Reconnecting Children with Nature:

Biophilic junior level learning environment design

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RECONNECTING CHILDREN WITH NATURE

BY

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Abstract

More than half of all humanity now live in urban centres. In westerns counties generally at least 80% of people's time is spent indoors. This means that people are spending less time outside and in places that can be considered 'nature'.

This is problematic because quantitative and qualitative research shows that isolation from the natural world negatively affects human well-being, suggesting that it is essential that nature is a constant part of humans' lives. This 'nature deficit' also impacts the development of personal bonds with nature which relates to learning to value and protect nature, and particularly affects young children. As children grow up in environments increasingly removed from nature, how will children form personal bonds with the living world if they spend their key developmental years removed from it?

To address this issue, this design-led research asks: how can we reconnect children with nature using biophilic design in junior level learning environments?

This question was explored through design-led research methodologies, primarily using an iterative design process, a 'triangulation' approach to research, and two sets of user-based interrogative research. This included a workshop with children aged 5-7 and a New Zealand primary school teachers' survey. These were conducted to gain insight into user opinions and preferences. Observations, discussions and results were combined and compared with related literature and initial design testing, and then refined into a set of key design elements (see chapter 8.0). These elements were found to be critical in creating well-functioning learning environments that offer biophilic potentials to improve learning, and directly appeal to the users. These elements were tested, developed, and refined through the design of a block of junior level classrooms, in Wellington, New Zealand.

Design explorations resulted in a proposed spatial solution that encourages children to interact with and experience nature on a regular basis, with the intention of stimulating the development of a personal bond with and value for the natural world.

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Please note: As the author is dyslexic, please ignore spelling errors in the pages of scanned sketches.

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1.0: Introduction

This section describes how living and working in spaces that are removed from the natural world negatively impacts human well-being physically and psychologically, and sets the context in which the design-led research is based. How these issues are approached in this research is also outlined here through the aims and objectives, and methodology sections.

1.1: Critical Issues: Child Development in a World without Nature

As children continue to grow up living primarily indoor lifestyles, they are becoming more removed from nature and the natural world, and are less likely to develop a personal bond with, or value for nature. In New Zealand, 80% of people's time is spent indoors (Public Health Advisory Committee 2002), and approximately 60% of children are in front of a screen for more than four hours every day (Duncan & McPhee 2015). This potential 'nature deficit' (Louv, 2008) is of concern because quantitative and qualitative research indicates that this negatively affects human physical and emotional well-being, in several key ways. For example, stress levels, blood pressure and depression may increase, while concentration and productivity may decrease (Beatley 2011; Browning et al. 2014; Browning 2016; Heerwagen et al. 1998; Mitchell et al. 2016; Kellert 2005; Kellert et al. 2008; Kellert & Calabrese 2015; Moss 2012; Wilson 1984). The development of personal bonds with nature may also be negatively affected, which particularly affects young children (Louv 2008; Kahn & Kellert 2002; Moss 2012). As the next generation grows up in this increasingly urban and indoor environment, an important question must be asked: how will children form personal bonds with nature and learn to value it if they spend their key developmental years removed from the natural world? The formation of this personal bond with, and value for nature is vital so that when children grow up to become the

citizens and leaders of tomorrow, they still value and strive to protect the natural world (Louv, 2008). Thus, people's ongoing relationship and connection with nature is a critical factor in both environmental and social sustainability and is of particular concern to those who design the spaces people inhabit; namely architects, urban designers, landscape architects and interior architects.

“

One of the most pressing and unrecognised problems of our age [is] the problem of environmental generational amnesia. The idea here is that people take the natural environment they encounter during childhood as the norm against which they measure environmental degradation later in life. With each ensuing generation, the amount of environmental degradation increases, but each generation takes that degraded condition as the nondegraded condition – as the normal experience.

(Kahn & Kellert, 2002, p.xii)

”

Lack of connection to nature in children has been linked to sensory and attention difficulties and to increased physical and emotional illness (Beatley 2011; Browning et al. 2014; Kellert et al. 2008; Louv 2008; Mitchell et al. 2016; Moss 2012). Careful consideration must be given to the spaces in which children spend their time, so these can be designed to facilitate a positive relationship with nature (Louv, 2008). In New Zealand, 5-13 year old children spend over half the year at primary school (Ministry of Education, 2017a), so focusing on learning environments is important in this context. As Louv explains:

“To improve health by trying to change human behaviour -preaching to people that they should change their habits- is not as efficient as using design to transform the environment in which people live’. (in: Kellert et al., 2008, p. 209) ”

For this reason, primary school learning environments were selected for the design-led research to explore how we can use biophilic design to reintroduce nature as a positive and beneficial part of everyday life and improve children's well-being.

“Regular positive interactions within nature allow children to feel comfortable in it, develop empathy with and grow to love it. No one can love what he or she doesn't know through intimate association.
(White & Stoecklin, 2008, p.3) ”

“It is not just children who need nature; nature needs children too.
(Moss, 2012, p.11) ”

“Both theory and data have provided tentative support for the hypothesis that children's emotional, intellectual, and values-related development, especially during middle childhood [ages 6-12]...is greatly enhanced by varied, recurrent, and ongoing contact with relatively familiar natural settings and processes. Moreover, these encounters benefit from a mix of direct, indirect, and vicarious or symbolic experiences of nature.
(Kahn & Kellert, 2002, p.146) ”

1.2: Research Question

Given these issues, this design-led research asks the question:

How can we reconnect
children with nature using
biophilic design in junior level
learning environments?

1.3: Research Aims and Objectives

Aims:

- To create a functional learning environment that encourages children to experience and interact with nature in a positive way and fosters a connection between child and nature.
- To explore how biophilic design can be applied to learning environments in a manner that may enhance cognitive education outcomes and directly appeal to children's thoughts and preferences for nature.
- To create a comfortable and functional 'outside' learning space that can be utilised for the full school year.

Objectives:

Conduct user (New Zealand primary school teacher and children aged 5-7) research to understand how they currently use, why and when they don't use, and when they think they could use outside spaces for learning. Along with understanding children's preferences for nature and learning and playing in nature.

Focus on designing at the scale of a child to develop the interactions and experiences of nature needed to develop the bond between child and nature.

Conduct research into functional New Zealand primary school learning environments to understand what aspects of learning space design are critical in creating quality learning spaces.

Examine biophilic design, how it has previously been applied to learning environments, and the different ways that it can affect human well-being and cognitive performance.

Define a set of design elements that are critical in creating a well-functioning learning environment that offers beneficial biophilic potentials to improve well-being, and directly appeals to users.

Conduct research into environmental/weather conditions of a specific site (Te Aro, Wellington) and develop concepts for an outside space that can be inhabited comfortably year round and in all weather conditions.

Through design, explore how to use biophilic design concepts to develop an enclosed space which has the sense of being an outside space.

Test through design how biophilic design and quality learning environment design can work together, without one negatively impacting the other.

Fig 1.1. Research methodology diagram.

1.4: Research Methodology

This research primarily uses existing frameworks of biophilic design to investigate and develop spaces which enhance well-being and encourage children to interact with nature at both a conscious and subconscious level. Because of the experience based and human scale ideas of biophilic design, it naturally lends itself to a design methodology similar to that of interior architecture. As a result, an inside out design approach was used, where the design started at the child experience scale and worked outwards spatially. During this process the design-led research focused on three different scales: child, classroom, and larger shared spaces. This was done because the design-led research focus was on creating experiences and specific spatial qualities at the child scale. Tests of literary theories and initial design explorations were conducted at the child experience scale, focusing on how certain spaces interact with the child. How these could be applied to learning spaces was then explored, working outward to eventually explore how these ideas could be reflected in the larger scale building forms and surrounding shared spaces. This allowed the design-led research to focus on and refine the experiences of nature at each stage of design. As a result of this, the design (especially when the focus was on child scale or classroom) appears at times to be floating without context. However, context/wider scales were still being considered during the entirety of the design process, so no layer of the design was ever fully isolated while being developed, even if the context isn't shown in the final imagery for each stage.

A 'triangulation approach' to the research was taken (see: Groat & Wang, 2002), so that conclusions drawn from biophilic design, learning environment literature, and design experiments could be compared with the observations of responses from the Children, Nature, Play and Learning Workshop and the New Zealand Primary School Teacher Survey. This was done to get a direct and holistic understanding on the preferences, opinions and needs of the users in a New Zealand context, along with testing the methods and ideas from literature in the specific research context. The amalgamation from this was then critiqued and refined into key design elements which were seen as critical to creating a quality New Zealand biophilic junior level learning environment. These were then explored and developed further through an iterative design process.

There was no flagship precedent case study that inspired design. Instead, the design-led research used several key precedent studies to help understand biophilic design theory and how it can be applied to learning environments. These were also used to understand the design and theory of innovative learning environments. This use of case studies gives the design-led research a solid understanding and grounding on the explored theories, and reflects the priorities of the research; focusing on the functionality of the design and its biophilic elements over considerations purely based on aesthetics.

Fig 1.2. Research order diagram.

During the development of the design-led research, the research scope was refined to focus on aspects that were found to be most important. An example of this was the refinement from designing a whole biophilic school (evident in chapter 4.0), to a block of four biophilic classrooms with shared learning spaces in-between. This refinement was made so that child experience scale design could be focused on, as well as allowing for more time to be spent developing a well-functioning biophilic learning environment, rather than taking time to develop a masterplan for a whole school. This kind of master planning would be a beneficial way to extend this research.

Due to the nature of design-led research, and how literature and precedent reviews were conducted concurrently with design development, the text is not in exact chronological order. Instead, it has been ordered to provide an easy to follow argument and development of the design process.

“

‘Children who don’t connect with nature before the age of 12 are less likely as adults to connect with nature. They therefore lose out on the resilience nature provides when you’re really stressed.

(Dr William Bird in: Moss, 2012, p.9)

”

“

We designed ourselves into this predicament and theoretically can design ourselves out of it, but only by adopting a radically different paradigm for development of the modern built environment that seeks reconciliation id nor harmonization with nature.

(Kellert, Heerwagen & Mador, 2008, p.5)

”

“

Biophilia is nonetheless a ‘weak’ biological tendency that is reliant on adequate learning, experience, and sociocultural support for it to become functionally robust... If our biophilic tendencies are insufficiently stimulated and nurtured, they will remain latent, atrophied, and dysfunctional.

(Kahn, Heerwagen & Mador, 2008, p.4)

”

2.0: Biophilia and Biophilic Design: Literature and Precedents Review

This section discusses the theory of biophilia and biophilic design, the different effects it can have on people, and in particular, children. It also explores how biophilic design can be used through investigating precedents. This section aims to clarify how biophilic design can be used to improve children's learning and general well-being, how it can be applied, and clarify the idea and existing use of 'inside-outside' space.

Fig 2.1. Three categories of biophilic design.

2.1: The Theory of Biophilia and Biophilic Design

Biophilia is the understanding that humans have an innate connection with nature and the natural world that formed as humans evolved over thousands of years from responding to survival in wild natural environments (Beatley 2011; Browning et al. 2014; Kellert & Calabrese 2015; Kellert et al. 2008; Wilson 1984). Now, in a small amount of time comparatively, people in western countries have almost completely removed themselves from these natural environments and moved into human-made and primarily interior environments. Spaces in which humans aren't exposed to the natural triggers that our bodies are designed to respond to. Research shows that this loss of connection to the natural world negatively impacts humans psychologically, cognitively and physically (Beatley 2011; Browning et al. 2014; Browning 2016; Heerwagen et al. 1998; Kahn & Kellert 2002; Kellert 2005; Kellert et al. 2008; Kellert & Calabrese 2015; Mitchell et al. 2016; Moss 2012; White & Stoecklin 2008; Wilson 1984). For example, having a visual connection to nature is shown to lower blood pressure and heart rate, improve mental engagements, and positively impact people's attitude and mood (Beatley 2011; Browning et al. 2014; Browning 2016; Kellert et al. 2008).

Biophilic design is applying the theory of biophilia to spatial design practice to enhance a sense of connection to nature, and thus increase human well-being (Browning 2014; Kellert & Calabrese 2015; Kellert et al. 2008; Wilson 1984).

Biophilic design is commonly broken into elements of ways to create a sense of nature within space. An early notable set of biophilic elements comes from the work of Stephen Kellert, in which he breaks up the theory into 72 elements which fit into six different categories (Fig. 2.2) (Kellert, 2008). However, in a later text written with Elizabeth Calabrese, they refine these to 24 elements in three categories (Fig. 2.3) (Kellert & Calabrese, 2015). The third text with a notable set of biophilic elements is by Browning et al. which includes 14 elements (Fig. 2.4) (2014). Comparing these three sets of elements, it is evident that the latter two sets cover most of Kellert's 72 elements within their more general elements (Fig. 2.5). For example in Kellert's 2008 set, light is broken into seven descriptive different elements, whereas these seven qualities of light are covered in one element in both the 2014 and 2015 sets.

Across these different strategies of creating a sense of nature within space, the categories these elements are split into generally fit within three topics; nature IN space, REPRESENTATION of nature, and nature OF space (Fig. 2.1). The first, nature IN space, covers actual elements of nature that can be used in design such as light, views of nature and water. REPRESENTATION of nature covers representations and metaphors of nature such as the use of natural materials, biomorphic forms and patterns. The last, nature OF space, is to recreate experiences people feel within nature, such as prospect, refuge and mystery.

KELLERT'S 72 ELEMENTS OF BIOPHILIC DESIGN (2008)

Environmental Features	Natural Shapes & Forms	Natural Patterns & Processes
Colour	Botanical motifs	Sensory variability
Water	Tree & columnar supports	Information richness
Air	Animal motifs	Age, change & the patina of time
Sunlight	Shells & spirals	Growth & efflorescence
Plants	Egg, oval & tubular forms	Central focal point
Animals	Arches, vaults, domes	Patterned wholes
Natural Materials	Shape resisting straight lines & right angles	Bounded spaces
Views & vistas	Simulation of natural features	Transitional spaces
Facade greening	Biomorphy	Linked series & chains
Geology & landscape	Geomorphy	Integration of parts to wholes
Habitats & ecosystems	Biomimicry	Complementary contrasts
Fire		Dynamic balance & tension
		Fractals
		Hierarchically organised ratios & scales
Light & Space	Place-based Relationships	Evolved Human-Nature Relationships
Natural light	Geographic connection to place	Prospect & refuge
Filtered & refused light	Historic connection to place	Order & complexity
Light & shadow	Ecological connection to place	Curiosity & enticement
Reflected light	Cultural connection to place	Change & metamorphosis
Light pools	Indigenous materials	Security & protection
Warm light	Landscape orientation	Mastery & control
Light as shape & form	Landscape features that define buildings	Affection & attachment
Spaciousness	Landscape ecology	Attraction & beauty
Spatial variability	Integration of culture & ecology	Exploration & discovery
Space as shape & form	Spirit of place	Information & cognition
Spatial harmony	Avoiding placelessness	Fear & awe
Inside-outside spaces		Reverence & spirituality

Fig 2.2. Kellert's 72 elements of biophilic design (2008, p.15).

KELLERT & CALABRESE'S 24 ELEMENTS OF BIOPHILIC DESIGN (2015)		
Direct Experience of Nature	Indirect Experience of Nature	Experience of Space & Place
Light	Images of nature	Prospect & refuge
Air	Natural materials	Organised complexity
Water	Natural colours	Integration of parts to wholes
Plants	Simulating natural light and air	Transitional spaces
Animals	Naturalistic shapes & forms	Mobility & wayfinding
Weather	Evoking nature	Cultural & ecological attachment to place
Natural landscapes & ecosystems	Information richness	
Fire	Age, change & the patina of time	
	Natural geometries	
	Biomimicry	

Fig 2.3. Kellert and Calabrese's 24 elements of biophilic design (2015, p.10).

BROWNING ET AL.'S 14 ELEMENTS OF BIOPHILIC DESIGN (2014)		
Nature is the Space	Natural Analogues	Nature of the Space
Visual connection with nature	Biomorphic forms & patterns	Mystery
Non-visual connection with nature	Material connection with nature	Risk/peril
Non-rhythmic sensory stimuli	Complexity & order	Refuge
Presence of water		Prospect
Dynamic & diffuse light		
Thermal & airflow variability		
Connection with natural systems		

Fig 2.4. Browning et al.'s 14 elements of biophilic design (2014, p.23).

COMPARISON OF THREE SETS OF BIOPHILIC DESIGN ELEMENTS

Browning et al. (2014) Kellert & Calabrese (2015) Kellert (2008)

Fig 2.5. Diagram grouping together author's similar elements of Biophilic design.

2.2: Biophilic Design and Human Well-being

The effects biophilic design can have are commonly split into three categories: cognitive; psychological; and physiological. Careful consideration of the effects elements cause should be given so that these align with the desired use and functionality of the space they are implemented in. For example, the improved concentration and attention from creating a sense of biophilic refuge¹ would be beneficial in a school/learning environment, however, these qualities are less important in a healthcare patient room (Browning et al., 2014). Instead, in that case, it would be more beneficial to focus on biophilic dynamic and diffused light, which is shown to reduce stress (Browning et al., 2014). Though all biophilic design effects are beneficial, and none should be intentionally excluded, as the design-led research explores learning environments the focus is on the elements that can enhance cognitive performance; memory, attention, concentration, and creative thinking.

Though all three (and many other) texts discuss the effects of biophilic design have on people, Browning et al. clearly links which effects each element has been shown to have, and the quality and quantity of the research backing each effect (2014). Using Browning et al.'s table of 'Biophilic design patterns & Biological Responses' (Fig. 2.6) elements of biophilic design that enhance cognitive performance can be isolated. These are split into three groups with ranging levels of quality and quantity of supporting evidence (2.7).

The patterns with most evidence supporting cognitive enhancement:

- Visual connection to nature: improved mental engagement.
- Prospect: reduced boredom, irritation and fatigue.
- Refuge: Improved concentration and attention.

The patterns with second most evidence supporting cognitive enhancement:

- Non-visual connection to nature: positively impacted cognitive performance.
- Non-rhythmic sensory stimuli: increased attention and exploration.
- Thermal and airflow variability: improved concentration.
- Presence of water: improved concentration and memory restoration.

And lastly, the patterns with anecdotal evidence supporting cognitive enhancement:

- Material connection with nature: improved creative performance. .

(Browning et al., 2014, p.12)

1. Biophilic refuge is the sense of comfort and safety humans get from being within a space that encloses them on three or more sides but still allows them to see out and observe. This relates to the primal need for safety and refuge from danger in these sorts of forms, such as caves (Browning et al., 2014).

Summary

Using biophilic design requires holistic thinking. Methods of biophilic design should be used in a carefully considered amalgamation of multiple elements working together throughout the entirety of a space, considering the richness of content, user accessibility and diversity of strategies (Browning et al. 2014). This requires targeted consideration and specific designing for the intended users and programme of the space to ensure consistency amongst the multiple strategies. In this context, the design-led research focuses on four junior level learning environments each for approximately 20 children aged 5-7. Thus biophilic strategies are scaled to child size and are aimed at child preferences regarding nature. Use of biophilic design elements with proven cognitive benefits are focused on throughout the design explorations. To make a more manageable set of elements for the design-led research to focus on, and because of the large amount of overlap between these author's elements, Browning et al.'s 2014 set of elements are primarily used. In particular, those found to positively affect cognitive performance. Explanations, ideas and methods of same/similar elements as described by other authors have also still been considered when designing and exploring.

BIOPHILIC DESIGN ELEMENTS EFFECTS ON HUMAN WELL-BEING

Fig 2.6. Diagram of Browning et al.'s 'Biophilic design patterns & Biological Responses' (2014, p.12).

Fig 2.7. Elements of biophilic design shown to have an effect on cognitive performance (Browning et al., 2014).

2.3: Biophilic Design and Children

Children experience nature differently from adults, judging it primarily around their experiences and interaction with it rather than its aesthetics (White & Stoecklin, 2008). This effects how biophilic design should be incorporated and requires a more experience based design approach, much like that used in interior design. Kahn and Kellert (2002, p.146) point out that children benefit more from “varied, recurrent, and ongoing contact with relatively familiar natural settings and processes. Moreover, these encounters benefit from a mix of direct, indirect, and vicarious or symbolic experiences of nature”. Having various different elements and types of biophilic design becomes more important, and differs from the needs of adults. For adults, where one high-quality biophilic installation may be effective (Browning et al. 2014), for children, with their fast-paced minds and lives, it may be more appropriate to have multiple biophilic installations so that they don't become bored with them over time. This sort of multisensory, multifaceted biophilic system, being an ongoing and familiar part of children's lives relates to the emotional, intellectual, and values-related development of children (Kahn & Kellert, 2002). For children to connect with nature and gain the long-term benefits it can provide, they need decent exposure to it so that they can learn, and form a positive personal bond with nature. For the design-led research, as school is a place children are guaranteed to be, it provides a good opportunity to inset nature into children's daily

lives. So the research focus was on creating various biophilic design elements throughout the learning spaces for children to interact with and experience during their time at school, ensuring that while they are at school, they are also exposed to nature.

A modern-day issue that nature now faces is competition from well marketed and addictive elements of indoor play such as TV, computer and video games etc. This is issue explored in the documentary Project Wild Thing, in which a method of marketing nature to children to get them to go outside is explored (Jones, 2014). A large part of this was making outside spaces exciting and appealing to children, essentially advertising the things they could do outside. In a learning environment context, one method of making outdoor spaces more enticing to children could be to use them in unique ways that could be more exciting or a bit rebellious in the children's eyes. An example could be taking activities that are usually inside and bringing them outside, such as allowing children to use a hallowed tree as a private breakout space for solitary reading. Or bring outside elements inside, like a stream running through the classroom. Making these nature elements exciting and enticing for children also increases the chance that users won't get bored experiencing/seeing the same biophilic installation and instead have positive reoccurring interactions with them time after time.

Summary

Due to how children experience nature, importance is shifted from aesthetic to experience of the biophilic design elements for the design-led research. Thus the design-led research explores how biophilic design elements can be developed to create different installations that are direct, symbolic or various experiences of nature, and that children can interact with and experience, and appeal to their preferences regarding the natural world. Understanding children's nature preferences will be a large factor in this, so that the installations are appealing and exciting to children, thus ensuring that a positive connection to their experiences occurs.

2.4: Biophilic Design Precedents

Throughout the design-led research, many biophilic design cases were explored and used to help understand how biophilic design can be used (Fig. 2.8-2.28 & 4.1-4.3). Discussed in the following section are three key cases that most helped advance the design-led research (Fig. 2.13-2.28).

Fig 2.8. The Red Bull Music Academy: gardens and rooms within a larger exterior structure.

Fig 2.9. Dome of Visions: transparent enclosure and thin timber structure creating minimal visual barrier between inside and out.

Fig 2.10. The Paul Chevallier School: use of biophilic design, especially creating a visual connection with nature.

Fig 2.11. Branson School Student Commons: classroom visually and physically open to the outdoors.

Fig 2.12. Mont Ceniz Academy: Blurring the line between inside and out through continuing ground finish either side of the glass exterior wall, and use interior use of water.

2.4.1: New Sandy Hook Elementary School

The New Sandy Hook Elementary School (NSHES) was designed specifically with biophilic design methods, and on which leading biophilic theorist, Stephen Kellert, was a consultant on.

Key aspects of this precedent that were considered during the design-led research project were:

- Biophilic designs application to learning environments. Despite the lack of biophilic design elements used in the classrooms themselves (Fig. 2.17), NSHES provides examples of biophilic designs application to the school's shared spaces, such as: the use of mezzanine floors and walkways which create a biophilic sense of risk; breakout nooks which provide a sense of biophilic refuge through three sided solid enclosures with views out to surrounding spaces; multiple different methods of tree symbolism from columns to wall patterns; and with the use of natural materials and textures (Fig. 2.14-2.16).

- Incorporation of nature into learning spaces without being tied to the curriculum. In other investigated schools with aspects of biophilic design a lot of the included nature elements were tied to the school's curriculum (See section 4.2). In the NSHES however, biophilic design is built into the building itself (e.g. through the finishes, tree symbolism, orientation etc.), meaning nature surrounds the students, and they experience aspects of the natural world every school day irrespective of the curriculum. It is this kind of biophilic design, that is constant and flexible, and emerges children in experiences of the natural world irrespective of curriculum, that this design-led research aims to achieve

Differences between the projects that should be considered:

- Incorporation of biophilic design elements were focused in the shared spaces, possibly because the NSHES design was for a whole school and not just a block of classrooms. However, for the design-led research, the focus is on creating a biophilic learning environment, specifically, a classroom.

New Sandy Hook Elementary School
Connecticut, USA
Svigals and Partners
2016

NATURE IN SPACE

REPRESENTATION OF SPACE

NATURE OF SPACE

Fig 2.13. Comparison of used biophilic design elements categories.

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Fig 2.14. Shared space with mezzanine floor, natural light, and tree columns.

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Fig 2.15. Tree symbolism.

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Fig 2.16. Breakout refuge space, providing enclosure that looks out onto larger adjoining space.

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Fig 2.17. Classroom, with little biophilic elements.

2.4.2: Fuji Kindergarten

The Fuji Kindergarten by Tezuka Architects is an example of the creation of inside-outside space (one of Kellert's 72 elements of biophilic design (2008) discovered and discussed in the initial design explorations in chapter 4 and 5). Here, this was done through blurring the separation between inside and out through the creation of a seamless flow between, and intertwining of these spaces.

Key aspects of this precedent that were considered during the design-led research project were:

- Blurring the transition between inside and out. This was done by having minimal physical barrier between the two spaces by using large glass sliding panels which could allow the internal space to completely open up the central outside space, or provides minimal visual block between inside and out when they are closed. The flow between these spaces is made more seamless by drawing the wall line back from the edge of the roof and flooring (Fig. 2.18). This means there isn't a harsh line between inside and out, but a transition from clearly inside, to an threshold 'in-between' space, to the clearly outside space.
- Intertwining the inside and outside. This was done by making the roof of the learning space an occupiable outside space, with lots of windows so children are aware that they are on top of their classroom (Fig. 2.20). Along with incorporating a tree (a typically outside

element) into the classroom which protrudes through the roof (Fig. 2.21-2.23). Wrapping the 'outside' spaces and elements around and into the inside space, so it becomes harder to separate the two as they become intertwined.

- Provide an outside space that is a functional extension of the inside learning space. Because of the circular form of the building, the central outside space acts like an extension of the classroom, and children are able to run free while still allowing for easy teacher visibility of the outside space from within the internal space (Fig. 2.19).

Differences between the projects that should be considered:

- Climate. Wellington experiences much stronger winds and UV radiation than Tokyo, and so such an open outside space shown here may not work in Wellington's climate. As it is an aim of this design-led research to create an 'outside' learning space that is comfortable and functional year round in all weather conditions, these factors need to be considered.
- As this is a kindergarten, the spatial requirements of learning environments are different than that of a primary school's. In kindergartens learning is done primarily through play, meaning learning spaces may be more relaxed and flexible than those of primary schools which require specific spaces for different specific learning tasks and activities.

Fuji Kindergarten
Tokyo, Japan
Tezuka Architects
2007

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Fig 2.19. Circular form of the kindergarten with central outdoor space.

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Fig 2.20. Occupiable roof with windows to classroom below.

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Fig 2.22. Tree protruding through roof, becoming an exciting and interactive feature.

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Fig 2.18. Seamless flow between inside and out with minimal barriers between the two spaces.

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Fig 2.21. Tree running through building.

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Fig 2.23. Section showing flow between inside and out, pushed back wall line and the internal tree.

2.4.3: Wind and Rain House

Nigel Cook's Wind and Rain house had a big influence on the design-led research's development. The idea of creating an 'in-between' space that feels like an outside space, but offers the comfort and functionality of an enclosed space. This creating an 'inside-outside' space that is comfortable and functional year round in all weather conditions.

Key aspects of this precedent that were considered during the design-led research project were:

- The creation of an outside space that is inside. This was achieved primarily through the use of a glazed outer-structure, which wrapped over the rooms and created an 'outside' courtyard between them (Fig. 2.25). The glazing then acts like a seamless edge between the actual inside and out, providing protection from the wind and rain but not visually blocking the space from the outside. The design of the 'in-between' space also ensures each room has a good view of nature/ the outside and allows more sunlight into every room as the house essentially gains a second North face.
- The use of materials to make the enclosed space feel like an outside space. This was done through the use of pavers and timber cladding, both of which are common and easily recognisable outside/exterior materials in New Zealand architecture (Fig. 2.24). Along

with physically bringing nature into the space to blur the definition of what space is inside and what is outside (similar to the tree in the Fuji Kindergarten, see: 2.4.2). This idea could be pushed further if the in-between space had patches of exposed ground so that plants could grow outside of pots and appear more like a common New Zealand outdoor garden

- Temperature control of the primarily glazed 'in-between' space. The risk of the space overheating in the warmer months was addressed by the inclusion of mechanically openable windows running along the roofs ridge line (Fig. 2.26). Their high placement making them efficient at expelling the rising hot air and allowing cool air to be brought in through the lower level windows.

Differences between the projects that should be considered:

- Program. As the design-led research is exploring learning environments rather than homes, there is a very different number of occupants intended to be within the space requiring very different acoustic qualities. The acoustic quality of space is critical in functional learning environments (see section 3.2), and the hard surfaces of glass and paved ground in the Wind and Rain Houses' 'in-between' space wouldn't function well as a learning environment. Instead, more soft finishes and furnishing would need to be added, for example, plants, acoustic panels, water and cushions.

Wind and Rain House
Paraparaumu, New Zealand
Nigel Cook
1988

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Fig 2.25. Glass out-structure creating an 'in-between' space that is neither entirely inside or outside.

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Fig 2.28. Incorporation of plants, spa and outdoor furniture into 'in-between' space, further blurring the definition of this space.

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Fig 2.24. Use of typically exterior finishes (timber cladding, pavers and plants) in enclosed space.

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Fig 2.26. Roof ridgeline windows for expelling hot, rising air.

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Fig 2.27. Glass outer structure increasing views to nature/outside.

**"Homes which create their own micro-climate and allow the owners to enjoy an indoor/outdoor lifestyle no matter what the weather may bring".
(Metal Roofing Manufacturers, n.d)**

3.0: Learning Environment Design: Literature and Precedents Review

This section explores literature and precedents of learning environment design, specifically looking at the typical architecture of current mainstream education in New Zealand, including innovative learning environments (ILE), and what spaces go into these, along with exploring what spaces and aspects are desired in quality learning environments. The aim of this section is to clarify aspects of space that contribute to creating quality learning environments so that these can be compared and developed with elements of biophilic design and user research.

3.1: New Zealand Primary School Design Requirements and Guidelines, and their Connection to Nature

In New Zealand, there are three types of schools: state, state integrated, and private schools (Ministry of Education, 2017b), all of which must adhere to the Ministry of Education's (MoE) requirements and guidelines document: *Designing Schools in New Zealand* (2015a). In this text, there is a strong push for schools to be designed for innovative learning environments (ILE), previously known as modern learning environments. These are spaces that provide a range of different spaces for children to choose for themselves where they would like to work. The emphasis for these spaces is on openness, flexibility, allowing for opportunities of collaboration between classrooms, and the ability to change with evolving educational practices (Fisher 2007; Ministry of Education 2015a, 2015b; Osbourne 2013, 2016).

The MoE's school design requirements and guidelines document (2015a) mainly focuses on:

- Environmental qualities of the space (acoustics, light, ventilation and indoor air quality, temperature, heating and insulation).
- Designing flexible learning spaces (reflecting the aims of ILE as discussed above).
- Efficiency (in form, operation and cost).
- Durability.

As already discussed (see chapter 2.0) research shows that human connection to nature affects their well-being. Because children spend approximately 56% of the year at school (Ministry of Education, 2017a) it is not surprising that school learning environments have an impact on children's development, as well as affecting their learning outcomes (Barrett et al. 2015; Crooks 2016; Osbourne 2016). In multiple publications, having a connection to the outside is cited as a factor in creating quality learning environments (Barrett et al. 2015; BRANZ 2007; Nair, Fielding & Lackney 2005; Osbourne 2016). In the MoE's requirements and guidelines document (2015a) however, outside learning spaces are only mentioned briefly, where they are described as an "important part of collaborative, enquiry based learning [that] can be achieved by allowing internal learning areas to spill out onto adjacent open decks or protected courtyard areas" (p.40). This, along with recommending designing for natural ventilation and lighting, is the only time anything natural or to do with nature or the outside is mentioned in the document. Though the benefits of nature are not being encouraged, the MoE text does discuss other aspects that can affect children's learning in more detail such as spatial environmental qualities including acoustics, light, ventilation and temperature.

Summary:

It is important to recognise this gap in current official New Zealand school design guidelines, as having a connection to nature has been shown to have so many effects on children well-being, learning outcomes and development (BRANZ 2007; Browning et al. 2014; Louv 2008; Moss 2012).

“

In most parts of the world, students are expected to spend their break times outdoors. Chances are there's no problem with this, but we need to make sure that we reciprocate with high quality outdoor environments - high quality enough even for teachers to choose to bring students outside during class time.

(Nair, Fielding & Lackney, 2005, p.110)

”

3.2: Aspects of Quality Innovative Learning Environments

To understand what spaces and group sizes are used in ILE, as well as the aspects that contribute to designing a quality learning environment, literature was explored and key aspects sketched. These texts included New Zealand literature by, and supported by the MoE (Ministry of Education 2015b, BRANZ 2007) (Fig. 3.2-3.5), New Zealand publications independent from the MoE (Osbourne, 2016) (Fig. 3.6), as well as leading overseas literature (Barrett et al., 2015) (Fig. 3.7). Across these texts, several key aspects of quality learning environments were referenced by authors (Fig. 3.1), including primarily:

- Air quality and ventilation
- Acoustic quality
- Daylighting
- Temperature control
- Ability to celebrate student's achievements and work.
- Provision of breakout spaces for students.

And secondly:

- Providing a view of nature.
- Creating an emotionally safe and supportive environment.
- Spaciousness/ability to easily move through space.

- Controlling colour levels to be exciting without being overwhelming.
- Providing options for collaboration.
- Providing storage.

While it is important to highlight these particular elements with reference to their impact on creating quality learning spaces, all aspects were still taken into account and compared to other conducted research. Air quality, acoustic quality, natural lighting and temperature control can all be grouped as qualities that affect the environmental comfort of the space. Though each of the aspects of this group is different, they function holistically, meaning if one aspect is changed, it will likely affect the others. For example, if windows are increased to allow for more ventilation or natural daylight, unwanted external noise or heat gain could also increase. Therefore these aspects should be considered and developed together.

Though not listed, it is also crucial to understand and consider the users of the space and their desires and preferences. For this reason, a participatory design approach is recommended, as the teachers and students are the ones that have the best grasp on where and how they like to learn, specific to that school, and what for them differentiates good learning environments from bad ones (BRANZ, 2007).

	Osbourne (2016)	BRANZ (2007)	Barrett et al. (2015)	Ministry of Education (2015b)	
View of nature					2
Provide outdoor learning					1
Air quality and ventilation					3
Acoustic quality					3
Daylighting					3
Temperature					3
Emotionally supportive					2
Encourage active learning					1
Spaciousness/moveability					2
Subtle changes of space					1
Colour levels					2
Stimulation complexity					1
Be able to adapt to technology					1
Easy access to social spaces					1
Visual access to aids					1
Consider scale of child					1
Learners have control over space					1
Celebrate progress & achievements					3
Personal spaces					1
Individualization					1
Cater for special needs students					1
Office breakout spaces					3
Flexible space					1
Variety of spaces					2
Spaces for specialised activities					1
Options for collaboration					2
Storage					2

Fig 3.1. Table comparing aspects of quality learning environments from stated literature.

Summary

Currently, there is a lack of MoE encouragement for connection to nature in learning environments which results in children missing out on the well-being developmental, social and learning benefits of having this connection is shown to offer. In response to this, the design-led research endeavoured to offer an example of these aspects can be incorporated in New Zealand school design.

Moving forward with the design-led research, the aspects of quality learning environment design are compared and combined with the findings of biophilic design, to ensure that the resulting space reaches a level of quality for both of these areas without one taking away from the other, as per one of the objectives of this design-led research (section 1.3). User research has also been conducted to assist the refining of these two areas, to ensure the aspects of quality learning environments and quality biophilic design focused on, are those that reflect what is best for the direct users.

Fig 3.2. Spaces in ILE (Ministry of Education, 2015b). This was used to understand the kind of spaces that are needed in an ILE.

Fig 3.3. Sizes of work groups in ILE (Ministry of Education, 2015b), this was used to understand the kind and sizes of space that are needed in an ILE.

QUALITY SCHOOL DESIGN - DESIGNING QUALITY^{LEARNING} SPACES: - BRANZ

SPACES

COMFORTABLE TEMPERATURE
(REGARDLESS OF OUTSIDE
TEMP)

HOLISTIC DESIGN APPROACH

FRESH
AIR

GOOD (NATURAL) LIGHTING

ST

STUDENTS/TEACHER CAN HEAR
EACH OTHER ACROSS CLASSROOM

EASY TO MOVE AROUND
SPACE/LAYOUT

PERSONAL SPACE

VISUAL ACCESS TO
VISUAL AIDS

AVOID OVERSTIMULATION
WITH TOO MANY BRIGHT
COLOURS

Fig 3.4. BRANZ (2007) aspects of quality learning environments.

QUALITY SCHOOL DESIGN - DESIGNING QUALITY^{LEARNING} SPACES: - BRANZ

CONSIDER THE AGE & SIZE
OF THE STUDENTS

SPACE NOT TOTALLY COMMITTED
TO ONE SIZE & LAYOUT (FOR
FUTURE FLEXIBILITY)

A SPACE THAT
FEELS SAFE &
COMFORTABLE

PROVIDE A VARIETY OF
SPACES

SPACE FOR SPECIALISED
ACTIVITIES

BE ABLE TO
ADAPT TO NEW
TECHNOLOGY

SPACE TO DISPLAY
CHILDREN'S WORK

EASY ACCESS TO SOCIAL
& RECREATION SPACES

LATER FOR STUDENTS
WITH SPECIAL NEEDS

FLEXIBLE SPACES FOR
VARIETY OF TEACHING
SPACES

PROVIDE PLENTY OF
STORAGE
(FOR TEACHER + STUDENT)

CONNECTION BETWEEN CLASSROOMS
(PROVIDES INTEREST)

Fig 3.5. BRANZ (2007) aspects of quality learning environments.

INNOVATIVE LEARNING ENVIRONMENTS — OSBORNE M — 2016

CONSIDER NEEDS OF EVERY LEARNER : INCLUSIVE ENVIRONMENT

ENCOURAGE ACTIVE LEARNING

NATURAL ENVIRONMENT

SUBTLE CHANGES IN ENVIRONMENT

- NATURAL LIGHTING
- AIR QUALITY
- COLOUR LEVELS
- SOUND LEVELS
- TEMPERATURE LEVELS

SPACIOUSNESS: PROVIDE 'TRAFFIC SPACE'

CELEBRATE PROGRESS & ACHIEVEMENTS

Fig 3.6. Osbourne (2016) aspects of quality learning environments.

CLEVER CLASSROOMS - BARRET ET.AL - 2015

NATURALNESS
- LIGHT

NATURALNESS - AIR QUALITY

EASILY CONTROLLED

NATURALNESS - TEMPERATURE

NATURALNESS
- LINK TO NATURE
- SECONDARY

NATURALNESS - SOUND - SECONDARY

STIMULATION - COLOUR

INDIVIDUALISATION - FLEXIBILITY
- VERITY OF SPACES

INDIVIDUALISATION - OWNERSHIP
- IDENTIFIABLE

STIMULATION - COMPLEXITY

INDIVIDUALISATION - CONNECTION
- SECONDARY

Fig 3.7. Barrett et al. (2015) aspects of quality learning environments.

3.3: Quality Learning Environment Design Precedents

Multiple ILE and school design precedents were explored and used to help understand what spaces make up learning environments, their size, how they relate to each other, and how they can connect to nature or the outside. Several of these precedents also demonstrate biophilic qualities. Three key precedents that most helped advance the design-led research are briefly discussed in the following section (Fig. 3.8-3.28).

3.3.1: Infant School

Key aspects of this precedent that were considered during the design-led research were:

- Multiple separate classrooms within one defined space (the roof) and using the resulting spaces in-between as shared play and learning spaces (Fig. 3.8).
- Pockets of space which are neither purely inside or outside space are created through having the external walls pushed in from the edge of the roof and finished flooring (Fig. 3.13). This 'in-between' space is similar to that of Fuji Kindergarten (section 2.4.2) but is exaggerated due to the larger depth and size of these spaces and the opposite forms of the circular roof against the linear walls.
- Use of colour to differentiate the different year levels of the classrooms. As well as providing bright spots of fun and exciting colour within the social spaces without becoming over stimulating (Fig. 3.10 & 3.12).

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Fig 3.8. Exploded axonometric view of the school showing the layout of the classrooms within the circular roof and floor edge, and the central shared spaces.

Infant School
Madrid, Spain
Rueda Pizarro Arquitectos
2012

Fig 3.9. View of the school's circular form and occupiable roof top.

Fig 3.10. Shared social spaces between the classrooms, accessible by all, spotted with bright and exciting colours and internal garden.

Fig 3.12. Each year level is designated a specific colour which is shown at its entrance, and used in sparing amounts so not be overstimulating.

Primary	Secondary
Air quality and ventilation	View of nature
Acoustic quality	Storage
Daylighting	Emotionally supportive
Temperature	Options for collaboration
Office breakout spaces	Colour levels
Celebrate progress & achievements	Spaciousness/ moveability
Thirdly	
Encourage active learning	Cater for special needs students
Provide outdoor learning	Visual access to aids
Subtle changes of space	Consider scale of child
Stimulation complexity	Personal spaces
Flexible space	Individualization
Easy access to social spaces	Spaces for specialised activities
Learners have control over space	Be able to adapt to technology
Variety of spaces	
Found in precedent	Not found in precedent

Fig 3.11. Table showing which aspects of quality learning environment design from literature were found in the precedent.

Fig 3.13. 'In-between' space is created from pockets which are not entirely inside or out, emphasised by the opposing forms of the curved roof and floor edge against the linear walls.

3.3.2: Cathedral Grammar Junior School

Cathedral Grammar Junior School is a 'garden school' in New Zealand's Garden City; Christchurch (Harvey, 2016), demonstrating aspects of quality learning environment design as well as connecting to nature. It is important to note that Fuji Kindergarten's, Tezuka Architects (section 2.4.2), also worked on this project, and some similarities can clearly be seen between the two projects. Such as the occupiable rooftop with a slide.

Key aspects of this precedent that were considered during the design-led research were:

- Connection to nature within the learning environment through: materiality; views; extension of roof and floor past exterior wall edge to create an 'in-between' space; large amounts of glazing to create minimal visual barrier between inside and out; continuation of structure between inside and out; and easy physical access to outside (Fig. 3.14, 3.16 & 3.19).
- Layout of learning spaces to create a central shared outside space that is easily visible from all classrooms making it a suitable breakout space that teachers can send students out to while still being able to easily see them (Fig. 3.14).
- Careful consideration for structure resulting in attractive natural exposed structures, which provide a sense of information richness while also offering a flexibility of space due to the large span which result in large, open spaces (Fig. 3.15 & 2.20).

Cathedral Grammar Junior School
Christchurch, New Zealand
Andrew Barrie Lad & Tezuka Architects
2016

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Fig 3.14. The central shared outside space that comes from the 'L' shaped plan. Large amounts of glazing are used along the classroom's edges facing this space and other neighbouring nature spaces, to ensure visibility of these nature spaces from all classroom spaces.

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Fig 3.15. Structure's wide spans allowing for open space providing flexibility of space.

Primary	Secondary
Air quality and ventilation	View of nature
Acoustic quality	Storage
Daylighting	Emotionally supportive
Temperature	Options for collaboration
Office breakout spaces	Colour levels
Celebrate progress & achievements	Spaciousness/ moveability

Thirdly

Encourage active learning	Cater for special needs students
Provide outdoor learning	Visual access to aids
Subtle changes of space	Consider scale of child
Stimulation complexity	Personal spaces
Flexible space	Individualization
Easy access to social spaces	Spaces for specialised activities
Learners have control over space	Be able to adapt to technology
Variety of spaces	

Found in precedent	Not found in precedent
--------------------	------------------------

Fig 3.17. Table showing which aspects of quality learning environment design from literature were found in the precedent.

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Fig 3.19. Extension of the roof and floor finish past the edge of the external wall creates an 'in-between' space which is not fully inside or out, similar to the Fuji Kindergarten (section 2.4.2).

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Fig 3.16. Continuous use of timber structure which creates a flow and connection between inside and out.

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Fig 3.18. Occupiable roof top with slide, similar to the Fuji Kindergarten (section 2.4.2).

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Fig 3.20. Exposed structure creates visual interest while its repetition and pattern stops it from overpowering the space

3.3.3: Ministry of Education's Reference Designs for ILE

These three schools are listed on the MoE's website to demonstrate ILE planning as a resource for learning environment designers (Ministry of Education, 2017c). It is important to recognise that all of these classroom blocks were designs for existing learning environments that were upgraded to ILE. They demonstrate the spaces that make up an ILE, the size of these spaces, and their relation to each other and other classroom aspects.

Taken from these plans was an understanding of:

- How spaces for different learning tasks and group sizes, such as those mentioned and sketched in section 3.2 (Ministry of Education 2015b), can be arranged in relation to each other and other aspects of the classroom, along with the sizes these should roughly be. One space which does seem to be underemphasized is storage for children and the teacher. Only "possible bag storage location" is shown on each plan.
- How ILE can be designed to allow for four traditional classrooms in one space.
- How outdoor learning spaces can be incorporated and arranged in ILE.

Avalon Block
Brewer Davidson
2015

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Fig 3.21. Avalon Block ILE design option one.

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Fig 3.22. Avalon Block ILE design option one.

Formula Block
Brewer Davidson
2015

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Fig 3.23. Formula Block ILE design option one.

Canterbury Block
Brewer Davidson
2015

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Fig 3.26. Canterbury Block ILE design option one.

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Fig 3.24. Formula Block ILE design option one.

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Fig 3.27. Canterbury Block ILE design option one.

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Fig 3.25. Formula Block ILE design option one.

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Fig 3.28. Canterbury Block ILE design option one.

4.0: Design-led Research 01: Understanding Biophilic Design and its Application to Learning Environments

This section discusses the methods of the initial design exploration investigating the application of biophilic design to school environments. Findings from this exploration are also discussed. This section aims to show the initial thinking and decisions which form the foundations of subsequent design-led research throughout the project.

4.1: Design Exploration Aims and Method

A 'quick start' design exploration was conducted within the first three weeks of the design-led research. The purpose of this exercise was to gain an understanding of biophilic design and produce quick examples of how it can be applied to school environments. This design exploration was conducted before most of the two literature reviews, and before the scope of the design was refined to a block of classrooms.

This exploration started by examining Kellert's 72 elements of biophilic design (2008) (Fig. 2.2), which became the basis of this initial design exploration, used to investigate how biophilic design can be applied in a school context. This was done in three ways:

- Through looking at several existing 'biophilic' or 'green' schools and finding which, where and how Kellert's 72 elements (2008) had been used.
- Through sketching possible ways Kellert's 72 elements (2008) could be used in a school context at three scales: school, classroom and child,
- By testing through design how some of these elements could be applied and used together in a classroom and school.

4.2: Existing Schools use of Kellert's 72 Elements of Biophilic Design

It was found in the explored schools (Fig 4.1-4.3) that children most commonly interacted with the natural elements of the school through the curriculum, e.g. Sidwell Friends Middle School and Commonwealth Secondary School's biology wetlands/pond. Though these sorts of installations can offer a deeper understanding of how natural elements work, it creates an unreliable interaction as there is the risk the element could become underused when the school's curriculum changed. This is particularly an issue for the design-led research which has no control over school curriculum. Instead, the biophilic elements should ideally be enticing enough that children want to interact with and be within the natural space without relying on a mandatory learning aspect.

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02. WATER

Pond from wetland with a boardwalk over top.

05. PLANTS

Outside vegetation visible from interior spaces, along with veggie gardens on the building's roof.

07. NATURAL MATERIALS

Timber cladding made of recycled materials.

08. VIEWS + VISTAS

Large glazed areas looking out onto wetland and greenery.

11. HABITATS + ECOSYSTEMS

Wetland used for biology lessons.

26. AGE, CHANGE, AND THE PATINA OF TIME

Timber fades and greys over time.

38. NATURAL LIGHT

Large glazed areas to get natural light into interiors.

71. FEAR + AWE

Occupiable roof.

Fig 4.1. Exploration of how and where Sidwell Friends Middle School uses Kellert's (2008) 72 elements of biophilic design.

Commonwealth Secondary School
Singapore

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02. WATER

A pond, wetland, and stream integrated with curriculum.

05. PLANTS

Multiple types and sized vegetation across the whole school, inside and out.

06. ANIMALS

Habitats and ecosystems at the commonwealth secondary school has brought birds, lizards, squirrels and snails to the school.

09. FACADE GREENING

Multiple green walls have been used around the school which are incorporated into the school's curriculum.

11. HABITATS + ECOSYSTEMS

The school includes a wetland, rainforest, aquarium and gardens.

13. BOTANICAL MOTIFS

Cracking pattern in paving around school resembles natural patterns like leaf veins.

Fig 4.2. Exploration of how and where Commonwealth Secondary School uses Kellert's (2008) 72 elements of biophilic design.

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01. COLOUR

Where wooden flooring of the Only About Children campus isn't used, a green carpet resembling grass is.

05. PLANTS

Multiple types and sizes of plants are kept within the school at different heights.

07. NATURAL MATERIALS

The campus includes a lot of use of exposed timber as flooring and furniture.

13. BOTANICAL MOTIFS

Tree pattern on the wallpaper.

14. TREE + COLUMNAR SUPPORTS

Columns designed to resemble trees, appearing strong.

38. NATURAL LIGHT

Large windows to get as much natural light as possible into high-rise school.

61. PROSPECT + REFUGE

Soft tent provides a private place of refuge.

Fig 4.3. Exploration of how and where Only About Children uses Kellert's (2008) 72 elements of biophilic design.

4.3: Sketch Exploration of Kellert's 72 Elements of Biophilic Design

By going through and considering how each of Kellert's 72 elements (2008), could be applied at the three scales, school, classroom and child, a clear understanding of each element, the reasoning behind it, and how they could be applied to a school context was gained (Fig 4.4-4.7). Some elements were difficult to explore because the sketch explorations were site-less (e.g. elements from the place-based relationship category) and some elements were found to overlap and differ only slightly (e.g. sunlight and natural light). When sketching at the child scale, the sketches explored how the element could be designed to encourage the child to interact with the element, specifically without relying on the curriculum. Designing for interaction proved to be much easier for the elements from Kellert's environmental feature category (2008), as these were physical things, which would fit with the wider 'nature IN space' category discussed in section 2.1. Whereas a lot of the other elements are more about space, form, sensual and visual qualities.

Fig 4.4. Sketch exploration of Kellert's (2008) 72 elements of biophilic design at three scales, School, Classroom, and Child.

Fig 4.5. Sketch exploration of Kellert's (2008) 72 elements of biophilic design at three scales, School, Classroom, and Child.

Fig 4.6. Sketch exploration of Kellert's (2008) 72 elements of biophilic design at three scales, School, Classroom, and Child.

		SCHOOL	CLASSROOM	CHILD
56. LANDSCAPE FEATURES	55. LANDSCAPE ORIENTATION			
	THAT DEFINE BUILDING FORM			
	61. PROSPECT + REFUGE			
	62. ORDER + COMPLEXITY			
	63. CURIOSITY & ENTICEMENT			
69.	70. INFORMATION & EXPLORATION & DISCOVERY			
	COGNITION			
	71. FEAR & AWE			

Fig 4.7. Sketch exploration of Kellert's (2008) 72 elements of biophilic design at three scales, School, Classroom, and Child.

4.4: Combination and Application of the Explored 72 Elements of Biophilic Design

When exploring how the sketched biophilic design elements could be applied and used together a site-less classroom was formed using different child scale elements to explore how they could fit into or influence the space, and work with other elements. This classroom was then multiplied to explore how it and its ideas could be applied at a whole school scale, and how more elements could be added to it. At this stage, an inner Wellington City site was used to test these ideas on.

CLASSROOM SCALE

04. SUNLIGHT

Large amounts of glazing on the north face.

05. PLANTS

A living green wall inside the classroom.

07. NATURAL MATERIALS

Natural materials show ageing and give people sense of time and age.

08. VIEWS

Views that contain natural and moving features.

19. SHAPES RESISTING RIGHT ANGLES

Sharp right angles have been rounded.

38. NATURAL LIGHT

Large amounts of glazing allows for natural light into the interior spaces, and light coloured walls reflect light deeper into space.

49. INSIDE-OUTSIDE SPACES

By bringing the floor of the outside deck inside, and using large glazed doors, the edge between outside and inside becomes blurred.

55. LANDSCAPE ORIENTATION

The classroom's outdoor spaces, windows and plants should be orientated to maximize sunlight.

61. PROSPECT + REFUGE

Using a change in height and sense of privacy, nooks of private refuge can be created within the classroom.

63. CURIOSITY + ENTICEMENT

The pockets of space create curiosity and enticement by creating unique spaces, that aren't all visible at the same time.

66. MASTERY + CONTROL

Sliding panels which allow the users to open and close spaces as they need creates a more flexible teaching space as well as giving the user control over their space.

Fig 4.8. Combination and application of the explored 72 Elements of biophilic design at the classroom scale.

SCHOOL SCALE

05. PLANTS

Multiple types of planting across the school creates a lush living view for the students and surrounding buildings.

06. ANIMALS

By designing a space that attracts animals, such as birds.

09. FACADE GREENING

Green wall provides unique planting which peaks interest in children.

11. HABITATS + ECOSYSTEMS

Incorporating a mini-forest.

30. BOUNDED SPACES

A planted edge along the exposed edge of school.

32. LINKED SERIES + CHAINS

The visible link between the classroom forms and spaces visually conveys organization while also creating a sense of mystery.

49. INSIDE-OUTSIDE SPACES

By bringing the occupiable outdoor space above and around the levels of the inside spaces, the line between inside and outside spaces becomes blurred.

55. LANDSCAPE ORIENTATION

Classrooms have been built up so not to visually block off or shade the natural/outdoor spaces.

56. LANDSCAPE FEATURES THAT DEFINE BUILDING FORM

In a built up and urban area, the blocking and undulating height and form reflects this.

62. ORDER + COMPLEXITY

The undulating, ever-changing but visually linked form of the buildings creates order amongst the seemingly complex form.

69. EXPLORATION + DISCOVERY

By including a dense cluster of nature it creates an intellectually stimulating environment.

71. FEAR + AWE

Raised outdoor play spaces with reasonable height create a moderate sense of fear.

Fig 4.9. Combination and application of the explored 72 elements of biophilic design at the school scale.

Fig 4.10. Inside-outside space: wrapping the occupiable outside space up and over the classroom so that they intertwine and the line between the two spaces becomes blurred.

4.5: Critical Reflections

When exploring how to incorporate multiple elements of biophilic design at the classroom and school scale it became clear that some elements were easy to incorporate (e.g. natural light and plants) while others required more sophisticated design thinking (e.g. 'inside-outside' space and sense of refuge). It was these more complex elements that created more spatially interesting moments. Specifically inside-outside space, which is when inside space appears, sometimes seamlessly, connected to the outside, such as in porches, interior gardens, atriums etc. The classroom scale design incorporated this through bringing finishes common to outside spaces, inside (as demonstrated in the Wind and Rain house, see section 2.4.3). In this case the rough exterior decking finish was brought into the classroom. This element was also explored at the school scale by wrapping the occupiable outside space around the classroom space (as demonstrated in the Fuji Kindergarten, see section 2.4.2), making the exterior walls and roof occupiable, and attempting to blur the line between the two spaces by intertwining them.

Following feedback and reflection from this initial design exploration, the design-led research focuses on:

- Starting the design with child scale moments of biophilic design, and developing the classroom around these so that biophilic design interactions and experiences inform the design of the classroom.
- Refining the design-led research scope to focus on developing a well-considered biophilic learning environment.
- Further exploring the theory of biophilic design, comparing how different author's elements differ and overlap, and refining these into a set of elements aligned with the research aims.
- Exploring how biophilic design can be used to encourage child interactions with nature without relying on a curriculum.
- Further exploring the idea of 'inside-outside' space.

5.0: Design-led Research 02: Direct and Subconscious Interactions with Nature

In this section, design testing was conducted to further understand literature on biophilic design, explore ways to design which encourages nature interactions and experiences, and further explore different ways of creating 'inside-outside' space touched on in the previous design stage. This section aims to gain a better understanding on biophilic design and its application to learning environments, and progress and refine the focus the design-led research.

5.1: Exploring Interactions, and a Sense of Nature using Biophilic Design

Similar to the first design-led research process, different authors' elements of biophilic design were explored through sketching at the child scale. This time focusing on physical, visual and auditory interactions with, and experiences of nature¹. These interactions were largely explored through elements from the 'nature IN space' category (Fig. 5.1-5.5), and the experiences were explored through elements from the 'nature OF space' category (Fig. 5.6-5.8) (see section 2.1).

1. At this stage, the majority of the biophilic literature review (chapter 2) was completed, but the learning environment design literature and precedents had not yet been greatly explored.

P1

P2. NON-VISUAL

Fig 5.1. Sketches exploring how to best design for visual and non-visual connections to nature (Browning et al., 2014).

Fig 5.2. Sketches exploring possible ways to seamlessly bring plants into classrooms, mainly exploring the use of plants for screens and raw tree trunks for columns.

WATERFALL WALL

-PHYSICAL
-AUDIO

BOARDWALKS OVER
WETLAND

SHALLOW POOL

-PHYSICAL

PATH
EDGING

INTERNAL CLEAR
GUTTER
-AUDIO
-VISUAL

CHAIN GUTTER

BIRD BATH

POND

-EDUCATION
-VISUAL

TREE
METAPHOR

WATER
NON-VISUAL CONNECTION
INFORMATION RICHNESS
SUNLIGHT

Fig 5.3. Sketches exploring possible ways to incorporate water into and around classrooms, and how these could be interactive.

Fig 5.4. Sketches exploring possible ways animals could be incorporated into and around classrooms, these focused on providing spaces that attractive animals.

Fig 5.5. Sketches exploring exciting ways to incorporate light into classrooms, and how to design these so that they are fun and enticing to the children.

Fig 5.6. Exploring the biophilic sense of refuge, which is the sense of comfort and safety humans get from being within a space that encloses them on three or more sides but still allows them to see out and observe. This relates to the primal need for safety and refuge from danger in these sorts of forms, such as caves. Having a sense of refuge is shown to improve concentration, attention and perception of safety (Browning et al., 2014).

Fig 5.7. Exploring the biophilic sense of risk/peril which is the sense of excitement people get from experiencing a controlled sense of risk, when they recognise that there is danger but know that they are actually safe, such as that experienced on a roller coaster. This is shown to improve mood and can help develop children's risk assessment skills and self-esteem (Browning et al. 2014; Moss 2012).

Fig 5.8. Exploring the biophilic sense of curiosity/mystery which is the sense of excitement humans get from the anticipation of not knowing what is coming next. This relates to the human need to understand and explore. By having a space that creates denial and reward; obscure and reveal, the space becomes engaging, exciting and enticing. This is shown to have a strong pleasure response and encourages people to explore the space (Browning et al., 2014).

5.2: Snapshot Designs Exploring Biophilic Learning Environments and Creating 'Inside-Outside' Space.

To develop the sketch ideas, different nature iterations and experiences were combined and tested to see how they could work together in a learning environment context. As well as using these iterations to further explore the idea of 'inside-outside' space, which was found in chapter 4 to create architecturally interesting spaces. This was explored in three different ways:

- Bringing nature inside (Fig. 5.9).
- Blurring the edge between inside and out (Fig. 5.10).
- Creating an outside that is inside (Fig. 5.11).

Fig 5.9. Bringing nature inside: this was done through the use of materiality (the raw timber structure), a built-in bird feeder outside the window (to encourage birds to land close to the classroom for children to observe), a planted screen (intended to partially separate breakout spaces), a large view to outside nature space, and the simple inclusion of a variety of indoor plants. Most of these encourage a physical and visual interaction with nature; the tactility of the raw timber and natural plants, and the views out to the outside nature and birds. However, risk and refuge ('nature OF space' elements which create an experience of nature) is also created through the raised platform spaces, and the confined cosy spaces created beneath. Lut laci del

Fig 5.10. Blurring the threshold: This was done through the transparent roof, use of outdoor decking flooring seamlessly running between inside and outside, along with the large glazed doors. Similar to the previous design, biophilic risk and refuge were created through the raised platform, creating an experience of the natural world. A sense of mystery is also incorporated through the hanging plants which form a screen that hides and reveals the refuge space behind. This refuge space is also enhanced by the stepping down of this space which separates it from the rest of the classroom. The key feature of this design is the transparent roof, which opens the space up and lets children watch the clouds and birds pass by overhead, and the changes in weather and sun during the day.

Fig 5.11. Creating an outside that is inside: this was done through focusing on creating an experience of nature, and designing an enclosed space that feels like an outside space. This was done by making the external walls and roof of the classroom transparent, resulting in minimal visual barriers between outside and in, along with the use of finishings and nature elements typically found outside. Though this space has fewer elements of nature for children to directly interact with, the space creates an experience of being outdoors, creating a whole body and subconscious interaction with nature.

5.3: Findings and Critical Reflections

Across the three design combinations, multiple types of nature interactions were explored, the most architecturally interesting spaces and ideas of which were generated from those that explore creating an experience of nature. This result was also reflected in the first design stage (chapter 4) which found elements from the category 'nature OF space' to be the most architecturally interesting. This is not to say that direct (visual, physical and audio) interactions should be excluded from the design, instead, they should be used together with subconscious interactions to create a holistic, multisensory nature experience. This could be done by using a nature experience to inform and change the architectural form of the classroom before incorporating more direct biophilic elements and interactions into this space, a method similar to that demonstrated in design 2.3.

It is critical that these experiences and interactions with the natural world are ones that the children enjoy so that they can attribute these positive emotions with nature itself. Thus, understanding children's nature preferences is critical, so that the spaces can be designed to directly appeal to them.

The idea of creating an enclosed 'outside' space explored in design 2.3 could also be developed to provide a comfortable and functional 'outside' learning space that can be utilised for the full school year (one of the design-led research aims). This could be done through developing this idea of an enclosed, sheltered space that is designed to feel like an outside space, creating a year-round, multisensory, nature experience in an 'in-between' space that feels neither entirely inside or outside (Fig. 5.12).

It is important to consider how the application of the biophilic moments affects the quality of the learning environment. For example, the large amounts of glazing in design 2.2 and 2.3 could negatively affect the temperature and acoustic qualities of the space. To ensure both aspects of the design are fully functional, these explored aspects of biophilic design shall be developed alongside aspects of quality learning environments.

Moving Forward with the Design-led Research

Following feedback and reflection from this design exploration, the design-led research will:

- Further develop the idea of creating an 'inside-outside' space with both interactions with, and experiences of the natural world.
- Conduct research into quality learning environments (chapter 3) and develop these findings in combination with elements of biophilic design.
- Conduct user research to gain an understanding of children's perceptions of and preferences for nature (chapter 7).

Fig 5.12. Diagram explaining inside outside space.

6.0: New Zealand Primary School Teacher Survey

This section discusses the methodology and results of a New Zealand Primary School Teacher Survey conducted to understand New Zealand primary school teachers' learning environment preferences, how they use their learning environments, what they want in an outdoor learning space, and how they do or would use it. This section aims to clarify important aspects of designing learning spaces, inside and out, so that they appeal to, and fit the needs of New Zealand teachers

Fig 6.1. Quotes from New Zealand primary school teachers regarding their thoughts on the importance of children's connection to nature and how this applies to learning environment design.

6.1: Purpose and Setup of the Survey

The purpose of the New Zealand primary school teacher survey was to gain professional insight into how New Zealand teachers are using their learning spaces¹. The survey was sent out to primary schools nationwide and received 19 responses². Participants were from a range of different types of schools and pedagogy, and were year 0 to year 8 teachers. The participants were asked questions about their preferences regarding classroom design, how they do and don't use outdoor spaces for learning and their thoughts on biophilia and its effects on children (appendix B).

6.2: Understanding the Survey Results

Fig. 6.6 illustrates results of a question where teachers were asked where they would like to teach each given curriculum topics. Though some spaces may have only been cited for one or two topics, the fact that the space came to mind at all gives it value. For example, sandpits were only mentioned for maths and topic inquiry, however after having discussions with a teacher, and as evident in Fig. 6.3, sandpits would be used by approximately a quarter of teachers for learning situations.

1. Ethics approval was obtained from the Victoria University of Wellington Ethics Committee for this study.

2. As there were a small number of responses to the survey, results are susceptible to bias. Because of this, results should not be considered absolute truths. Nevertheless, results largely align with learning environment design literature, and suggest directions for further design-led research investigations.

GROUP SIZES CURRENTLY TAUGHT OUTSIDE

Fig 6.2. Graph showing the group sizes teachers currently teach outside, used to understand the most beneficial type and size outdoor learning spaces.

PLACES FOR OUTSIDE TEACHING

Fig 6.3. Graph showing the spaces teachers currently teach in outside, used to understand what type of outdoor learning spaces would be most useable.

PLACES FOR OUTSIDE TEACHING

Fig 6.4. Depiction of which topics teachers are most likely to teach outside, used to understand the equipment, furniture and type of space necessary to create the most useable spaces.

WHAT STOPS TEACHERS TEACHING OUTSIDE

Fig 6.5. Graph showing what currently stops teachers from using outdoor spaces. Where possible, these aspects should be considered and solutions designed for so that teachers can use outdoor teaching space whenever they want to.

	Writing	Maths	Reading	Environmental	Art	Dance	Science	Drama	Te Reo	Topic Inquiry	Kapa Haka	Handwriting	Music	Technology	Total
Sheltered space	24%	18%	12%	12%	6%	6%	6%	6%	6%						94%
Under a tree	12%	6%	12%	6%	6%		6%		6%						53%
Playground	6%	6%	6%	6%	6%		6%		6%						41%
All outdoor areas	6%		6%		6%	6%		6%							29%
Table	18%	6%			6%										29%
Garden				12%			6%			6%					24%
Seating	6%	6%	6%												18%
Field						6%		6%			6%				18%
Sandpit		6%								6%					12%
Grassy bank	6%		6%												12%
Electricity						6%									6%
Total	76%	47%	47%	35%	29%	24%	24%	18%	18%	12%	6%	0%	0%	0%	

Fig 6.6. Table showing teachers responses when asked where outside they would teach each given topic. This was used to uncover what participants thought were good outdoor teaching spaces. Along with seeing if there was any overlap between spaces that worked for multiple topics or any topics require specific outdoor spaces. The most cited was sheltered space, which reflects the finding that bad weather and sun (UV) exposure are the top two factors that stop teachers using outdoor spaces.

Fig 6.7. Depiction of the changes teachers have seen in their students once they return to class after being outdoors.

Fig 6.8. Graph showing which benefits of connecting with nature teachers think are most beneficial in learning environments. Results from this were used to help refine which biophilic elements should be focussed on.

AVERAGE IMPORTANCE GIVEN BY TEACHER TO ASPECTS INCLUSION IN LEARNING ENVIRONMENT

Fig 6.9. Teachers responses to the question: what would make an ideal learning environment? Where ten is positively affecting the learning environment and zero is negatively affecting it. Shown in bold are the averages of the teachers' responses. This shows what the teachers most valued in their teaching space (averages 8-9) were all mentioned in the studied literature (section 3.1).

Fig 6.10. Key findings from the New Zealand primary school teacher survey.

6.3: Findings and Critical Reflections

Key findings from the survey are shown in Fig. 6.10.

To design usable outdoor spaces it is important to address why these spaces are currently not used (Fig. 6.5). For this reason, the design-led research specifically addresses the issue of how to create an outdoor space that is protected from bad weather, uncomfortable temperatures, and UV exposure (the top three reasons outdoor spaces are not used). The other reason outside spaces aren't used is largely to do with their design (lack of suitable space, furniture, writing surface, equipment). This is addressed in the design-led research through developing spaces that reflect the found preferences and needs of the teachers.

If these outdoor learning spaces are to act as an extension of the classroom, the visibility of these spaces is key. Visibility is mentioned multiple times in the survey results (Fig. 6.3 & 6.5) and in literature (chapter 3.0) as a critical aspect of functional learning spaces. For this reason, careful consideration should be given to the planning and layout of these spaces and their relationship to classrooms so that they are visible from within the main classroom.

The main aspect that teachers felt negatively impacted their teaching space was having desks arranged in a linear fashion, facing the whiteboard (Fig. 6.9). This is an aspect common in traditional learning environments and reinforces the push and attraction towards innovative learning environments, which offer more flexible space. The teachers valued flexible spaces highly with averages of 8 & 9.

Results from the survey are used in combination with findings from learning environment literature and precedent studies, to help design a functional learning environment that New Zealand teachers can easily use and children can flourish in. Along with being compared and refined with other research (biophilic and workshop results), so that the four nodes of research are explored and developed together to create spaces that appeal directly to teachers and children, are functional, and connect children with nature.

7.0: Child Nature Learning Play Workshop

This section discusses research undertaken to understand children's predispositions and preferences for nature, and how they learn and play in nature. The aim of this section is to clarify what aspects of nature appeal to children, which the design-led research uses to develop a space that directly appeals to 5-7 year old children.

Fig 7.1. Game One: Favourite spaces.

Fig 7.2. Game One: Favourite spaces.

Fig 7.3. Game Two: Pin the activity on the space.

Fig 7.4. Game Three: Design a learning space.

Fig 7.5. Game Three: Design a learning space.

Fig 7.6. Game Three: Children's completed model learning space

7.1: Purpose and Set Up of Workshop

The children, nature, learning and play workshop was conducted to understand children's perceptions and preferences of learning spaces and nature¹. By understanding these, they can be applied to design to develop spaces that directly appeal to children. The hypothesis of this research is that creating these kinds of learning spaces could facilitate a heightened relationship between children and nature. If children enjoy being in a space that they link to nature, then these positive emotions and feelings may transfer to and create a personal sense of value for nature itself (Louv, 2008).

A small group² of five children aged 5-7 (junior level), both female and male³ participated, from a variety of Wellington schools demonstrating different teaching pedagogies.

The children played 3 'games' about learning spaces and nature. These games were designed to get the children talking about what they want in learning and play spaces, and why. The first game, named 'favourite spaces', involved showing the children images of different learning and play spaces and asking them to choose their favourite by placing a sticker on it (appendix D).

This was followed by a discussion about why that particular option was chosen. In the second game, named 'pin the activity on the space', a variety of classroom and nature scenes were pinned to a wall and the children were asked to choose which space they would most want to do given curriculum based tasks in (appendix E). Tasks included: reading, handwriting, maths, art, play etc. In the final game, named 'design a learning space', the children were provided with an empty physical model of a classroom with an indoor and outdoor space (appendix F). They were told they could put whatever they wanted to in this learning space by choosing from a selection of cut out elements. These elements were items ranging from typical classroom elements, electronic items, biophilic elements, and 'soft seating' elements (Fig. 7.7). Elements categorised as biophilic included things that reflected the qualities of biophilic design as described in leading literature on the topic (see for example: Browning et al. 2014; Kellert & Calabrese 2015; Kellert et al. 2008). Climbing walls/nets and tents were categorised as biophilic because of their ability to create a sense of risk and refuge (Browning et al. 2014; Kellert & Calabrese 2015; Kellert et al. 2008).

1. Ethics approval was obtained from the Victoria University of Wellington Ethics Committee for this study.

2. Because the number of participants described was necessarily small, the workshop is susceptible to bias and results could change if a larger number of children attended. Because of this, results should not be considered absolute truths. Nevertheless, results suggest directions for further design-led research investigations.

3. In order to maintain confidentiality when discussing the children, gender pronouns have been replaced with the pronoun 'they', and faces have been blurred in all images.

Fig 7.7. Diagram of game three: design a learning space results.

7.2: Findings and Critical Reflections

Through all three workshop games, some things were consistently discussed by the children including: a preference for being outside; excitement about climbing; attraction to water; preference for bright colours, and providing spaces for focused learning tasks (Fig. 7.8). The following is a summary of the workshop findings, additional results and discussion of the workshop is documented in (Woodward & Pedersen Zari, 2018).

7.2.1: Preference for being outside

The children had a general attraction to the idea of learning in outdoor spaces for their fresh air and trees. Though outdoor learning spaces are nothing new, for them to be most effective they should be useable year round and in all weather conditions. This could be done through creating spaces that vary between being indoors and out, blurring the threshold between inside and out, or designing indoor spaces that feel like they are outside.

7.2.2: Climbing and risk

Climbing was continuously mentioned as an element of fun during the workshop and can be translated as relating to the biophilic element of risk which is the sense of excitement you get when you experience a controlled risk, like on a rollercoaster or watching a scary movie. For

the children, this was the excitement of being up high and the possibility of falling. Though it may seem counter-intuitive, allowing children to experience a controlled sense of risk can be beneficial for their development. Experiencing a controlled sense of risk has been shown to allow children to learn for themselves what is and isn't dangerous, develops self-esteem, cause a strong release of dopamine or pleasure responses, arouse attention and curiosity and refresh memory and problem solving skills (Browning et al. 2014 Kellert et al. 2008; Kellert & Calabrese 2015; Moss 2012). Design opportunities relating to an attraction to climbing include careful consideration of vertical spatial opportunities in learning spaces, for example through the use of mezzanine floors, climbing ropes, bridges, climbing nets, trees and so on.

7.2.3: Water

Though the children were attracted to water, they were hesitant about incorporating water into interior spaces because of fear of injury, causing damage and being disciplined for mess making. While some of these fears do reflect valid difficulties in designing safe and functional indoor water spaces, bringing water into the classroom is not the only way to encourage children to interact with water. Instead, wet areas could be added to outside spaces near the classroom such as ponds, streams, waterfalls, clear pipes, visible rainwater harvesting systems, hand pumps and more.

Fig 7.8. Diagram of workshop key findings.

7.2.4: Colour

It was found that the children were consistently attracted to bright, colourful spaces. However, excessive use of bright colours can be overstimulating and distracting for children in learning spaces (Barrett et al. 2015; BRANZ 2007). Instead, colours should be used strategically to attract children's attention to certain parts of the space. For example, typical play, entry or some outside spaces can incorporate a bright colourful aesthetic that will appeal to children. While the classroom could use multiple gradients of a single colour, which has been shown to trigger higher cognitive functions like memory, categorisation, and association (Gushiken, 2012).

7.2.5: Children's ability to concentrate

Spaces that allow children to concentrate are a critical aspect of a functional learning space. In the workshop, the children linked concentration spaces to those with desks, working surfaces and private cubby spaces. This highlights the importance of including suitable focused workspaces and surfaces in learning space design, regardless of whether these are inside or outside. The biophilic sense of refuge is spatially similar to private cubbies and breakout spaces which give children their own private workspace (Browning et al., 2014; Kellert et al. 2008; Kellert & Calabrese 2015). With the creation of private breakout of space, teacher's visibility of these spaces must be considered.

7.2.6: Conclusion

Results from the workshop suggest insights into what children think would make fun learning spaces rather than what would constitute a practical learning space. They highlight what kind of natural elements and spaces children are likely to be attracted to, and demonstrate possible ways to incorporate these elements into a learning space that children may positively respond to.

Taking these findings forward in the design-led research, the key elements that the children raised (preference for being outside, attraction to climbing, water and bright colours, and provide spaces for concentrating) were tested through design to develop a solution that directly appeals to 5-7 year old children. This direct appeal is what is intended to increase the bond between children and nature, and develop their personal sense of value for nature.

8.0: Key Elements of New Zealand Biophilic Junior Level Learning Environment Design

This section refines the findings of the conducted research into a set of 6 elements found to be critical in creating functional, high-quality biophilic junior level learning environments in New Zealand. Why these six elements were selected, and how they can be used is also described in this section, with the aim that they can be used to frame other design projects and provide criteria on which to critique the development of this design-led research project.

Fig 8.1. Combination of elements taken from biophilic design (chapter 2) quality learning environment design (chapter 3), New Zealand primary school teacher survey (chapter 6), and the children, nature, learning and play workshop (chapter 7).

8.1: Grouping and Aligning Elements from the Four Areas of Research

To refine the focus and scope of this designed research, the findings of the four areas of research conducted (biophilic design (chapter 2), quality learning environment design (chapter 3), New Zealand primary school teacher survey (chapter 6), and the children, nature, learning and play workshop (chapter 7)) – were collected and compared to understand how they overlapped (Fig. 8.1). This was done by starting with Browning et al.'s 14 elements of biophilic design (2014) and seeing how these related to each other (e.g. the overlap between presence of water, visual connection to nature, and non-visual connection to nature). This was followed by adding elements from the other areas of research. These either connected element groups together, (e.g. 'easy access to social and recreation spaces' from quality learning environment literature, which connected prospect and visual connection to nature) or were grouped with elements that encapsulate similar ideas, and increased the size of the group's bubble to show its importance (e.g. refuge, which links aspects found in quality learning environment literature and the workshop). In the few cases where a key aspect of research did not relate to any of the biophilic design elements, a new bubble was created (e.g. visibility, which is a critical factor of quality learning environment reflected in both literature and findings from the survey). Biophilic

elements which did not have any overlap with other research elements were removed, aside from those which have been shown to improve cognitive performance (Browning et al, 2014). These remained because they were found in the survey to be the most beneficial human impact of biophilic design in a learning environment context (in teachers opinions).

From this mapping, elements were then refined based on:

- Elements that had the biggest groups/ incorporated multiple ideas from the different areas of research, meaning they would positively contribute to multiple aspects of the design (e.g. refuge, thermal and airflow variability, flexibility, visual connection to nature).
- Elements that were found in literature, precedents, and the survey as a critical part of creating quality learning environments (e.g. flexibility and visibility).
- Elements that were found in the workshop to be appealing to the children, meaning they could create a space that children enjoy being in (e.g. risk).
- Elements that have been found to have the biophilic potential to benefit the children's learning (Browning et al., 2014) (e.g. refuge, thermal and airflow variability, visual connection to nature).

COGNITIVE PERFORMANCE

EMOTION, MOOD + PREFERENCE

STRESS REDUCTION
COGNITIVE PERFORMANCE
EMOTION, MOOD + PREFERENCE

STRESS REDUCTION
COGNITIVE PERFORMANCE
EMOTION, MOOD + PREFERENCE

ELEMENT OF
BIOPHILIC DESIGN

LEARNING ENVIRONMENT
LITERATURE

TEACHER
SURVEY

CHILD
WORKSHOP

Fig 8.2. The six key elements of New Zealand biophilic junior level learning environments, which area of research they are discussed in, and how they have been shown to affect people.

8.2: Key Elements of New Zealand Junior Level Learning Environment Design

8.2.1: Refuge

A biophilic sense of refuge can be linked to the idea of creating private breakout spaces for individual students and creating comfortable safe-feeling spaces. Biophilic refuge is the sense of comfort and safety people get from being within a space that encloses them on three or more sides but still allows them to see out and observe. This relates to a human's primal need for safety and refuge from danger that is found in similar forms, such as caves. Having a sense of refuge is shown to improve concentration, attention and perception of safety (Browning et al., 2014).

8.2.2: Risk

A biophilic sense of risk was selected because it relates to height and climbing, which was found in the workshop to be an aspect of nature that children were very attracted to. This relates to the hypothesis that if children enjoy being in the space that they attribute to nature, then these positive feelings may transfer onto valuing nature itself. Biophilic risk is the feeling of excitement which people get from experiencing a controlled sense of risk, when they recognise that there is a danger but know that they are actually safe. For example, the excitement of roller coasters or watching a scary movie.

Creating this controlled sense of risk has been shown to improve mood, and can help develop children's risk assessment skills and self-esteem (Browning et al. 2014; Moss 2012).

For children, this sense of risk could be created through heights and a risk of falling, which ties to the aspects of climbing that they showed to enjoy in the workshop. Risk such as this can be managed through barriers, safety ropes, soft mats etc.

8.2.3: Environmental qualities

As discussed in 3.2, the qualities that relate to the environmental comfort of a learning space are closely tied together and require holistic design consideration. For this reason this group of elements was renamed 'environmental qualities', which better reflects all aspects that the group includes, such as:

- Acoustics.
- Ventilation.
- Lighting.
- Temperature.
- Sun (UV) exposure.

These aspects are shown in both biophilic and learning environment literature to improve learning ability (BRANZ 2007; Browning et al, 2014; Ministry of Education 2015a). A large factor of this element depends on site conditions, so has been designed in response to the chosen site (see section 9.1), primarily through considering materiality, use of glazing, orientation, and openings.

8.2.4: Visual connection to nature

Having a visual connection to nature overlapped with multiple ideas and elements from both biophilic design and learning environment design research. It has been proven to lower blood pressure and heart rate, improve mental engagement, and positively impact attitude and happiness (Browning et al., 2014). As found in earlier design explorations (chapters 4 & 5), creating a visual (or physical) interaction with nature can be created relatively easily, through considering views out to biodiversely planted spaces, bringing nature into the classroom and/or attracting nature (e.g. animals) to site for people to look at or engage with.

8.2.5: Flexibility

Flexibility was included as a critical aspect because it encapsulated multiple ideas that were found to affect the quality of learning environments from relevant literature and survey findings. Having a flexible space means that it can be used in multiple different ways (related to key ideas of ILE) and gives users control over space and thus a sense of ownership. Flexible spaces are also more likely to be used in the future because they can adapt to unforeseeable changes, such as technological or climatic.

To achieve these kinds of spaces, one needs to consider how open space can be maximised, through layout and planning, to allow for a variety of spaces to be used for different tasks, and can be easily altered (e.g. closed off or opened up) depending on the needs of the tasks. This changeability and use of moveable furnishings can also give users a sense of control over their space.

8.2.6: Teacher visibility

Teacher visibility of learning spaces is an aspect that had less overlap with other aspects of research than the other key elements, but was included as it was found to be critical in the functionality of learning environments in the literature and survey.

To address this issue, careful consideration must be given to visibility during the layout/planning of spaces, especially those outside the classroom (if they are intended to be used as an extension of the classroom), along with the breakout/refuge spaces within the classroom. Teachers should be able to easily see all of the spaces in which students are working without having to remove themselves from the main classroom space.

8.2.7: Conclusion

These six key elements of biophilic education design have been defined to focus the scope of the proceeding design-led research developments. These are explored through design iterations in the following chapters to develop a comfortable, functional learning environment that improves children's learning and their connection to nature.

9.0: Design-led Research 03: Developed Biophilic Classroom Design

In this section, the design of a biophilic classroom is developed through an iterative process, on site. Design refinements are made to develop a space which directly appeals to users' needs and preferences, while also combining biophilic design with quality learning environment design to create a high functioning, well-being enhancing, learning environment for 5-7 year old children. This section aims to produce a developed design that demonstrates how the six key elements of biophilic junior level learning environment design in New Zealand can be used.

9.1: Site

To test and develop the design-led research, Te Aro Primary school was selected as a site on which to develop a new block of junior level classrooms. This site was selected due to the school's high value for nature and the environment in their curriculum and school values (Te Aro school, n.d.). Along with this, due to central city location, most students likely live highly urban lifestyles and may be less likely to spend time in nature.

Though this is an existing school, the design-led research did not investigate how the newly designed classrooms relate to the existing school aside from layout and access. This was because the design is intended to be an example of methods and ideas that could be applied to other contexts, and so a close tie to the existing school would have taken away from this. For this reason, it was seen as outside the scope of the research to conduct a deep site history and analysis because it was not the intention to develop a design tightly tied to one school/site. The main individual qualities of the site that were considered were mainly its climate and weather conditions (wind, rain, temperature, sun orientation and UV exposure), along with views, land contours, and layout of existing school spaces (in terms of the new block of classrooms access in relation to these).

The focus, was on the site's environmental conditions because these were found to be the main reason that teachers currently do not use outdoor spaces for teaching (see survey findings, chapter 6). Wellington is a temperate, rainy city, with extreme winds. It rains for 42% of the year and has wind gusts stronger than 63km/hr for 45% of the year (Chappell, 2014). Average temperatures are 17°C in summer and 9.6°C in winter (Annon., 2018). A study conducted in 2014 on sun shading for outdoor Wellington structures found that for 91% of the year warm shade would be needed to create a comfortable space (Fig. 9.3) (McKay et al., 2014). This means that there is little risk of spaces overheating so long as they are openable to the outside breeze (to cool the space when necessary). Sun and ultraviolet radiation (UV) exposure are a big issue in New Zealand, with the country receiving approximately 40% more UV than northern hemisphere countries at similar latitudes (Cancer Society, 2014). It was found that in Wellington UV protection is required for approximately 30% of the year (Fig. 9.3) (McKay et al., 2014). These weather, temperature and UV issues are directly related to existing reasons why New Zealand teachers are not using outdoor spaces for learning (see survey findings, section 6.3) and so become critical issues which the design-led research seeks to resolve.

Fig 9.1. Yearly wind on site.

Fig 9.2. Yearly rain on site.

Fig 9.3. Shade & UV protection needed on site.

Fig 9.4. Axonometric view of site showing existing context, orientation, existing school buildings and prevailing winds.

Fig 9.5. Views from site.

9.2: Key Design Idea

Developing on the idea of creating spaces that provide a constant experience of nature and the idea of 'inside-outside' space, a three layered design with an outside, 'in-between' space, and inside was developed. The 'in-between' space is intended to feel like an outside space while also having the functionality and comfort of being an enclosed space. The outer structure for this will be as transparent as possible to allow for a seamless connection between inside and outside. The 'in-between' space houses shared learning and play spaces along with the classrooms which provide enclosed and acoustically separated space for focused learning tasks.

Fig 9.6. Diagram depicting the three layer design idea.

9.3: Iterative Classroom Design Development

The layout of the spaces and the classrooms' relationships to each other was developed while considering acoustics, the possibility of sharing spaces, access to natural light, view shafts, and proximity to each other and high-use spaces¹.

Providing a range of communal breakout spaces contained within one space was explored at this stage. However, the design-led research moved away from this due to the strong division of teachers' opinions on primarily communal spaces (see chapter 6), and the acoustic and visibility issues that are created in these kinds of spaces. Research suggests that multiclass, open plan, primarily collaborative learning spaces may negatively impact (or at least be of no benefit to) children's learning (Wilson, 2015).

The design-led research focused on developing classrooms to be used as homerooms which could be opened or closed off from central shared spaces as tasks required. This gives teachers more flexibility to teach in the style they prefer.

1. The classroom design was developed while also considering its potential relationship with the outer structure but have been separated in this document for readability.

Fig 9.8. Exploration of different layout options of classrooms and resulting central shared space.

Fig 9.9. Initial classroom design test exploring: stepping spaces to fit in with the site's slope; use of levels to separate spaces; breakout space directly outside the main classroom; and incorporation of a climbing net; changeable walls for flexible spaces.

Fig 9.10. Classroom design development, exploring: an occupiable roof as a breakout space (this idea was moved away from due to visibility issues for teachers watching children); forming a net bridge across two mezzanine platforms; small level changes in breakout spaces; how space under stairs could act as a breakout and storage space; and the use of cantilevers and glazing to emphasise height, and sense of risk.

9.4: Developed Biophilic Classroom Design

The developed biophilic classroom design has been designed for the scale of a 5-7 year old child by designing the height and depth of spaces for their size. Though an adult still fits in the classroom the spatial priority is shifted from the one adult and given to the children using the space.

The use of colour has also been considered. Using gradients of a single colour has allowed for some bright exciting colours to be used without becoming overstimulating for the children (BRANZ, 2007).

Each of the six specified elements of New Zealand biophilic learning environments are explored in this design: through the use of raised cantilevering platforms; climbing nets; enclosed breakout nooks; consideration of glazing to allow for visual connection to the biodiversely planted surroundings; consideration of the ventilation, daylighting and acoustic separation of the classroom; flexibility of spaces; and teacher visibility of all classroom spaces.

Window placement and size was designed while considering maximising access to daylighting and the views that the 'in-between' space was anticipated to provide. Two sides of the classroom have minimal windows, which were anticipated to face south in order to minimise heat loss in winter.

The inclusion of the climbing net is designed to appeal to the children's attraction for climbing and height that was revealed in the workshop (see chapter 7).

Fig 9.12. Two raised cantilevering breakout spaces create a biophilic sense of risk, one of which has an occupiable climbing net, the other a nook beneath it to provide a space with a sense of refuge. The sunken mat area with tiered seating for easily visibility, window pocket seats provide space for individual breakout spaces, and high-level windows to expel hot air.

Fig 9.13. Perspective plan showing large multiuse space with a spatially separate entry space which includes storage for children. Floor finish materiality to create a seamless flow between inside and out.

Fig 9.14. Close up view of the refuge space: the lowered ceiling and five sided enclosure while still being able to look out and observe. The lower floor level and change to softer furnishings creates a space that feels separate from the main classroom.

Fig 9.15. Raised breakout space and occupiable climbing net: lack of a solid balustrade, cantilevering structure, and climbing net create the perception of risk even though the spaces are safe.

Fig 9.16. Large openable sections of walls offer flexibility to the teacher, by providing the ability to open up the classroom up to the shared spaces within the 'in-between' space or close off the classroom for focused tasks.

Fig 9.17. Sunken mat provides tiered seating and improves children's visibility of the board, while still being at a suitable level that the board can be seen from the main classroom area and the teacher can see the main classroom area.

9.5: Critical Reflection

Main design strengths:

- Consideration of all specified key elements of creating a New Zealand biophilic learning environment.
- Incorporation of aspects of the natural world that were found to appeal to 5-7 year old children (climbing, heights, learning outside and bright colours) (chapter 7). Creating a space that appeals to children with the intention that they will experience the space positively and that these positive feelings may transfer to nature itself.
- The biophilic design aspects do not negatively impact the functionality of the learning environment or vice versa. Instead, they work together to assist and improve children's learning.
- Incorporates aspects of the natural world into the classroom, beyond just bringing pot plants inside.

Three key points of suggested refinement:

- The classroom is not shown in context, so misses out on the potential to connect with surrounding nature.

Because the classrooms are designed from the child experience scale, out (to larger, shared spaces), the classroom design is shown without context at this stage. Though the classroom was developed with the thinking that it would be enclosed within an 'outside' space, filled with plantings, this was not visually represented. This was explored in the next design stage when the larger scale and the shared spaces were developed.

- Instead of trying to bring nature to site, would it have been possible to build/design with existing nature?

This was a valid point brought up by reviewers that would produce an interesting investigation. Because the design-led research was attempting to showcase examples of how to use biophilic design in learning environments that could be used in other contexts, tying the design of the classroom too closely to what was existing on site would have taken away from this.

- How will the net and other elements be translated into the 'in-between' space?

The intention is that the spaces should be designed so that they are open and function harmoniously together. This could be done through bringing aspects of the classroom, such as the net, use of platforms and refuge nooks, into the shared 'in-between' space.

Moving forward:

- Apply classroom design to site and explore how it should be altered to suit the conditions on site and its relation to other classrooms and shared spaces (especially window placement and building orientation).
- Consider visibility of shared spaces from the classroom in terms of classroom layout.
- Develop the 'in-between' space to create a constant experience of nature that can be used comfortably and functionally year round.
- Develop the outer structure, and how it can enclose both the 'in-between' space and classrooms, and create a comfortable environment for these.
- Develop the shared learning and play spaces within the 'in-between' space, giving particular consideration to how these relate to the classrooms and each other.

10.0: Design-led Research 04: Developed Design

Discussed in this section is the iterative design development of the layout of classrooms and shared spaces on site, the 'in-between' space, and the outer structure surrounding these. This section aims to explore, refine and demonstrate how an enclosed space can be designed to feel like an outside space, providing a constant experience of nature, while still providing functional and comfortable shared learning and play spaces year round, in all weather conditions.

10.1: Iterative Site Layout Design Development

The layout of the classrooms on site was explored while considering view shafts, wind, sun, orientation, visibility of shared spaces from classrooms and relationship to the existing school. Reflecting the responses of the survey (chapter 6), the shared 'outside' learning spaces were organised so that the spaces expected to be in high use (sandpits, water features, and bench space) were placed closest to the classrooms. A variation of a horseshoe layout was developed, which creates a central space to be filled with shared learning and play spaces, maximises sun access to all learning spaces (classroom and shared), and allows for a large planted area to be visually open to the existing school, which is intended to be a space that is shared with the whole school.

Fig 10.1. Site layout exploration considering: slope; different spaces for shared learning and play; access to views and sunlight; visibility of created shared spaces; and shelter against winds. A rectangular mass is used as a placeholder for each classroom.

*SUN TO ALL BUILDINGS + SPACES

- LAYOUT OF CLASSROOMS SHOULD STOP WIND FROM BLOWING INTO OPEN SHARED SPACE
- ONLY ONE CLASSROOM HAS VIEW TO OCEAN THOUGH ALL HAVE GARDEN VIEW
- SPLITTING UP GARDEN SPACE ISN'T OPTIMAL USE OF SPACE IN TERMS OF CREATING SPACE THAT WHOLE SCHOOL CAN USE

- SUN TO ALL BUILDINGS + SPACES, THOUGH EAST CLASSROOM IS SHADED A LITTLE FROM NORTHERN SUN
- WIND STOPPED FROM ENTERING SPACE BY OVERALL STRUCTURE, CLASSROOM LAYOUT SHOULD STOP WIND FROM BLOWING INTO SHARED OPEN SPACE
- ALL CLASSROOMS SHOULD HAVE A VIEW OF OCEAN
- LARGE GARDEN AREA OPEN TO EXISTING SCHOOL

- SUN ACCESS TO ALL SPACES + ROOMS, EXCEPT B/C + MESSY WORKSHOP ROOM. THOUGH THIS ISN'T NECESSARY IN W/C.
- LAYOUT OF CLASSROOMS SHOULD STOP WIND BLOWING INTO SHARED SPACE FROM ENTRANCE
- ALL BUT SOUTHERN CLASSROOM HAVE A VIEW OF THE OCEAN
- GARDEN OPEN TO EXISTING SCHOOL

- ALL CLASSROOMS SUNNY, THOUGH SHARED SPACE IS SHADED.
- NOT CLEAR ENTRY, THIS CAN BE DESIGNED THOUGH
- WIND STOPPED BY OVERALL STRUCTURE THOUGH RISK TO BLOW IN THROUGH ENTRANCE
- ALL BUT WESTERN CLASSROOM HAVE VIEW TO OCEAN
- LARGE GARDEN OPEN TO WHOLE SCHOOL
- JOINING BUILDINGS TOGETHER MAKES SPACE FEEL LESS OPEN + BLOCKS SUN + VIEW TO OPEN SHARED SPACE

- SUN ACCESS TO ALL ROOMS EXCEPT W/C (WHICH ISN'T NEEDED)
- LAYOUT OF CLASSROOMS SHOULD STOP WIND ENTERING OPEN SHARED SPACE
- ALL CLASSROOMS HAVE VIEW OF OCEAN
- LARGE GARDEN AREA, ONE OPEN TO EXISTING SCHOOL, THE OTHER ON STEEP HILL WITH POSSIBILITY FOR FUN CLIMBING PLAY ELEMENTS

- SUN TO ALL SPACES, THOUGH LIMITED NORTHERN SUN TO SOUTH CLASSROOMS
- OVERALL STRUCTURE STOP MAJORITY OF WIND, THOUGH RISK WIND WILL BLOW INTO OPEN SHARED SPACE FROM ENTRANCE
- ALL CLASSROOMS HAVE VIEW OF OCEAN
- GARDEN OPEN TO EXISTING SCHOOL

Fig 10.2. Site layout exploration considering: slope; different spaces for shared learning and play; access to views and sunlight; visibility of created shared spaces; and shelter against winds. Conducted using an initial classroom design.

Fig 10.3. Initial sketch design of shared space between classrooms, with a central stage, timber decking boardwalk, with plants growing amongst.

Fig 10.4. Developed site layouts exploring different horseshoe layouts, access to sun, visibility of the shared spaces, and site slope relationships. Conducted using developed classroom design.

Fig 10.5. Developed site layouts exploring different horseshoe layouts, access to sun, visibility of the shared spaces, and site slope relationships. Conducted using developed classroom design.

10.2: Iterative Shared Space Design Development

For this section, the design switched back to the child experiential scale to develop the shared spaces¹. These largely stemmed from workshop and survey findings regarding what outside spaces children enjoy playing and learning in. Such as providing water and climbing features (interactive rainwater feature, climbing tree column and an occupiable roof), along with spaces for focused learning tasks (refuge and risk breakout spaces, and workbenches and seats). Findings from the survey were also considered in terms of providing spaces for multiple group sizes (whole or multiclass stage space, small group breakout spaces, and individual breakout spaces). Installations were designed so that they could come out from the columns of the outer structure so that the structure itself became one with the learning spaces.

1. These moments were developed at the same time as the outer structure but have been separated in this document for readability.

SHARED LEARNING SPACES

- WATER FOUNTAINS
- SANDPITS
- TREEHOUSE
- BENCHES
- BY WATER FEATURE
- STAGE
- BREAK OUT SPACES
- MID LEVEL WALL
- CAVE/CURBY

Fig 10.6. Sketch summary of discussions with a New Zealand primary school teacher regarding outdoor learning and play spaces.

Fig 10.7. Climbing walls and tree columns: investigating how to provide for the children's attraction to height and climbing.

Fig 10.8. Workbench and seats: investigating how these could resemble tree roots coming out of the metaphoric tree columns and provide work and social spaces for small groups.

Fig 10.9. Exploring sandpit design and the possibility of including a raised platforms or benches with these. Along with exploring how the stage can work with the site slope.

Fig 10.10. Rainwater features: investigating how rainwater could be brought into the space and used to feed sinks and/or garden spaces.

Fig 10.11. Site layout iterations exploring how the shared spaces could be arranged on site in combination with the outer structure, and ensure good visibility of shared spaces from the classrooms.

Fig 10.12. Site layout iterations exploring how the shared spaces could be arranged on site in combination with the outer structure, and ensure good visibility of shared spaces from the classrooms.

10.3: Iterative Outer Structure Design Development

The development of the outer structure revolved around finding order in complexity. It was the intention of the outer structure to have a somewhat organic form, however after initial designs, it was clear that these were too 'messy' and resulted in the space feeling chaotic and overstimulating. Initial experimentation utilised the biophilic pattern complexity and order, which relates to how people subconsciously look for patterns in things, like those found in nature. Being able to detect such patterns has been found to produce a positive psychological and cognitive response (Browning et al., 2014). For this reason, patterns were used in the roof, walls, columns and beams of the outer structure to provide a sense of order, and give the eye something to focus on within the information-rich form.

During the development of these spaces (though not shown in Fig. 10.14-10.17) the designs were still critiqued on from an experience perspective. By placing a camera at the approximate height of a 6 year old and walking around the space, this ensured that while making design changes and developments at the wider scale, the desired experience in space was still being achieved.

Fig 10.13. Initial sketch explorations of outer structure design.

Fig 10.14. Roof design development: done concurrently with the exterior wall and column layout development. Exploration of how classrooms could penetrate through the outer structure roof. The main changes in the roof design were finding and then refining a pattern with which to control and simplify the roof design. Effects of different transparencies and the layout of different roofing materials (e.g. Polycarbonate vs clear glazing and strips of green glazing) were developed and refined based on shadows cast and protection from UV radiation at certain times of day.

Fig 10.15. Exterior wall and column layout design development: exploration of how classrooms could penetrate through exterior walls to get access to fresh air; development of layout of walls and columns; simplification of exterior wall design by making them flat and giving them a repeating and identifiable pattern; experimentation with hierarchy of columns through thickness (three main 'trees' holding up the roof are the largest with extra detailing in their adjoining 'tree branch' beams, columns at the edge of a 'tree' are thinnest, and columns apart of minor 'trees' are in-between these two sizes); and the placement of three main 'trees' at entry, near centre of shared space (which is the climbing 'tree'), and at the entry to the secret garden (alluding to something exciting happening at this part of site).

Fig 10.16. Column and beam design development: columns were developed to look like trees. These were developed with the guidance of a structures expert, to develop a structure that was visually lightweight and did not obscure the vertical view and visual connection to the sky through the transparent roof.

Fig 10.17. Climbing tree design development. This was developed in response to children's enjoyment of heights and working in high spaces found in the workshop. Exploring different seating; benches; platforms; spaces beneath could be created through different stair designs; and how these stairs could resemble tree roots.

Fig 10.18. Example of the sun study conducted to test shadows caused by different roof transparency.

Fig 10.19. Example of the sun study conducted to test shadows caused by different roof transparency.

10.4: Changes to Developed Biophilic Classroom Design

Alterations were made to the classroom design to fit with the site conditions. For example: stepping the sunken mat and mezzanine floor in with the site slope. The classrooms were also mirrored so that the two faces with more glazing and the two attached 'outdoor' breakout spaces, were facing east, west or north. Maximising access to daylight from these breakout spaces, and the classroom itself.

The classroom roofline was also altered to provide a simpler form against the more busy form of the outer structure. As well as allowing for an occupiable roof, and increasing the size of the high-level windows to allow for more ventilation through the stack effect.

Which of the two outdoor breakout spaces has the mid-height wall was also switched due to their position and surroundings on site. This wall height was lowered slightly so to be a more suitable bench height for a 5-7 year old child.

Fig 10.20. View of biophilic classroom's 'outside' breakout spaces. One which is more private with a sense of ownership to the classroom through the bench height wall that wraps around it. The other is more public and opens onto the adjoining pathway which links the classrooms.

Fig 10.21. Classroom section: changed roofline to provide simple form contrasting the surrounding angular form of the outer structure (shown in lines behind).

10.5: Developed Design

The final developed design responds to findings from the biophilic and learning environment literature review and feedback from the users regarding what they want in, and how they use outdoor learning spaces. The intention of the 'in-between' space contained within the outer structure is to provide a functional and comfortable 'outside' learning space that can be used year round, in all weather conditions. This space is designed so that it feels like it is an outside space, providing children with a constant experience of nature. The enclosure has been refined to produce a space that feels unconfined, with as little visual barrier between inside and out as possible.

To create this sense of an outside space within the outer structure, the transition between inside and out was critical and largely affected the design of the outer structure. Because it was the intention for this space to feel like an outside one, people had to be able to transition succinctly from outside into this space, without noticing an obvious change in space. This was achieved through:

- Transparent materiality providing minimal visual barriers between inside and out.
- Extending the structure of the roof (beams) beyond the roof finish so that there is not a hard line of open sky, to solid roof.
- Pushing the exterior wall back from the edge of the roof so that there was a transitional semi-covered space between outside and the enclosed 'in-between' space.
- Bringing a tree into the transitional space

and protruding this through the roof.

- Bringing plantings, timber decking, stepping stone and other elements typically found outside into the 'in-between' space.
- Bringing plantings right up to the exterior walls of the outer structure, on both the enclosed and outside edge, so that there is no abrupt edge of space or plantings.
- Designing the outside space surrounding the outer structure to match that within the 'in-between' space, so there is no difference between the treatment of the outside and 'in-between' spaces.

The environmental qualities of this 'in-between' space were also critical in creating a comfortable, year-round space. As it is intended to be a 'natural' space, these aspects of environmental comfort were carefully considered in relation to passive systems that could be used in the 'in-between' space. This was achieved through:

- Providing ventilation gaps and protruding the classrooms through the exterior wall of the outer structure to allow for fresh air in the 'in-between' space and directly into each classroom.
- Providing protection from UV radiation, through carefully considered roof materiality.
- Maintaining a comfortable temperature, which was addressed through the ability to open and close the space, and expel hot air through high-level ventilation gaps. This could be developed further with guidance from a building scientist.

Fig 10.22. Developed design exploded axonometric view. The pattern of the roof system is based on a natural phenomenon called 'shy canopy', which is when trees can sense that another tree's leaves are approaching, so they stop growing in that direction. This results in beautiful streams of light coming through the canopy. This has been translated into the design through the streams of stained green glass between the larger roof panels. These larger panels are constructed primarily of polycarbonate to block maximum UV radiation, along with panels of clear glazing, to allow for a sense of openness to the sky, and allow the children to observe the change in weather and movement of the sun.

Fig 10.23. Section view, showing uninterrupted flow between classroom and shared spaces. This view also depicts how the transition between outside and 'in-between' space has been blurred by bringing the exterior wall in from the roof edge, to create a semi-covered transitional space. To allow for constant fresh air into the 'in-between' space, ventilation gaps have been left at the connection between the exterior walls and roof, and each classroom has also been poked through the outer structure so that they have direct access to fresh air. The occupiable green roof has been designed to provide a sense of risk (from the height and perceived risk of falling), and prospect, so that children can look out and observe the entire site as well as the wider Wellington City. The roof of the outer structure is propped up so not directly sitting on the beams, making the roof appear lighter and making the space feel more open.

Fig 10.24. Plan view. The main entrance to the space faces south towards the existing school. From this entrance, timber walkways and stepping stones link the classrooms and shared spaces. One pocket of space outside of the central hub is the 'secret garden'. This is a space that will be wildly planted, with the possibility to collaborate with local artists and the children to create some large oversized insect sculptural art to add to the sense of intrigue and mystery. This space also provides access to the occupiable green roof. The white dashed line indicates the edge of the roof, extending beyond the exterior walls. The large semi-covered outside space that includes a climbing net is open to and facing the existing school.

Fig 10.25. Internal perspective of the 'in-between' space, filled with biodiverse plantings for children to run through, interact with, hide within, and fully emerge themselves in.

Fig 10.26. This climbing tree column is one of the three main tree columns of the structure. Its platforms, along with the pockets created beneath them, provide the children with unique breakout spaces, giving both a sense of risk and refuge. Seating and work-benches are created from the 'tree roots' which splay out the bottom of the column. These 'roots' are designed to be at the appropriate height for the children to climb up like stairs.

Fig 10.27. A range of seats and benches are designed to look like tree roots coming out the bottom of the tree columns, and provide a range of different spaces, surfaces and heights for different sized groups of children to work at. Their height and gap beneath also create a fun jungle gym of sorts for the children to play on as they run across, jump onto, weave between and duck under the roots.

Fig 10.28. The rainwater system enables water to become an interactive part of the space through the use of chain downpipes, which run water down into the space and onto a 'tree root' bench that feeds it into a sink. When these sinks overflow, the water spills onto the vegetation, giving the children a holistic water experience. These spaces that encourage water events and water interactions have been strategically placed near sandpits so that the children can experiment with mixing sand and water, and are fitted with a regular water tap so there isn't a dependence on rainwater.

Fig 10.29. In response to teacher feedback on the usability of sandpits for many learning and play activities, two sandpits have been designed. Each of these are in the sight lines of two different classrooms which easily allow teachers to send groups or individual students out to the sandpits whilst still being able to keep an eye on them from within the classroom.

Fig 10.30. An open flexible use space was incorporated which adjoins onto one of the sections of openable exterior wall, so there is the opportunity to open this space up further when weather permits.

Fig 10.31. Multiuse stage can be used by a range of groups for a range of activities and caters for learning tasks with larger groups, with enough tiered seating for students from all four classrooms to be seated at once (e.g. for assemblies). This is placed in the middle of the shared spaces to be visible from all classrooms and become a hub for all four classrooms.

Fig 10.32. Taking advantage of the site's sloped terrain, a bridge was designed in a section of pathway, to add to the sense of fun in the space.

Fig 10.33. Flap doors, scaled to the crawling height of a child, were added to create a fun way for the students to enter and exit the space. They also create a sense of mystery, intrigue and excitement due to their fun and unique nature which relates to biophilic design principles.

Fig 10.34. To blur the transition between moving from the outside into the semi-covered space of the design, the roof beams are extended so that there isn't a harsh line between sky and roof. Instead, the transition reads as sky, beam, sky, roof. To push this further, a tree has also been brought into the structure.

10.6: Critical Reflection

Main design strengths:

- Development of an 'outside' space that can comfortably and functionally be used as a learning space year round, and in all weather conditions.
- Development of a space that allows children to experience and play/learn amongst nature for a large part of their daily lives, regardless of their home lifestyle. It is anticipated that this will assist in fostering a bond between child and nature; if they recognise it as an important and positive part of everyday life.
- Provision of functional 'outside' learning spaces which reflect the desires of the users and can act as extensions of the classroom, offering flexibility and opportunities to collaborate with other classes.

Key points of suggested refinement:

- Opportunity to consider indigenous cultural dimensions of nature, particularly Māori culture, which has deeply rooted relationships with land.

This would be a really interesting and worthy area of research to explore. The relationship between biophilic design and Māori approaches to living and building with nature, and how these together could be applied to learning environments should be studied. For this design-led research however, the scope was refined to focus on biophilic design, to get an in-depth understanding of it and how it can be designed to benefit children's learning.

- The opportunity for enhanced dialogue between the architectural typology of classrooms to engage with the canopy.

This point is acknowledged, and would be a good point for extending the research; seeing how the outer structure could influence the design of the classroom, or how the two could work together more. Exploring how to individualise the four classrooms would also be a beneficial area for the design-led research to explore further.

- Consideration of the architectural identity of the building (what you see when you approach the building)?

Though not pictured and perhaps not celebrated as much as in some typical architectural design projects, the exterior design of the building was still considered (as evident from the external views of the images from the iterative outer structure design development –section 10.3). Due to the design-led research's methodology of working from a child experience scale first, and focusing specifically on the spaces in which children will be experiencing, this pulled the design focus away from the exterior look of building overall, to be more concerned about spatial experience from the interior. The transition between outside and the 'in-between' space, which is what is experienced upon the approach of building, has been thoroughly considered. Refining the design of the architectural identity of the building could add to the sense of school pride in the building, and could develop the positive experiences in the space (which could be transferred onto nature itself). This would certainly be a beneficial area to extend the design-led research.

11.0: Discussion, Key findings and Reflection

This section critically reflects on the design exploration and testing in relation to the Research Aim and Objectives.

11.1: Key Findings

- This design-led research aligns with other research in the field of biophilic design, which suggests that it is possible to use biophilic design without taking away from the functionality of space's programme. The design-led research suggests that using biophilic design can actually improve functionality (through productivity) of these spaces.
- Since biophilic design is largely an experience based design method, designing from the user experience scale, outwards, and focusing on the human -or in this case child-scale is critical in ensuring experiential spaces are created rather than object orientated forms. This was used in the design-led research to ensure that these biophilic experiences were being created in the internal environments.
- To begin reinserting nature back into people's lives, people do not need to be forced outside for a mandatory time every day. This design-led research suggests that we can design nature into spaces where people spend their lives. Even in spaces and climates that do not naturally lend themselves to comfortable outside space for a large portion of the year.
- Designers and influencers of learning environments should consider incorporation of the natural world, and view it as an essential part of learning environment design. By doing this nature can begin to be reinserted as a consistent part of children's lives, and contribute toward healthier child development

(Kellert et al. 2015; Louv 2008; Moss 2012).

- The initial research assumption was that the design-led research was going to largely be about encouraging children to physically interact with nature. However, after looking into case studies and initial design experimentation it became clear that designing for physical interactions offered less of an architectural challenge than designing for experiences of nature. This is not to say that experience of nature is more important or better at fostering a bond between child and nature than physical interactions are, and instead, they should be used together. In the design-led research the exploration of designing to create an experience of nature was explored through developing 'inside-outside' space, and the biophilic sense of risk and refuge. And interaction with nature was explored through developing a visual connection with nature, creating enticing nature spaces that the children wanted to be and play in.

11.2: Research Constraints and Limitations

- Working from the child experience scale is good for developing the experiences intended to be had in spaces, though it meant the 'in-between' space -one of the most important parts- of the design was left until last. This also meant that there was little reflection of the design from the outside in, for example, looking at how the 'in-between' space could affect the design of the classroom.
- The developed design takes up a larger area of land compared to a standard block of four classrooms. Though the 'in-between' space does provide more learning spaces for the four classrooms as well as providing a covered 'outside' play space for the whole school, the land and initial cost of building this large outer structure could be difficult for public schools (which are government funded), without community fundraising.
- Another limitation of the developed design is that it didn't largely factor in the growing use of technology in schools. Though it is still expected that children learn to read and write by hand in the junior years of school, learning to use and learning with technology is only increasing.

11.3: Possible Ways to Advance the Research

There are many ways in which the research could be expanded, the most fruitful of which are expected to be:

- Reflecting on the design from inside out. Specifically how the classrooms could be influenced by the shared spaces and outer structure, and how these elements could engage with each other more.
- Further refine classrooms design individually so that they directly respond to the aspects of the site they are on. As well as making them recognisably different from each other to instil students with a sense of ownership and belonging to a specific class.
- Test and develop the design of the 'inside-outside' space to see how it could work on other sites with different climates, e.g. hot weather.
- Develop and refine the design in relation to it's context, e.g. existing school, local culture, native culture, and significant environmental conditions.

- Incorporating children in the design of the project could allow them to learn about nature and how we can insert it into our everyday lives, a lesson they could take with them into their adult life and continue to share. This highlights the possibility of exploring participatory design techniques in conjunction with biophilia in future research.

- Explore how this design-led research could be applied at a whole school scale, and at different ages (preschool, full primary, secondary and tertiary). Since the elements of biophilic design that were explored targeted cognitive performance, some aspects of the design could also be translated into workspaces. However, since the developed design closely ties these aspects to the preferences of the 5-7 year old children from the workshop, and the learning environment functionality, these elements would be to be reworked to align with the specific users and functionality of the new programme.

- Explore deeper into the child scale and develop the architectural hardware that students directly engage with.

- Develop the environmental comfort systems of the 'in-between' space and classrooms (heating, cooling, and ventilation) with assistance from a building scientist/services engineer, to develop and refine passive systems that ensure the spaces will be comfortable year-round.

- Taking into account the increasing use of technology in classrooms, exploring how biophilic design can work in conjunction with digital learning could ensure that the biophilic aspects don't get left behind in the increasingly technological world.

- Testing if the design-led research ideas would work in real life would require building and testing the explored spatial methods of enabling children to regularly experiencing nature, and watching the effects it has on children, and then examining how this may have impacted their adult life and values. This, of course, is unfeasible for a one year design-led research project but could be explored in the future.

12.0: Conclusion

Human well-being is being negatively affected

Currently, there is nothing in New Zealand school design guidelines about connection to nature. Though there are guidelines about daylighting and natural ventilation, nature itself isn't even mentioned in the texts. Instead, the focus is very much on the interior learning spaces and the current learning environment trend of innovative learning environments. This complete disregard for a factor which impacts healthy human development and well-being is problematic because these are the spaces that all children end up spending most of their time during their developmental years. As a result, these spaces shape the kind of people these children become.

While it is important for children to be able to use their learning spaces for standard curriculum-based learning, there is also an exciting opportunity for designers and architects to create spaces that not only improve children's cognitive performance and emotional well-being but also encourage them to experience nature in a positive way. Creating spaces that consistently expose children to nature, encourages the formation of personal value for it, and takes advantage of the multiple potential well-being benefits of biophilic design can be a critical step in ensuring more sustainable societies and perhaps future healthier ecosystems.

13.0: References

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14.0: Appendices

Appendix A: Ethics Approval - Survey

Phone 0-4-463 5205
Email Averil.coxhead@vuw.ac.nz

MEMORANDUM

TO	Emma Woodward
COPY TO	Maibritt Pedersen Zari
FROM	Dr Averil Coxhead, Acting Convener, Human Ethics Committee
DATE	30 May 2017
PAGES	1
SUBJECT	Ethics Approval: 24705 Can we have class outside? Reconnecting children with nature.

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 8 December 2017. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Averil Coxhead,
Acting Convener, Victoria University Human Ethics Committee

Appendix B: Survey Questions

Current and Ideal Classroom Design

What school do you teach at? Note: this is not being used to identify you in any way. This information will only be used if your school is selected as a site to test the design research on so that designs can directly target the responses from your school.

How many students do you have in your classroom?

What year group(s) do you teach?

What kind of classroom do you currently teach in? (Select as many as apply)

Open plan with flexible teaching spaces

Traditional classroom with one teacher in a designated space

A shared class (multiple teachers in one space)

Other

What do you think would make an ideal learning environment for the year group you teach?

Please indicate using the scale bar which elements of classroom design are important to your students ideal learning environment, where 0 is a negative aspect (that you wouldn't like it included), 5 is neutral (you wouldn't mind if it were included or not) and 10 is very important (a critical aspect to your students ideal learning environment)

Negative Aspect 0 1 2 3 4 5 6 7 8 9 10 Critical Aspect

Small (1 person) pocket spaces with cushions and soft finishes.

Break out spaces for groups of ~5 students

Space and equipment for play based learning

Flexibility of space usage

Variety in types of spaces for students to choose between

Unique spaces (e.g. mezzanine or raised floor/stage level)

A rectangular floor plan

Spacious amount of indoor space

Spacious amount of outdoor learning space

Shared space with neighbouring classrooms

Computers

Ipads

Indoor plants

Having animals inside the classroom (e.g. a fish tank)

An indoor water feature

Having natural materials within the classroom (e.g. Timber wall finishes)

Views to the outside/nature

Easy access to the outside

An outdoor learning space

Good acoustics

Natural lighting

Natural ventilation

Built in storage

In class children's storage space/cloak bay

Flexibility to arrange desks

Desks arranged in a linear fashion facing white board

Group tables

Individual desks

Low tables (kneeling height)

Soft chairs (e.g. bean bags and sofas) with writing trays

Inclusion of teacher's work space/desk in classroom

Are there any other aspects you think are critical to an ideal learning environment for your students or have any comments regarding what you think makes a good classroom design/teaching space?

Section 2: Children and Nature

Have you noticed a difference in your students' behaviour when they return to the classroom after being outside? If yes, what do you observe? E.g. better/poorer concentration, more/less restlessness.

Which three benefits of enhancing children's connection with nature do you think are most important in learning environment design?

Increased concentration

Reduced violence

Increased productivity

Reduced stress

Reduced irritation

Reduce fatigue

Reduced anxiety

Increased social interaction

Other (Please state)

Do you have any further comments regarding connecting children with nature?

Section 3: Current use of Outdoor Learning

How do you currently use outdoor spaces as learning spaces? (Select as many as apply)

Small group work (teacher lead)

Small group self-directed activities.

Whole class (teacher lead)

Independent student learning

I don't use outdoor spaces as learning spaces

My school doesn't have any outdoor spaces suitable to use as learning spaces

Other (Please specify)

What topics -excluding Physical Education- do you currently teach outside? (Select as many as apply)

Mathematics

Reading

Writing

Art

Dance

Drama

Handwriting

Topical inquiry

Music

Kapa haka

Te reo

Technology

Science

Environmental / Sustainability topics

Other (Please state)

Where outside do you teach these topics? (Select as many as apply)

School field

Space directly outside the classroom

School garden

School outdoor teaching space

Sandpit

Forested area

Outside seated area

Shaded area

Other (Please state)

Do you have any further comments regarding how you like to use your schools outdoor spaces for learning?

Section 4: Outdoor Learning Possibilities and Limits

What topics -excluding Physical Education- do you think you could teach outside if you had a suitable area and what would make the area suitable, e.g. writing: space sheltered from weather with seating and writing surface? Select and answer for as many as apply

Mathematics

Reading

Writing

Art

Dance

Drama

Handwriting

Topical inquiry

Music

Kapa haka

Te reo

Technology

Science

Environmental / Sustainability topics

Other (Please state)

What are the barriers that would stop you from using outdoor space? (Select as many as apply)

Bad weather (e.g. wind, rain)

Sun exposure (risk of children getting sunburnt)

Temperature (e.g. too cold)

Lack of outdoor furniture

Lack of visibility between inside the classroom & outside spaces (i.e. teacher is unable to see children outside alone)

Distance between classroom and suitable outdoor space

Lack of suitable outdoor space

Space is often being used by another class

Lack of suitable equipment

Difficulties in controlling students outside / in open unconfined space

Risk of students getting dirty and bringing dirt back into the classroom

Causes children to act hyperactive

Acoustics/hard to hear

Uncomfortable seating

No desks or hard surfaces to write on

Lack of ability to change the space to better suit specific activities' needs

Other (Please state)

Is there a group size you wouldn't be comfortable with teaching outside even in an appropriate dedicated space? (Select as many as apply)

Small group work (teacher lead)

Small group self-directed activities

Whole class/large group (teacher lead)

Independent student learning (individual student to learn outside while still within sight of teacher inside with rest of class)

Other (Please state)

If you had clear visibility and direct access to the space directly outside your classroom do you think you would use the space...

More

Less

It would not affect my decision to use space

If an outside teaching space had a roof do you think you would use the space...

More

Less – I'd prefer an outdoor space without a roof

It would not affect my decision to use space

If an outside teaching space had soft walls, e.g. Drop down fabric walls, do you think you would use the space...

More

Less – I would prefer an open outdoor space without walls

It would not affect my decision to use space

If an outside teaching space had a hard, durable floor (e.g. timber decking instead of grass) do you think you would use the space...

More

Less – I would prefer an outdoor space with a natural ground i.e. grass

Wouldn't affect my decision to use space

Do you have any further comments about how outdoor spaces in schools could be designed to make them more suitable for teaching & learning?

Appendix C: Ethics Approval - Workshop

Phone 0-4-463 5480
Email susan.corbett@vuw.ac.nz

MEMORANDUM

TO	Emma Woodward
COPY TO	Maibritt Pedersen Zari
FROM	AProf Susan Corbett, Convener, Human Ethics Committee
DATE	16 June 2017
PAGES	1
SUBJECT	Ethics Approval: 24866 Can we have class outside? - focus group

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 18 August 2017. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Kind regards

Susan Corbett

Convener, Victoria University Human Ethics Committee

Appendix D: Workshop - Game One

Example of spaces children were asked to choose between in game one: favourite spaces.

Appendix E: Workshop - Game Two

Spaces pinned up for game two: pin the activity to the space.

Example of children's responses to the game.

Appendix F: Workshop - Game Three

Photos of the model made by the children in game three: Design a learning space.

Appendix G: Workshop - Consent Forms

Can we have class outside? *Reconnecting children with nature*

PARENT/CAREGIVERS CONSENT FOR CHILD TO PARTICIPATE IN WORKSHOP

This consent form will be held for 1 year.

Researcher: *Emma Woodward*, School of Architecture, Victoria University of Wellington.

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.
- I agree for my child to take part in an audio recorded workshop.

I understand that:

- I am agreeing to keep the information shared during the workshop confidential. I am aware that after the workshop, my child and I must not communicate to anyone, including family members and close friends, any details about the workshop.
- I can withdraw my child from the workshop while it is in progress however it will not be possible to withdraw the information I have provided up to that point as it will be part of a discussion with other participants.
- The information my child provides will be destroyed 1 year after the thesis is completed in ~March 2018.
- Any information my child provides will be kept confidential to the researcher and the supervisor.
- I understand that the results may be used in a Masters Thesis.
- My child's name or face will not be used in reports, nor will any information that would identify them.

Signature of parent/caregiver:

Name of parent/caregiver:

Name of child:

Date:

8/7/17

- I would like to receive a copy of the workshop research summary and have added my email address below.
- I would like to receive a copy of the final thesis and have added my email address below.

Email address:

Yes ☒ No ☒

Yes ☒ No ☒

Can we have class outside?
Reconnecting children with nature

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Yes ☒ No ☐

Yes ☒ No ☐

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Email address:

☐ Yes ☐ No

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- I would like to receive a copy of the final thesis and have added my email address below.

Yes ☒ No ☐

No ☒

Email address:

Child Consent form

I am happy to play the nature classroom games and for Emma Woodward
and collect and record my answers.

Your name: ..

How do you feel about playing (Circle/colour appropriate face)

Child Consent form

I am happy to play the nature classroom games and for Emma Woodward
and collect and record my answers.

Your name:

How do you feel about playing (Circle/colour appropriate face)

Child Consent form

I am happy to play the nature classroom games and for Emma Woodward
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Your name: _____

[Redacted name box]

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