A study on children's spatial─social─natural interactions within primary school: Design approaches for Case studies in Ho Chi Minh City, Vietnam

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Abstract. A growing body of global, evidence-based, research confirms the health, wellness, and academic benefits of childhood exposure to nature. This work explores the feasibility of designing landscape and architectural interventions within primary schools to enhance children's daily multi-sensorial natural experiences. In Ho Chi Minh City (HCMC), Vietnam, schools have been negatively impacted by issues related to large-scale urban development and by climatic changes. The environmental qualities (both built and natural) have been diminished, and urban pupils are losing their connections with nature in all temporal and spatial dimensions. There is therefore an urgent need to investigate primary school architecture in HCMC in order to provide children with improved educational environments that can provide opportunities for reconnecting them with nature, and to support pro-environmental behaviours. Responding to this, we have developed a research framework with three primary schools in HCMC, as case studies to investigate how various school settings influence child-nature-connection when comprehensively considering how children discover and interact with nature within study and play environments. The study involves observation of children's interactional behaviours while they are directly experiencing nature. The method has been adopted to examine spatial, psychological, and behavioural dimensions of exposure to nature within educational settings. Results indicate that children's natural experiences diverge from spatial and natural characteristics in different settings and contexts. Findings offer insights for decision-makers 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.

Keywords: Multi-sensorial Natural Experiences, Environmental Preferences, Spatial─Social─Natural Interactions, Natural Diversity, Primary School Architecture.

1   Introduction

At primary schools, every pupil should have the opportunity to have close and frequent contact with nature. Research has shown that this interaction contributes to students' achievements [1] and health in general, including mental and social wellbeing [2]. In line with this, greater natural experiences are found to be positively associated with children's pro-environmental behaviours and attitudes in adulthood [3]. Therefore, confronting the limited conditions of increasing urbanisation as well as degradation in the quality of the urban environment, presents challenges in contemporary school architecture and the need to find proper approaches that offer students' opportunities to have direct experiences with nature. Designing a new school, or renovating an old school, should consider children's daily access to nature and the richness of biodiversity surrounding (and within) the school site, in order to reconnect children and nature through spatial multi-sensorial engagements [4].

To accomplish this, the study involves investigations of place-based components (i.e. geographic locations, material forms, cultural and subjective meanings) and their influences on the way we human beings feel, think, and act toward nature. Our work supports further exploration of potential practical interventions [5] in urban and architectural settings [6, 7]. Recent research, studying how 7 to 12 year-old pupils within primary schools in Glasgow, Scotland, experienced nature through multiple senses, found that the greater naturalness values of schools positively contribute to the quantitative and qualitative degrees of children's natural exploration and preferences [8]. However, children's interactional behaviours when exploring nature within school environments has not yet been thoroughly investigated. This requires that we address the questions:

- *Where and how can a child have higher multi-sensorial interactions with natural features and settings? and*
- *Why is it that some spatial environment can raise clear feelings of being connected to nature while others cannot?*

Another aspect that needs more emphasis here is the child's nature connection as a combination of three kinds of interactions: with *nature*, with *space*, and *with other people*. Together this describes the 'spatial─social─natural' interaction. For example, the physical and natural settings of a place could encourage children to engage more with nature [9], or a child could invite a peer or an adult to come into contact with natural objects and vice versa [10]. Thus, to provide an understanding of how different connectedness values vary between different contexts and scales [7], the degree of children's connection with nature requires an additional affiliation to spatial and social components, rather than only features of individuals with nature. For this reason, we further investigate children's Spatial─Social─Natural interactional behaviours when they experience nature within various school settings, in order to have a more comprehensive understanding, and to promote contextual-based school design approaches in the architectural research context.

Furthermore, with broadening interests in cultural, social, and educational differences that are considered important factors in altering preferences of natural landscapes [6, 11], in this study we have studied children's experiences with nature in various primary schools in Ho Chi Minh City (HCMC), Vietnam. In comparison with the findings of our previous case studies in Glasgow, it seems that most children in HCMC are significantly more disconnected from nature within all aspects of their living and study environments [12]. Resultant differences in perceived nature and favoured spaces are due to different climate types, thermal comfort and satisfactions, and can significantly influence the usage of indoor and outdoor environments at schools. In terms of direct, 'hands-on' experiences of nature, they have less frequent contact due to curricula and co-curricular activities. These contextual factors lead to particular characteristics in classrooms and school environments, wherein natural features are located within indoor and outdoor spaces to offer a proxy for the children's direct natural experiences. These features are considered important factors that influence the degree of naturalness that children are exposed to, and subsequently on their responses regarding their perceptions of nature, and on their identification of favourite places within study and play environments.

In summary, this study attempts to examine children's Spatial–Social–Natural interactional behaviours while directly experiencing nature within various school settings and contexts. It is anticipated that the outcomes will offer insights for decision-makers 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.

2 Research methods

2.1 Research design

This research employed behavioural observations at HCMC case studies when children were doing the task of exploring natural elements and stimuli within their classrooms and playgrounds (similar to our previous study with Glasgow case studies [8]). The work was undertaken to establish how children in these locations interacted with the spaces, natural landscapes, and other people. Following a review of environmental-behaviour studies conducting observation techniques [13, 14, 15], the method included behavioural mappings which were conducted to capture children's behavioural patterns within real spatial settings.

2.2 Selection of case studies

Children were recruited from three HCMC primary schools, including the public-school Tran Quoc Thao (TQT) (in the city centre district), the private school Tue Duc Pathway (TDP) (in the community-educational designated area of a developing district), and the home school Tre Xanh Steiner (TXS) driving as the Waldorf Steiner approach (in the residential area of a developing district). These schools were selected

since children groups were taught with different educational approaches and curricula within considerably different learning environments [12].

2.3 Participants

There were 122 pupils without special needs (46% males, 54 females) with their ages ranging from 9 to 13 years old (M_{age} = 10.11 years; SD = 0.92). Particularly, the numbers of pupils in TQT, TDP, and TXS were 69, 39, and 14, respectively.

2.4 Ethics

Approval for this study was granted by the University of Strathclyde Ethics Committee. Permission from schools and parents of all participating school children was obtained.

2.5 Data collection

This study applied direct observation with camera recording for collecting data. Each participant group was recorded for 10-15 minutes in both the classroom and playgrounds. The particular investigated places of each studied school group are shown in **Fig. 1** and **Fig. 2**.

Fig. 1. Investigated playground areas of three primary schools

- In TQT – three groups of pupils in grades 3 to 5 (namely TQT_3, TQT_4, and TQT_5) did the indoor and outdoor surveys at the same designated typical classroom and playground areas.
- In TDP – three groups of children with ages ranging from 9 to 11 years old, namely TDP_3, TDP_4, and TDP_5, took outdoor surveys at the main playground. However, only two groups TDP_4 and TDP_5 had indoor surveys in their classrooms separately.
- In TXS – two groups of students grade 3&4 and 5 (TXS_3&4 and TXS_5) had indoor surveys within their classrooms which had the same layout. Regarding outdoor tasks, the students of grade 3&4 explored nature in the sandy and hard-surfaced playground area (O1) while the grade 5 students investigated the O2 area which is used

for outdoor studying activities (for instance, learning carpentry skills, doing handi-crafts, and making bonfires) with a vegetable garden.
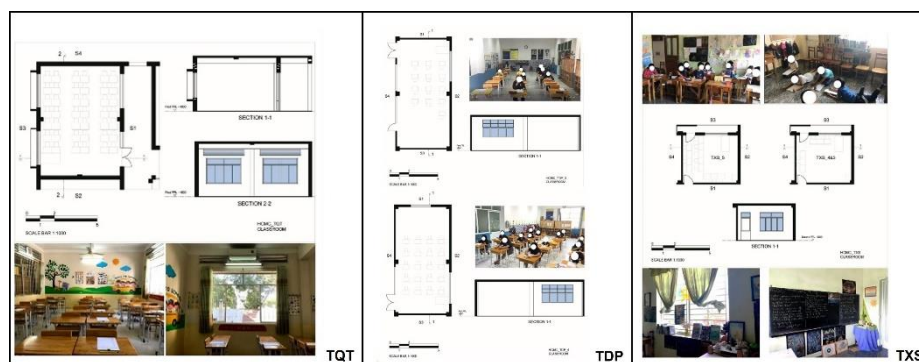
Fig. 2. Architectural features and children's seating layouts within investigated classrooms of three schools

In classrooms, an unmanned camera was placed at the teacher's table or at a high position to capture all pupils to explore the correlation between their seating positions and their behaviour when exploring nature from here. At playgrounds, the number of cameras was based on the size and form of the site to define children's utilizing each area actively or passively, and how children interact with natural elements and with peers.

2.6 Data analysis

Three categories of children's interactions while exploring nature within a place are the following: spatial, social, and natural interactions. Because the features of organisation of the observable attributes are different, the sets of coding in the classroom and play-ground areas were designed to differentiate accordingly.

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

— Classroom Social Interaction (CSI): referred to how a child interacts with his/her classmates; including: '*solitary behaviour*', '*conversation with others*', and '*on looking behaviour*'.
— Classroom Natural Interaction (CNI): referred to how a child interacts with nature; including: '*natural exploration*' and '*working on paper*' (when the child who focused on the survey papers only'.

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

— Playground Spatial Interaction (PSpI): referred solely to the interaction between a child and a space where he/she presented and occupied; including: *'active interaction'* (more than 30 seconds in a position) and '*passive interaction'* (less than 30 seconds).

— Playground Social Interaction (PSoI): mean a child interacts with other people; 4 classifications according to the human distances of Hall (1963) are: '*intimate'* (0-0.5m), '*personal'* (0.5-1.2m), '*social'* (1.2-4.0m), and '*public'* (4.0-12.0m).

— Playground Natural Interaction (PNI): referred to how a child interacted with natural elements and landscapes; particularly, they are: '*involved'* (a child who observing natural elements) and '*non-involved'* (a child with off-task behaviours).

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 **Fig. 3**.


Fig. 3. Interaction keys and symbols of Children's interactions within a playground area

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 Results

3.1 Children's Spatial─Social─Natural interactions in playground areas

TQT playgrounds (Fig. 4)
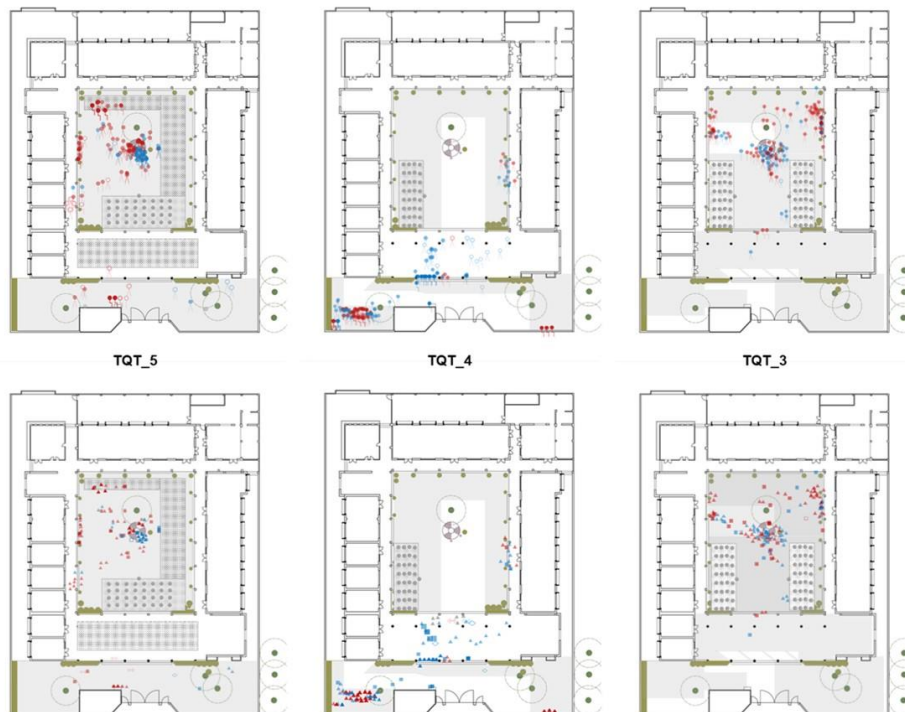
Fig. 4. Maps of children's spatial–social–natural interactions in time on-task of three pupil groups within HCMC_TQT playground areas

─ PSpI: children thoroughly avoided sunny areas and had the highest concentrations at the places where had seating opportunities. Younger pupils had higher degrees of movement within the shaded area to observe different natural objects other than visual distances in comparison to older groups who mostly occupied their locations during the surveys.

- PSoI: children mostly gathered at the places where are decorated with attractive and visible natural elements while they worked individually at positions where space is open, largely empty of substance, and free space, and walked around to explore other natural elements except flower-plants.
- PNI: They were mostly attracted by flower-plants and the green vertical wall. Additionally, the hands-on distances between children and these natural features supported higher frequencies of direct experiences through senses of touch, taste, and smell.
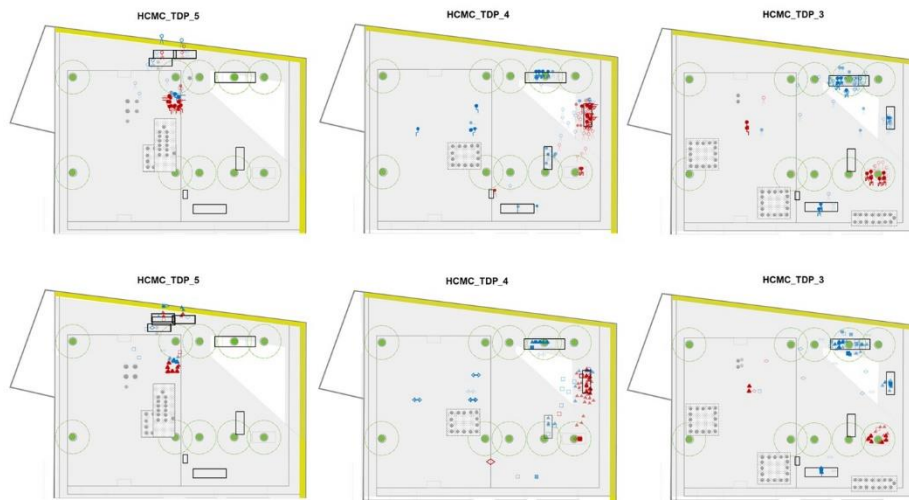
TDP playgrounds (Fig. 5)

Fig. 5. Maps of children's spatial–social–natural interactions in time on-task of three pupil groups within HCMC_TDP playground areas

- PSpI: the sunny areas were not occupied when pupils did surveys. With large areas of high trees' shade covering, the boundaries of their activities expandingly occurred within the playground. Younger children mainly gathered at trim-trail or climbing facilities to observe nature from high positions than other pupils, and they also had higher frequencies of traveling throughout the schoolyard.
- PSoI: Seating in groups by gender within intimate distances was the vast majority of social interaction patterns of children.
- PNI: Children had a much more intense inclination for observing natural elements from visual distances rather than close-distances of non-visual senses.
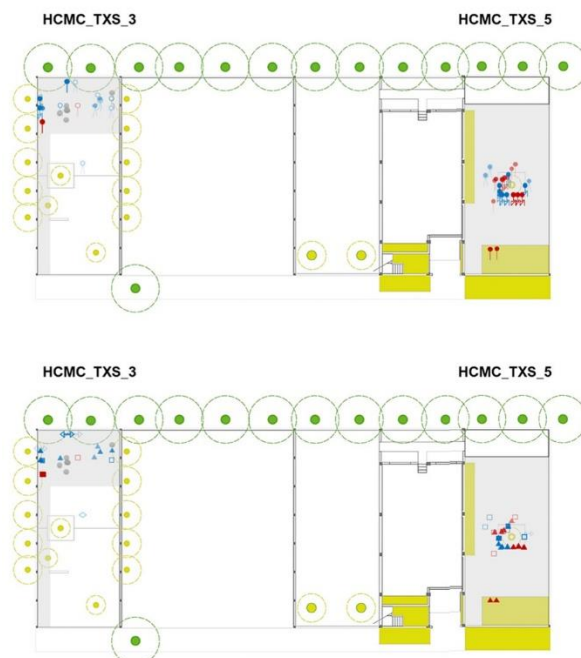
TXS playgrounds (Fig. 6)

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

— PSpI: Older children (TXS_5) were comfortable within their fully-shaded area compared to the football yard where younger pupils (TXS_3&4) heavily concentrated in the partly-shaded area to observe nature. The greater movement frequency of younger than older children, who mostly remained their positions during the survey period, was also observed.

— PSoI: Older pupils gathered within intimate distances at the central area to observe nature while younger pupils mainly worked independently within personal and social distances.

— PNI: TXS_5 children mostly observed nature only from vision distances although there were various natural elements to explore by both visual and non-visual senses. Similarly, the sand yard where TXS_3 investigated was glaringly sunny, and trees were not in the hands-on distances of non-visual senses; thus, they could explore nature through a sense of looking only.

3.2 Children's Social─Natural interactions in playground areas

Within classrooms when children explore nature, there are 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 social activities and interactions with nature are shown in **Fig. 7**.
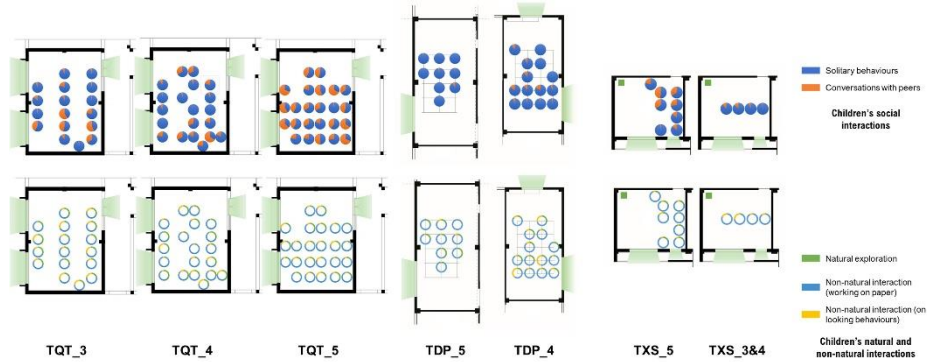
Fig. 7. Indoor interactions in time on-task of pupils groups within investigated classrooms

TQT classrooms (TQT_5, TQT_4 and TQT_3)

Three TQT groups did their natural exploration surveys within the same classrooms. It can be seen that children of three groups spent more time working individually and focused on working papers rather than having conversations with others and observing surrounding environments. However, the remarked difference in three groups was seating arrangements; and significantly, intimate distances between children's desks increased their time proportions of discussing with peers. While the grade 5 group heads the figure of spending time communicating with other people and the least time to observe surrounding environments for natural explorations, younger children took much time to work individually and to detect nature.

TDP classrooms (TDP_5 and TDP_4)

Children of grades 5 and 4 have higher degrees of working on tasks independently because individual desks are arranged in rows and at personal distances. With only one window near the teacher's table and in the line of children's sight 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's 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.

TXS classrooms (TXS_5 and TDP_3&4)

During time on-task, younger pupils frequently moved their heads to the window or moved around the room and then turned back to fill on papers. Oppositely, in the older pupils' classroom, the frequencies they looked out of these openings to observe outdoor environments were much higher. The results show that both groups also spent less time observing nature and had higher degrees of working individually than communicating with other friends although working within intimate distances compared to other

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classrooms. There are differences in social interactions that reveal the increased preferences of older children's interactions with friends in natural explorations.

4   Findings and Implications

Drawing on the analysis, notable issues in three 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.

4.1   Features of school playgrounds

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

— Firstly, the boundary of children's activities was heavily influenced by weather conditions and seating opportunities, especially in sunny and shaded areas. Notably, they heavily gathered at places where offer comfortable thermal satisfaction of shade from trees and buildings to explore nature.
— Children's posture varied according to features of playground settings. For example, they mostly preferred to sit down in cases of available seating at hard surfaced covering areas, or comfortably settle down at grass-surfaced areas and lay down on the grass, or to observe nature from higher positions and larger view-fields, such as from tree houses or trim-trail facilities.
— The size of the space could also direct the movements of children and their non-visual interactions with visible natural elements. 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.

These findings reveal 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). They suggest the landscape and architectural features in designing school settings in HCMC conditions 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. Furthermore, there are advantages in designing playgrounds with natural-based surface covers and adventurous challenges from natural elements that not only increase children's physical activities but also would probably evoke children's engagement with nature.

This study also further reveals significant distributions and influences of natural elements that evoke children's interests and favours, such as flower-plants; they have important roles in enhancing children's direct interactions with nature. This information should be considered to develop targeted interventions for setting up playgrounds and other recreational spaces according to characteristics of pupil groups and their activities.

4.2 Features of classroom settings

Overall, the results of investigated groups found the influences of physical settings of classrooms, including characteristics of openings and seating arrangements, could regulate the pupil's social and natural interactions when they explore nature.

Firstly, the effects of physical features of classroom openings in considerations of children's positions can be suggested in the frequencies of children's natural observations within indoor 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.

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 this study, the distance of study desk arrangements significantly shapes the characteristics of social interactions that influence children's indoor interactions with nature. 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 1**.

Table 1. 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					
	ρ						
Conversations with peers	r	**-.988****	1.000				
	ρ	0.000					
On looking behaviours	r	0.016	-0.007	1.000			
	ρ	0.873	0.944				
Natural exploration	r	.227*	-.207*	.256*	1.000		
	ρ	0.026	0.042	0.011			
Working on paper	r	**.559****	**-.574****	**-.397****	**-.291****	1.000	
	ρ	0.000	0.000	0.000	0.004		
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

Particularly, individual working was positively associated with time proportion of concentration on the task, including working on paper ($r=.559, p<.01$) and observing nature ($r=.227, p<.05$). In contrast, conversations with peers were negatively associated with focusing on working papers ($r= -.574, p <.01$) and natural exploration ($r=-.207, p <.05$). 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 ($r=.483, p<.01$), while others who had less time off-task increased individual time during the natural observation process ($r=-.474, p<.01$). Furthermore, another slightly significant association was found between children's social interaction features and the amount of indoor perceived natural types ($r=.206, p<.05$); this result indicated that children could figure out more natural types when working in groups.

The results from the association between children's social interaction features and the amount of indoor perceived natural types indicated that children could figure out more natural types when working in groups. When children explore nature, logical reasoning thinking is reflected by capabilities of defining natural classifications and linking the relationships between natural elements and stimuli, for example, the wind was figured out through movements and sounds 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. Thus, these findings may help us to promote important implications in organizing various types of activities in correspondence with characteristics of connections with others, and with nature, in indoor environments.

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. The decision-making process in the design of school indoor environments should consider the installation and renovation of opening systems (e.g. position, size, and height), and the interior layout of study desks and furniture to ensure every child has the opportunity for direct experiences of nature, and support optimal outcomes in children's development goals.

5   Conclusions

This study adopted observations and mappings of HCMC pupils as they explored nature within classrooms and playgrounds, in order to understand how they interacted with the spaces, natural landscapes, and other people. This work has provided evidence-based guidelines for refurbishing schools and planning new schools that supports the enhancement of children's sensorial experience of nature, especially in HCMC context.

The findings and conclusions are inevitably limited due to finite access permissions and time restrictions; the researcher investigated 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 occupation, have not yet been explored. In order to create more accessible methods for enriching the child-nature connections within an entire school building and site, further studies of various architectural forms and spaces are needed. Additionally, further exploration of spatial-social-natural interactions, involving a comparison between active and passive engagements with nature, might yield other insights particularly around organizing children's curricula.

Acknowledgements

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