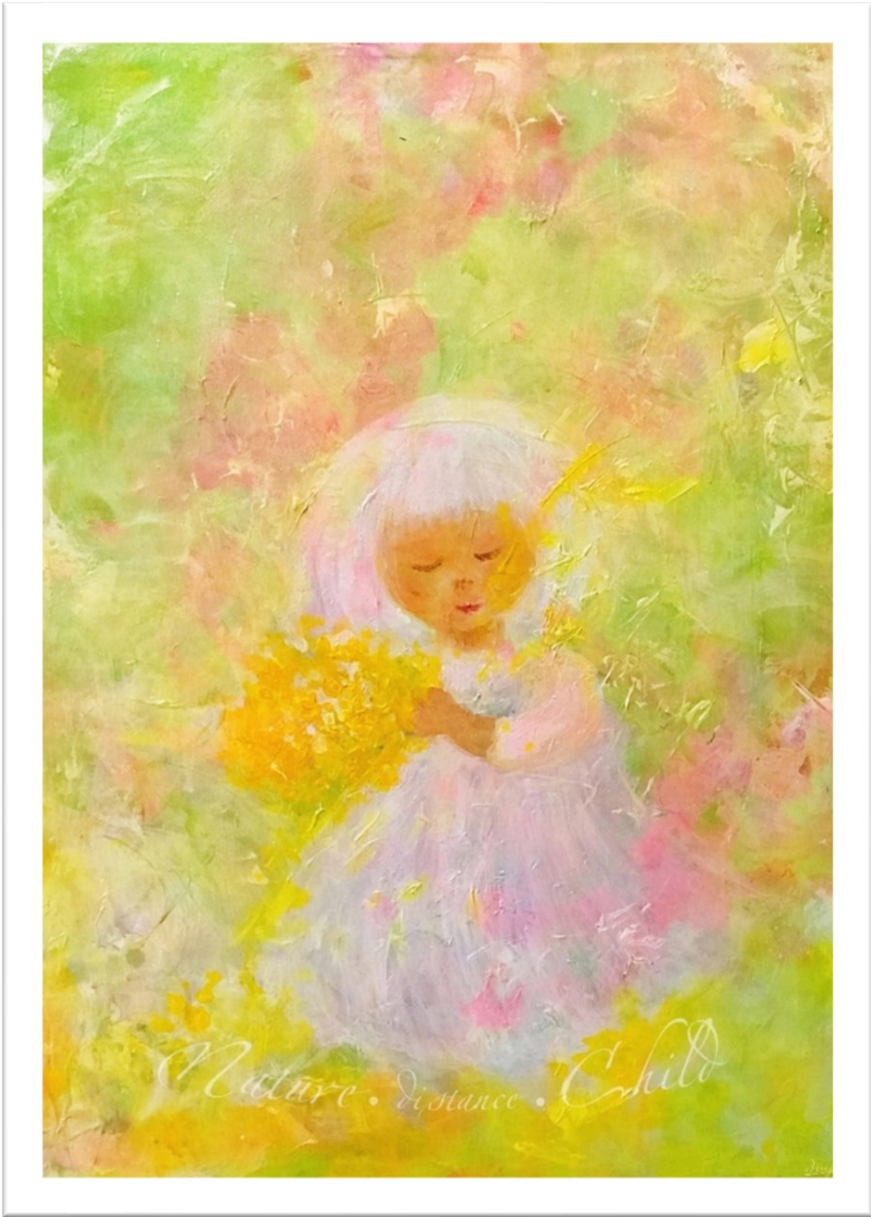
Lastly, I want to mention the urgency and importance of setting up school environments adapting to public health crises, particularly the COVID-19 pandemic as a contemporary example. With the widespread of COVID-19, restrictions have been put in place, public spaces and buildings have become high-risk platforms for disease transmitters. Schools have to close completely and face-to-face interaction has had to give way to the virtual world in living environments. Right now, by positive impacts of the vaccine program, we have been increasingly adjusting to a '*new normalcy*' in the post-pandemic world in which social distancing of the population remained a requirement. Parts of primary schools in the UK and in HCMC have re-opened fully and/or by blended models with many guidelines of spatial and social settings in place to ensure children's health. In this flow, urban and architectural designers in general, are challenged and forced to offer adaptable approaches, as Forsyth (2020) argued "*… The current pandemic brings the question of designing for infectious diseases back to the forefront and raises important questions for future research and practice.*" Similarly, according to Maturana et al. (2021), three prospective research fields, including urban dynamics, measurements and formula of spatial and social distancing, and adaptive patterns of living and working spaces, are required for human's health and well-being. In the particular context of primary school designs, spatial and functional settings for social distancing and flexibility of learning models are considered potential fields for future investigations. In this study, we found that spatial and natural settings influence children's spatial-natural-social interactions, and there are associations between these kinds of interactions. Therefore, requirements of spatial and functional settings for children's health and wellbeing at school environments during and post the COVID-19 pandemic would involve sweeping changes in the relationship between the child and nature. In a broad aspect, we can argue that today's architect is challenged by new concepts on educational methods and the impacts of emerging technologies, by complicated, disordered, and uncertain situations (Hertzberger, 2008; Salama, 2020). For this reason, the need for further multidisciplinary research on how we can maintain and enhance children's connection with nature through informed and well-designed changes in the built environment is both vital and urgent.

9.5. Concluding remarks

As the motivation of this research, our belief is that children's well-being intertwines with having an enhanced, diverse, and equitable access to nature. Therefore, this study once again reaffirms that claim by contributing evidence to advance the children and nature movement while also addressing the disconnect with nature we witness worldwide. This work does so by developing the measurements and observations for visual and nonvisual sensorial experiences of nature for primary school children within their school environment in Glasgow, Scotland, and Ho Chi Minh City, Vietnam.

The major aim in exploring and analysing how school environmental settings are designated according to different social and pedagogical contexts influence the threshold of children's multisensorial experiences of nature has been to establish a holistic approach to the primary school architecture for (re-)connecting the child-nature connection – these are successful outcomes of this study. This work has aimed to comprehensively and successfully bring spatial, psychological, and behavioural dimensions with a mix of quantitative and qualitative into the methodological research to investigate four main research objectives, including naturalness values of children's visual and non-visual experiences of nature, how children explore, feel, and interact towards nature within studying and playing environments, and their environmental preferences at schools.

Based on the research findings, it can be confidently suggested that: - taking primacy of the child-centered approach at the core of every step of the designing process, and - considering the distance ranges of children's visual and non-visual experiences with nature in mind. These will help decision-makers achieve the desired improvement in primary school architectural environments regardless of environmental and social contexts. This work has provided evidence-based guidelines for refurbishing schools and planning new schools that will ensure the enhancement of children's sensorial experience of nature, the improvements of their health and well-beings, as well as nurturing their affinity toward the natural world for biophilia.



"**Child-Nature-Distance**" by Author (@Ivy)

I believe in the beauty of Nature – the natural world, the beauty of the Child's nature as a human, and the beauty in how Nature and Child intimately connect together.

"**Love must be awakened**" — Rudolf Steiner (1861 – 1925)

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Appendices

Appendix A : Research information sheet

University of Strathclyde Engineering

DEPARTMENT OF ARCHITECTURE

RESEARCH INFORMATION SHEET for the Primary School Approval

Title of study

Children's Experiences with Nature in the Primary School Architecture

Purpose of the study

School plays a significant role in children's sustainable development. Particularly in the early periods, the learning environment may have a long-lasting impact in later life. Children need to be given opportunities to directly connect and discover the values of original nature. The purpose of this research is to examine factors of the built environment that contributes to the children's direct experiences with the natural environment in primary school projects. The valuable findings are expected to understand the impacts of primary schools' physical environments on natural cognition and interactions of children between the ages of 6 to 12. Following these results, the proposed research will explore the suitable applications of primary school design strategies in corresponding with educational curriculums toward achieving sustainable education and development.

Data collection methods

1. **Site study**
   Expected time to visit school for meeting and site study: from 1st May to 15th May 2018 (4 days)
2. **Open-question surveys**
   Children will complete the open-question survey papers by drawing and/or writing when sitting in the classroom, and walking around the outdoor spaces.
   Participants: 3 designated classes (P3, P4, and P7)
   Time: 40 – 45 minutes/class for each survey
   (5 minutes: introduction and instruction, 15 minutes: classroom-survey, 20 minutes: outdoor-survey)
3. **Classroom and Outdoor Observations**
   Researcher will observe children's activities in classrooms and outdoor spaces during survey periods and intervals.
   Participants: 3 designated classes (during survey periods), and all pupils at schoolyard (during intervals)

Appropriate time for surveys and observations: 15th May – 15th June 2018 (6 days)
These methods may include some or all of the following: photographs, and videotaping.

Student researcher: To Thanh Phuong, PhD student of Architecture Department, University of Strathclyde
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Thank you for reading this information sheet, and for considering taking part in this research.

Appendix A_ 1. Research information sheet for the primary school approval in Glasgow

University of Strathclyde Engineering

DEPARTMENT OF ARCHITECTURE

RESEARCH INFORMATION SHEET

Title of study

Children's Experiences with Nature in the Primary School Architecture

Purpose of the study

School plays a significant role in children's sustainable development. Particularly in the early periods, the learning environment may have a long-lasting impact in later life. Children need to be given opportunities to directly connect and discover the values of original nature. The purpose of this research is to examine factors of the built environment that contributes to the children's direct experiences with the natural environment in primary school projects. The valuable findings are expected to understand the impacts of primary schools' physical environments on natural cognition and interactions of children between the ages of 7 to 12. Following these results, the proposed research will explore the suitable applications of primary school design strategies in corresponding with educational curriculums toward achieving sustainable education and development.

Data collection methods

1. **Site study**
   Expected time to visit school for meeting and site study: from 15th January to 15th February 2019
2. **Open-question surveys and focus group interviews**
   Children will fill into the open-question survey papers by drawing and/or writing when sitting in the classroom, and walking around the outdoor spaces. Then designated focus groups will be taken interviews in their classrooms.
   Participants: 3 designated classes
   Time:
   55 – 60 minutes per class for each indoor/outdoor survey
   45 – 60 minutes per class for focus group interview
3. **Classroom and Outdoor Observations**
   Researcher will observe children's activities in classrooms and outdoor during class time and free time.
   Participants: 3 designated classes (classrooms during study time and free time), and all pupils (outdoor spaces during free time)
   Time: 15 minutes/class in study time, and free time
   Appropriate time for surveys and observations: 15th February – 15th March 2019

These methods may include some or all of the following: photographs, audio and videotaping.

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Thank you for reading this information sheet, and
for considering taking part in this research.

The place of useful learning

Appendix A_ 2. Research information sheet for the primary school approval in HCMC

Appendix B : Parents' survey forms

University of Strathclyde Glasgow

Dear Parent(s),

I would really appreciate if you could take a couple of minutes to complete this short survey below. Your responses will be used when making decisions regarding sustainable development in the school environment. Please tick or circle the most appropriate answer, and feel free to add any comments in the spaces provided.

Many thanks for your cooperation.

Name of Child: .... **Date of Birth:** .... ☐ **Female** ☐ **Male**

1. What type of accommodation do you live?

☐ Private house ☐ High-rise flat ☐ Tenement flat ☐ Four-in-a-block building ☐ Others

2. Is there garden in your accommodation? ☐ Yes ☐ No

3. Do you have pet? ☐ Yes ☐ No

	4. Where does your child play on a typical weekday?					**5. Where does your child play on a typical weekend?**				
	Never	Rarely	Some-times	Often	Always	Never	Rarely	Some-times	Often	Always
Home-site	1	2	3	4	5	1	2	3	4	5
Nearby parks and playgrounds	1	2	3	4	5	1	2	3	4	5
Adventure playgrounds	1	2	3	4	5	1	2	3	4	5
Pavements	1	2	3	4	5	1	2	3	4	5
Commercial facilities	1	2	3	4	5	1	2	3	4	5
Sport facilities	1	2	3	4	5	1	2	3	4	5
Wild areas *(E.g., forests, lakes, wetlands)*	1	2	3	4	5	1	2	3	4	5

6. Which resources does your child use to learn about the subject of 'Nature' outside the school?

☐ Family member(s) ☐ Reading books at home ☐ Watching programs on TV and Internet ☐ Outdoor trips and courses ☐ Other

	Not important	Somewhat important	Important	Very important	Extremely important
7. Are you interested in the topic of children's direct experience with nature?	1	2	3	4	5
8. Is direct experience of nature meaningful and important for your child?	1	2	3	4	5

Thank you very much for your cooperation!

The place of useful learning

Appendix B_ 1. Parents' survey form of Glasgow case studies

University of Strathclyde Glasgow

Initials of Child: .... Date of Birth: .... ☐ Female ☐ Male

1. What type of accommodation do you live?

☐ Private house – site area ≤ 100m² ☐ Private house – site area > 100m² ☐ Low-rise apartment (≤ 9 storeys) ☐ High-rise apartment (> 9 storeys) ☐ Others

2. Is there garden in your accommodation? ☐Yes ☐No **3. Do you have a pet?** ☐Yes ☐No

	4. Where and how often does your child play?			
	Not at all *(0)*	Rarely *(less than 6 times per year)*	Occasionally *(once per month)*	Often *(more than 2 times per month)*
Home-site	1	2	3	4
Nearby parks and playgrounds	1	2	3	4
Adventure playgrounds	1	2	3	4
Pavements	1	2	3	4
Commercial facilities	1	2	3	4
Sport facilities	1	2	3	4
Wild areas *(E.g., forests, lakes, wetlands)*	1	2	3	4

5. Which resources does your child use to learn about the subject of 'Nature' outside the school?

☐ Family member(s) ☐ Reading books at home ☐ Watching programs on TV and Internet ☐ Outdoor trips and courses ☐ Other

	Not important	Somewhat important	Important	Very important	Extremely important
6. Are you interested in the topic of children's direct experience with nature?	1	2	3	4	5
7. Is direct experience of nature meaningful and important for your child?	1	2	3	4	5

Thank you very much for your cooperation!

The place of useful learning

Appendix B_ 2. Parents' survey form of Ho Chi Minh case studies

Appendix C : Report of Progress Form

CASE STUDY – REPORT of Progress

School:	Date:
Class:	Time: Indoor: …………………………………………….. Outdoor: …………………………………………
Floor:	Temperature: Indoor: …………………………………………….. Outdoor: …………………………………………
Number of pupils:	Humidity: Indoor: …………………………………………….. Outdoor: …………………………………………
Boys: ………….………. Girls: ……………………	Weather: Indoor: …………………………………………… Outdoor: …………………………………………

Note: ……………………………………………………………………………………………………..

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Appendix C_ 1. Report form of data collection progress

Appendix D : Pupil's interview papers

Pupil's Interview Paper (5 - 10 minutes/child)

School: .... Initials: ....

Date: .... Time: .... Class: .... Gender: Male ..... / Female ....

1. Which place do you like most at your school? Why?

   ....

   ....

2. What activities would you like doing in free times at school?

   ....

   ....

3. Which natural element do you like most? Please can you tell me why?

   ....

   ....

4. Please pick up the classroom you like most? Why did you choose it?

I-1

I-2

I-3

I-4

Appendix D_ 1. Children's focus-group interview form - Page 1

5. Please pick up the playground you like most? Why did you choose it?

O-1

O-2

O-3

O-4

O-5

O-6

Appendix D_ 2. Children's focus-group interview form - Page 2

Appendix E : Interviewing form of architects and educators

Professional's Interview Form

Initials:	Age: 18-25 ... 25-30… 30-35… 35-40... 40-45... 45-50... 55-60....	
Occupation:	Gender: Male.... Female	Date: .... Time: ....

....
......

1. Which classroom and playground do you like?	
I-......	O-......
2. From your viewpoint as an expert in primary-school education/architect, which classroom and playground are the most suitable educational environments for children at the primary school? Why?	
I-......	O-......
3. From your viewpoint as an expert in primary-school education/architect, what are the most important factors need to be considered in setting up classroom and playground environment of primary school architecture?	

Thank you very much for your contribution!

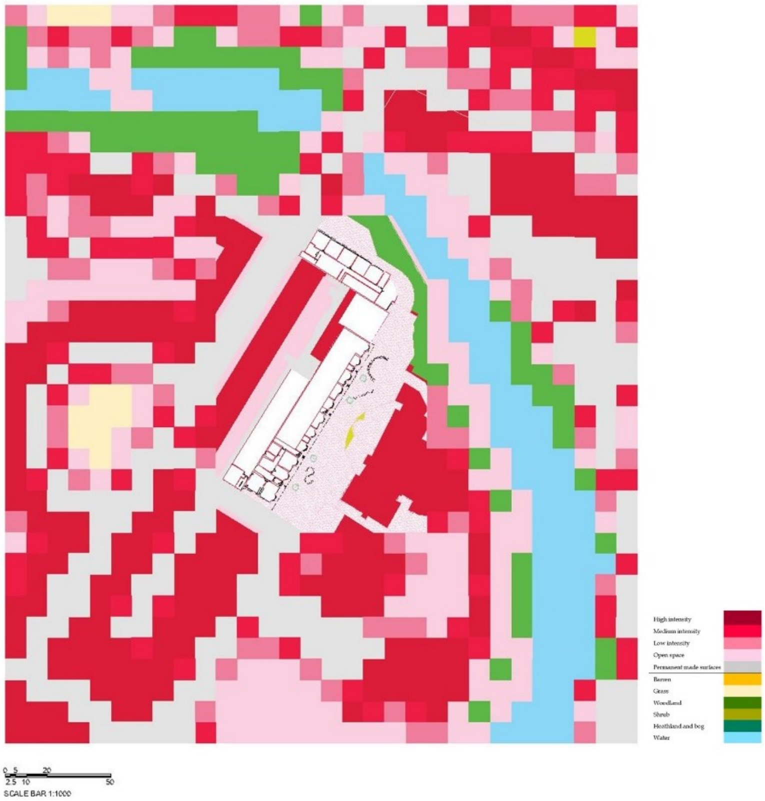
Please sign here:

....
.

To Thanh Phuong © December 2018 – March 2019

Appendix E_ 1. Interviewing form of architects and educators

Appendix F : Land coverage plans of studied schools



TGA_K: The naturalness of non-visual senses

		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**103195.8**			
BUILT ENVIRONMENT	High intensity	23732.9	0.143	0.000	
	Medium intensity	11400.0	0.050	0.013	
	Low intensity	8600.0	0.038	0.019	
	Open space	20182.6	0.124	0.093	
	Permanent made surfaces	20633.4	0.108	0.000	**0.224**
Total Natural area		**18647.0**			
NATURAL ENVIRONMENT	On-site	947.0			
	0-50 meters	6700.0	0.099	0.099	
	50-70 meters	6100.0			
	70-100 meters	4900.0			

Appendix F_ 1. TGA_K: The land coverage plan and the Naturalness of non-visual senses

TGA_M: The naturalness of non-visual senses

		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**72198.9**			
BUILT ENVIRONMENT	High intensity	2728.2	0.019	0.000	**0.348**
	Medium intensity	8112.5	0.061	0.015	
	Low intensity	12018.8	0.082	0.041	
	Open space	12361.5	0.076	0.057	
	Permanent made surfaces	6450.2	0.040	0.000	
Total Natural area		**30527.8**			
NATURAL ENVIRONMENT	On-site	2827.8	0.234	0.234	
	0-50 meters	12000.0			
	50-70 meters	4600.0			
	70-100 meters	11100.0			

Appendix F_ 2. TGA_M: The land coverage plan and the Naturalness of non-visual senses

TGA_N: The naturalness of non-visual senses

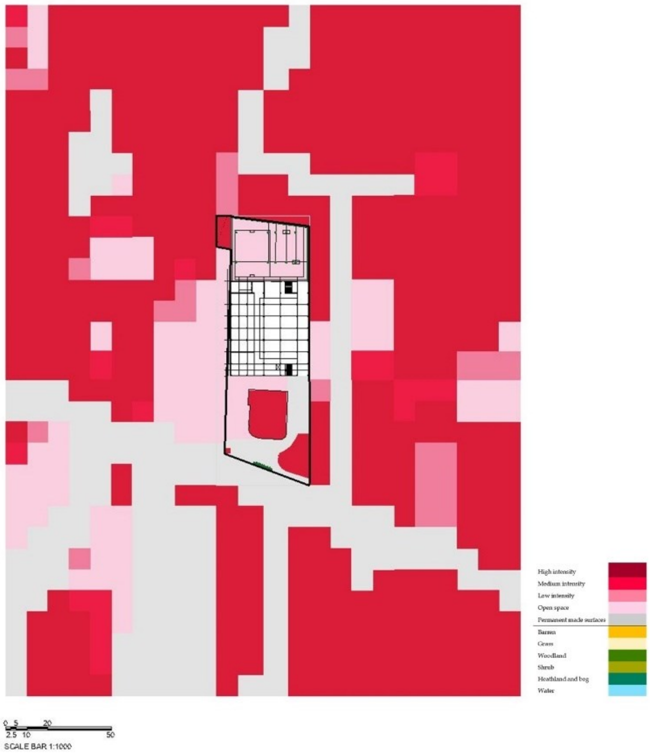
		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**58379.9**			
BUILT ENVIRONMENT	High intensity	2972.6	0.024	0.000	
	Medium intensity	11911.0	0.095	0.024	
	Low intensity	22331.3	0.177	0.088	
	Open space	10377.9	0.094	0.070	
	Permanent made surfaces	9984.0	0.088	0.000	**0.189**
Total Natural area		**803.2**			
NATURAL ENVIRONMENT	On-site	167.1			
	0-50 meters	136.1			
	50-70 meters	0.0	0.007	0.007	
	70-100 meters	500.0			

Appendix F_ 3. TGA_N: The land coverage plan and the Naturalness of non-visual senses

HCMC_TQT: The naturalness of non-visual senses

		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**61914.4**			
BUILT ENVIRONMENT	High intensity	25821.9	0.204	0.000	
	Medium intensity	1648.6	0.011	0.003	
	Low intensity	17398.3	0.133	0.067	
	Open space	2525.0	0.023	0.017	
	Permanent made surfaces	14520.6	0.121	0.000	**0.086**
Total Natural area		**0.0**			
NATURAL ENVIRONMENT	On-site	0.0			
	0-50 meters	0.0			
	50-70 meters	0.0	0.000	0.000	
	70-100 meters	0.0			

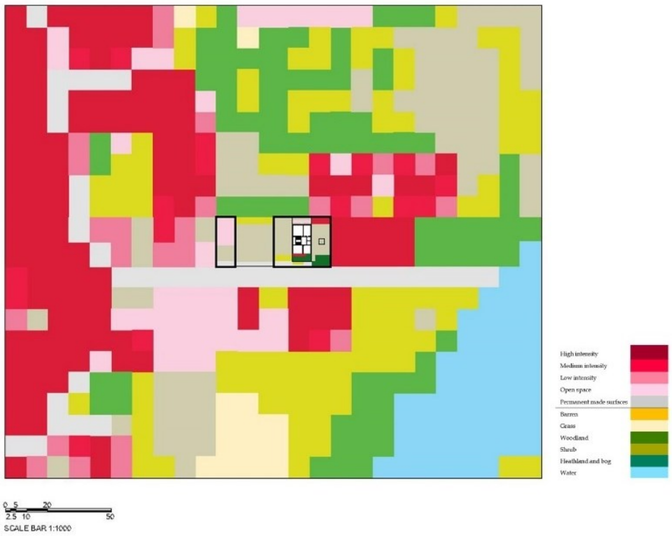
Appendix F_ 4. HCMC_TQT: The land coverage plan and the Naturalness of non-visual senses



HCMC_TDP: The naturalness of non-visual senses

		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**78258.5**			
BUILT ENVIRONMENT	High intensity	46471.6	0.276	0.000	
	Medium intensity	2212.3	0.015	0.004	
	Low intensity	2512.3	0.016	0.008	
	Open space	9396.2	0.075	0.057	
	Permanent made surfaces	18110.5	0.129	0.000	**0.069**
Total Natural area		**55.5**			
NATURAL ENVIRONMENT	On-site	55.5	0.001	0.001	
	0-50 meters	0.0			
	50-70 meters	0.0			
	70-100 meters	0.0			

Appendix F_ 5. HCMC_TDP: The land coverage plan and the Naturalness of non-visual senses



HCMC_TXS: The naturalness of non-visual senses

		Area (sqm)	Impact value	Naturalness value Noto/ Noh/ Nota/ Nosm	Naturalness of non-visual senses NoTo/ NoH/ NoTa/ NoSm
Total Permeable Area		**56587.6**			
BUILT ENVIRONMENT	High intensity	12187.7	0.098	0.000	
	Medium intensity	1817.5	0.019	0.005	
	Low intensity	2505.0	0.024	0.012	
	Open space	4362.9	0.046	0.035	
	Permanent made surfaces	3783.4	0.036	0.000	**0.309**
Total Natural area		**32340.1**			
NATURAL ENVIRONMENT	On-site	837.2	0.257	0.257	
	0-50 meters	7367.7			
	50-70 meters	8630.1			
	70-100 meters	15505.1			

Appendix F_ 6. HCMC_TXS: The land coverage plan and the Naturalness of non-visual senses

Appendix G : The visible areas and ratios of built-natural environment of observed viewpoints

Place_ID	Viewpoints	Visible areas and ratios of built-natural environment				
		Built		Natural		Total
		area (sqm)	ratio	area (sqm)	ratio	area (sqm)
TGA_K	K7.I.1	800	99.0%	8	1.0%	808
	K7.I.2	84	77.6%	24	22.4%	108
	K7.I.3	1702	94.5%	99	5.5%	1801
	K7.I.4	104	78.9%	28	21.1%	132
	K7.I.5	188	81.2%	44	18.8%	232
	K7.I.6	83	77.8%	24	22.2%	107
	K7.I.7	537	93.3%	38	6.7%	576
	K7.I.8	400	87.9%	55	12.1%	455
	K4.I.1	14488	70.7%	5998	29.3%	20486
	K4.I.2	15419	59.6%	10435	40.4%	25854
	K4.I.3	10699	51.7%	10008	48.3%	20707
	K4.I.4	10191	71.2%	4120	28.8%	14312
	K4.I.5	10085	66.8%	5003	33.2%	15088
	K4.I.6	5533	56.5%	4257	43.5%	9790
	K4.I.7	7485	69.3%	3312	30.7%	10797
	K4.I.8	4394	62.8%	2600	37.2%	6993
	K3.I.1	14589	70.9%	5985	29.1%	20574
	K3.I.2	14941	61.6%	9332	38.4%	24273
	K3.I.3	9694	52.0%	8945	48.0%	18639
	K3.I.4	10106	71.5%	4037	28.5%	14143
	K3.I.5	9570	67.3%	4659	32.7%	14229
	K3.I.6	4702	55.8%	3731	44.2%	8433
	K3.I.7	6752	69.7%	2937	30.3%	9689
	K.O.1	21770	52.0%	20100	48.0%	41870
	K.O.2	18619	51.3%	17688	48.7%	36306
	K.O.3	22004	47.0%	24835	53.0%	46839
	K.O.4	14131	60.8%	9119	39.2%	23250
	K.O.5	9434	61.4%	5939	38.6%	15373
	K.O.6	8297	58.6%	5873	41.4%	14171
TGA_M	M.I.1	115	39.2%	178	60.8%	292
	M.I.2	112	36.1%	198	63.9%	310
	M.I.3	393	39.3%	606	60.7%	999
	M.I.4	395	41.2%	564	58.8%	958
	M.I.5	288	48.9%	302	51.1%	590
	M.I.6	2042	51.3%	1938	48.7%	3980
	M.I.7	698	54.8%	575	45.2%	1273
	M.I.8	465	55.8%	369	44.2%	834
	M.O.1	15826	40.1%	23662	59.9%	39488
	M.O.2	19635	34.0%	38056	66.0%	57691
	M.O.3	14382	30.4%	32949	69.6%	47330
TGA_N	N.I.1	11245	67.3%	5475	32.7%	16720
	N.I.2	5807	62.4%	3504	37.6%	9311
	N.I.3	5724	63.7%	3268	36.3%	8992
	N.I.4	4291	64.3%	2386	35.7%	6677
	N.I.5	4774	65.0%	2567	35.0%	7340
	N.I.6	5692	62.4%	3434	37.6%	9126
	N.I.7	7325	64.4%	4049	35.6%	11374
	N.I.8	3495	66.6%	1751	33.4%	5246
	N.O.1	27925	61.2%	17724	38.8%	45648
	N.O.2	26590	62.6%	15863	37.4%	42453
	N.O.3	19455	62.8%	11504	37.2%	30959

Appendix G_ 1. Results of indoor and outdoor viewpoints of TGA case studies

Place_ID	Viewpoints	Visible areas and ratios of built-natural environment				
		Built		Natural		Total
		area (sqm)	ratio	area (sqm)	ratio	area (sqm)
HCMC_TQT	T.I.1	6450	78.0%	1821	22.0%	8272
	T.I.2	3542	78.5%	972	21.5%	4514
	T.I.3	2597	78.6%	706	21.4%	3303
	T.I.4	2642	99.5%	13	0.5%	2655
	T.I.5	4027	84.5%	738	15.5%	4765
	T.I.6	2869	79.6%	734	20.4%	3603
	T.I.7	5368	72.4%	2044	27.6%	7412
	T.I.8	2839	65.4%	1505	34.6%	4344
	T.I.9	2113	64.2%	1179	35.8%	3292
	T.O.1	8782	94.8%	478	5.2%	9260
	T.O.2	10287	94.4%	611	5.6%	10898
	T.O.3	2212	82.3%	475	17.7%	2687
	T.O.4	8639	94.4%	514	5.6%	9153
	T.O.5	3030	86.8%	461	13.2%	3491
HCMC_TDP	P5.I.1	760	63.5%	437	36.5%	1198
	P5.I.2	409	88.4%	54	11.6%	463
	P5.I.3	869	79.8%	220	20.2%	1089
	P5.I.4	292	96.1%	12	3.9%	304
	P5.I.5	642	98.9%	7	1.1%	649
	P5.I.6	89	100.0%	0	0.0%	89
	P5.I.7	365	100.0%	0	0.0%	365
	P5.I.8	33	100.0%	0	0.0%	33
	P4.I.1	882	82.8%	183	17.2%	1065
	P4.I.2	323	54.9%	265	45.1%	588
	P4.I.3	1526	82.4%	325	17.6%	1852
	P4.I.4	1006	83.6%	197	16.4%	1203
	P4.I.5	2202	81.3%	505	18.7%	2707
	P4.I.6	1456	89.8%	165	10.2%	1621
	P4.I.7	2115	85.0%	372	15.0%	2488
	P4.I.8	1426	91.1%	140	8.9%	1566
	P.O.1	14426	89.3%	1726	10.7%	16152
	P.O.2	1338	90.5%	140	9.5%	1478
	P.O.3	13710	86.5%	2132	13.5%	15842
	P.O.4	2862	69.4%	1263	30.6%	4125
HCMC_TXS	S.I.1	623	23.5%	2026	76.5%	2649
	S.I.2	394	14.7%	2292	85.3%	2686
	S.I.3	340	16.5%	1727	83.5%	2067
	S.I.4	1025	24.1%	3223	75.9%	4248
	S.I.5	656	15.6%	3543	84.4%	4199
	S.I.6	536	26.9%	1453	73.1%	1989
	S.I.7	167	85.3%	29	14.7%	196
	S.I.8	191	89.1%	23	10.9%	214
	S.I.9	43	86.1%	7	13.9%	50
	S.O.1	1323	13.9%	8188	86.1%	9511
	S.O.2	1280	15.9%	6768	84.1%	8048
	S.O.3	12515	42.0%	17300	58.0%	29815

Appendix G_ 2. Results of indoor and outdoor viewpoints of TGA case studies

Appendix H : Time ratios of children's spatial-social-natural interactions in classrooms and playgrounds

Appendix H_ 1. Time ratios of children's social and natural interactions in classrooms

Participant ID	Gender	Social interactions		Natural explorations	Non-natural explorations		
		Solitary behaviours	Conversations with peers		Focused on paper	Onlooker behaviours	Off-task
HCMC_TQT_5 (total analyzed time: 620 seconds)							
5.1_A.HNK	Female	x	x	x	x	x	x
5.2_A.HQ	Female	x	x	x	x	x	x
5.3_A.PTT	Male	0.54	0.46	0.26	0.39	0.13	0.10
5.4_B.LT	Male	0.59	0.41	0.04	0.54	0.07	0.13
5.5_D.NLT	Male	0.65	0.35	0.09	0.56	0.00	0.18
5.6_D.NT	Male	0.32	0.68	0.05	0.30	0.05	0.31
5.7_D.PNK	Female	0.44	0.56	0.13	0.31	0.04	0.20
5.8_D.TK	Female	0.79	0.21	0.29	0.48	0.10	0.01
5.9_H.NH	Male	0.80	0.20	0.10	0.71	0.02	0.03
5.10_K.BLT	Female	0.30	0.70	0.12	0.32	0.14	0.02
5.11_K.LV	Male	0.54	0.46	0.06	0.50	0.02	0.00
5.12_K.NHN	Female	0.97	0.03	0.24	0.39	0.17	0.06
5.13_K.VM	Female	0.66	0.34	0.15	0.55	0.11	0.00
5.14_L.HN	Female	0.67	0.33	0.14	0.48	0.13	0.03
5.15_M.NH	Male	0.58	0.42	0.12	0.59	0.10	0.00
5.16_M.NS	Male	0.41	0.59	0.18	0.31	0.11	0.12
5.17_N.QTB	Female	0.35	0.65	0.04	0.40	0.04	0.13
5.18_N.VHT	Female	0.60	0.40	0.08	0.62	0.05	0.00
5.19_N.DNP	Female	0.82	0.18	0.07	0.68	0.17	0.00
5.20_NGH.NNG	Female	0.68	0.32	0.18	0.51	0.09	0.00
5.21_PH.HL	Female	0.59	0.41	0.16	0.58	0.14	0.00
5.22_T.NH	Male	0.36	0.64	0.08	0.46	0.05	0.00
5.23_T.TNA	Male	0.31	0.69	0.11	0.44	0.02	0.06
5.24_ TH.LNP	Female	0.73	0.27	0.26	0.51	0.08	0.04
5.25_TH.NHA	Female	0.49	0.51	0.20	0.49	0.20	0.05
5.26_TH.PMA	Female	0.78	0.22	0.09	0.65	0.13	0.00
5.27_TH.QLM	Female	0.90	0.10	0.15	0.65	0.05	0.01
HCMC_TQT_4 (total analyzed time: 457 seconds)							
4B.1_B.ND	Male	0.66	0.34	0.22	0.35	0.15	0.02
4B.2_D.PM	Male	0.68	0.32	0.22	0.60	0.05	0.02
4B.3_H.HHV	Female	x	x	x	x	x	x
4B.4_H.NQ	Male	x	x	x	x	x	x
4B.5_KH.LTM	Female	0.80	0.20	0.13	0.66	0.02	0.00
4B.6_KH.TDN	Male	0.94	0.06	0.20	0.53	0.09	0.00
4B.7_L.DNK	Female	0.90	0.10	0.07	0.61	0.08	0.00
4B.8_M.TNA	Female	0.99	0.01	0.34	0.63	0.02	0.00
4B.9_NG.TNB	Female	0.97	0.03	0.12	0.76	0.06	0.00
4B.10_PH.LH	Male	0.93	0.07	0.28	0.58	0.05	0.00
4B.11_PH.PNG	Male	1.00	0.00	0.11	0.86	0.04	0.00
4B.12_TH.HNM	Female	1.00	0.00	0.10	0.52	0.06	0.33
4B.13_TR.TNB	Female	0.93	0.07	0.30	0.35	0.29	0.00
4C.1_A.NH	Female	1.00	0.00	0.06	0.89	0.04	0.02
4C.2_G.PS	Female	0.68	0.32	0.07	0.54	0.08	0.00
4C.3_H.ND	Male	0.82	0.18	0.33	0.39	0.17	0.01
4C.4_KH.BM	Male	x	x	x	x	x	x
4C.5_KH.NH	Male	0.80	0.20	0.34	0.44	0.07	0.00
4C.6_L.BNH	Male	0.61	0.30	0.29	0.37	0.09	0.04
4C.7_M.VHT	Female	0.83	0.17	0.21	0.47	0.16	0.00
4C.8_TH.TQ	Male	0.34	0.66	0.16	0.37	0.05	0.07
4C.9_TR.VM	Male	0.85	0.16	0.37	0.36	0.19	0.00
4C.10_U.TP	Female	0.78	0.22	0.25	0.37	0.19	0.00

HCMC_TQT_3 (total analyzed time: 600 seconds)							
3.1_A.TB	Female	0.99	0.07	0.40	0.60	0.12	0.01
3.2_B.NNK	Female	0.96	0.04	0.33	0.42	0.21	0.00
3.3_CH.CNM	Female	0.97	0.03	0.32	0.50	0.15	0.00
3.4_D.HQ	Male	0.81	0.19	0.07	0.47	0.26	0.09
3.5_KH.PM	Male	0.94	0.06	0.21	0.74	0.02	0.00
3.6_KH.PHM	Male	0.88	0.12	0.31	0.19	0.22	0.16
3.7_M.DD	Male	0.92	0.08	0.18	0.62	0.14	0.00
3.8_M.DM	Female	0.99	0.01	0.22	0.70	0.06	0.00
3.9_NG.CK	Female	0.77	0.23	0.12	0.45	0.24	0.11
3.10_NH.VX	Female	0.41	0.59	0.07	0.34	0.04	0.01
3.11_NH.LT	Female	0.97	0.03	0.30	0.54	0.14	0.00
3.12_PH.HQ	Male	0.59	0.41	0.26	0.33	0.10	0.02
3.13_S.NL	Male	0.54	0.47	0.20	0.50	0.03	0.10
3.14_TH.LN	Male	0.43	0.57	0.06	0.35	0.06	0.14
3.15_TH.HB	Female	0.65	0.35	0.16	0.55	0.20	0.00
3.16_TR.VHT	Female	0.89	0.11	0.17	0.45	0.28	0.00
3.17_V.LB	Female	x	x	x	x	x	x
3.18_Q.TB	Male	0.99	0.02	0.18	0.38	0.18	0.25
HCMC_TDP_5 (total analyzed time: 431 seconds)							
5.1_B.PG	Male	0.99	0.01	0.16	0.75	0.08	0.00
5.2_CH.PLB	Female	0.97	0.03	0.08	0.71	0.04	0.00
5.3_D.LDA	Male	0.99	0.01	0.14	0.59	0.12	0.00
5.4_GI.TH	Female	1.00	0.00	0.40	0.58	0.02	0.00
5.5_M.BNP	Female	1.00	0.00	0.03	0.96	0.01	0.00
5.6_NH.CT	Male	0.98	0.02	0.22	0.76	0.00	0.00
5.7_NH.PTY	Female	1.00	0.00	0.22	0.73	0.05	0.00
5.8_V.DK	Female	0.99	0.01	0.10	0.73	0.03	0.00
5.9_V.LPT	Female	0.92	0.08	0.40	0.53	0.01	0.00
HCMC_TDP_4 (total analyzed time: 380 seconds)							
4.1_C.TC	Male	1.00	0.00	0.21	0.77	0.02	0.00
4.2_D.HK	Female	0.82	0.02	0.08	0.84	0.08	0.00
4.3_D.LH	Male	0.84	0.16	0.22	0.56	0.07	0.00
4.4_D.LHH	Male	0.89	0.11	0.23	0.60	0.06	0.00
4.5_H.TLT	Male	0.98	0.02	0.28	0.59	0.13	0.00
4.6_L.CK	Female	1.00	0.00	0.31	0.40	0.29	0.00
4.7_M.ND	Male	0.92	0.08	0.28	0.52	0.12	0.00
4.8_M.PT	Female	0.95	0.05	0.19	0.38	0.38	0.00
4.9_NG.CH	Female	0.95	0.05	0.02	0.85	0.08	0.00
4.10_NG.TK	Female	0.91	0.09	0.17	0.62	0.12	0.00
4.11_NGH.PMB	Female	0.89	0.11	0.19	0.64	0.10	0.01
4.12_TH.VNM	Female	1.00	0.00	0.12	0.80	0.08	0.00
4.13_TR.LD	Male	0.83	0.17	0.10	0.34	0.39	0.00
4.14_U.VTT	Female	0.98	0.02	0.10	0.81	0.08	0.00
HCMC_TXS_5 (total analyzed time: 540 seconds)							
5.1_A.PTT	Male	0.98	0.02	0.15	0.76	0.07	0.00
5.2_A.TXM	Female	0.86	0.14	0.11	0.57	0.07	0.00
5.3_CH.DNQ	Female	x	x	x	x	x	x
5.4_KH.PNC	Female	0.79	0.21	0.10	0.71	0.06	0.00
5.5_KH.TT	Male	0.85	0.14	0.06	0.70	0.04	0.04
5.6_M.HH	Male	0.51	0.49	0.10	0.36	0.03	0.41
5.7_NG.NMT	Female	0.73	0.27	0.03	0.68	0.02	0.00
5.8_PH.ND	Male	0.66	0.34	0.12	0.46	0.04	0.02
5.9_PH.NHA	Male	0.65	0.35	0.03	0.47	0.09	0.28
5.10_TH.DTG	Female	x	x	x	x	x	x
HCMC_TXS_4&3 (total analyzed time: 620 seconds)							
4.1_KH.NN	Male	0.94	0.06	0.02	0.85	0.08	0.00
4.2_L.NMQ	Female	1.00	0.0	0.06	0.81	0.10	0.00
3.1_A.TXN	Male	0.88	0.12	0.04	0.56	0.22	0.25
3.2_K.DS	Male	0.89	0.11	0.05	0.68	0.16	0.00