

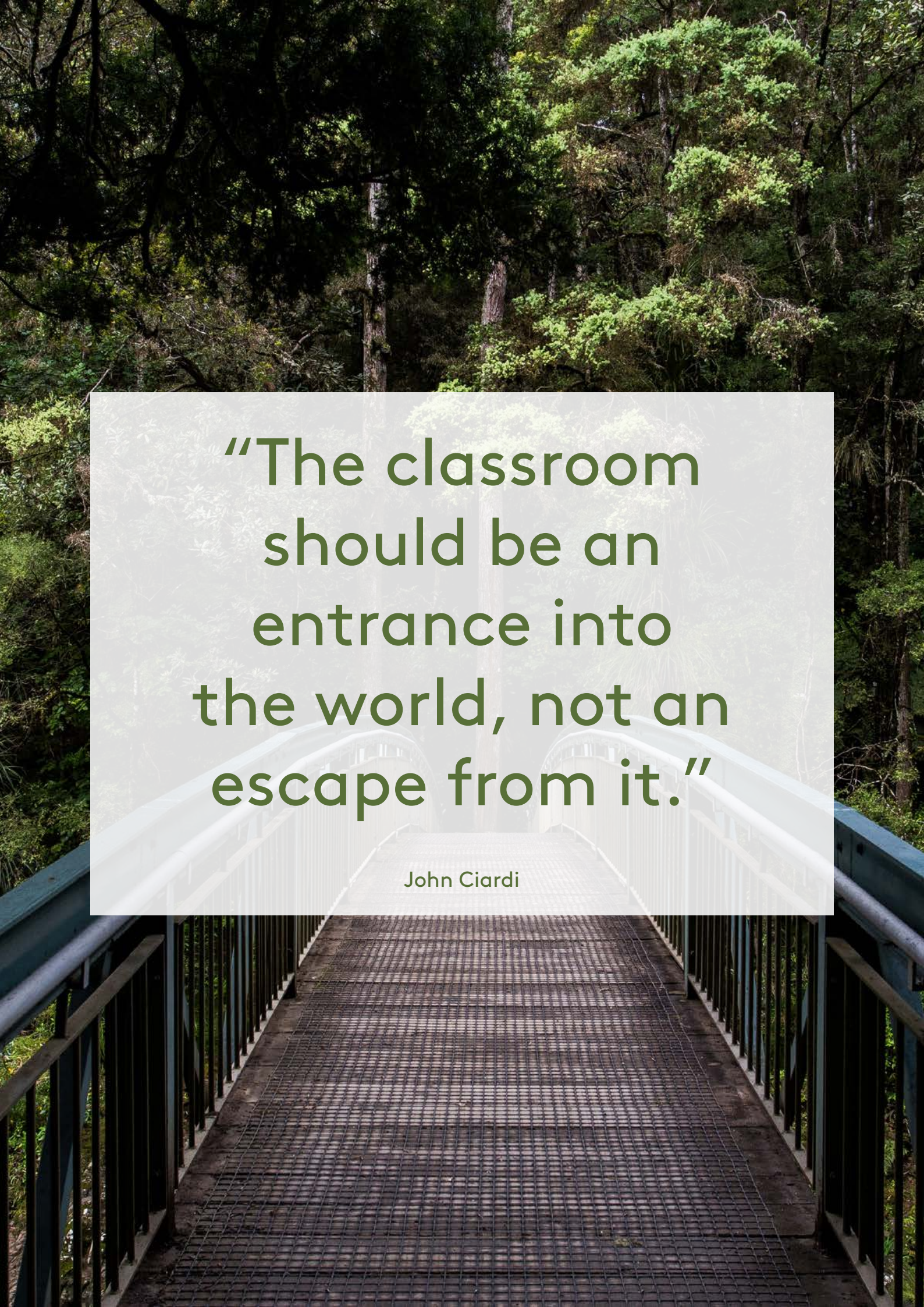


# BIOPHILIC DESIGN FOR THE CLASSROOM

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How biophilic design can provide attention consistency in the classroom and help children learn better





“The classroom  
should be an  
entrance into  
the world, not an  
escape from it.”

John Ciardi



# Executive Summary

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Biophilia is fast becoming a mainstream design philosophy in the workplace. It has been proven to aid concentration, creativity, wellbeing and help with resilience against stress.

The principle of biophilic design is to better connect people with nature – within the spaces we inhabit - through the introduction of natural elements in furniture, interior design, architecture, art, outlook, airflow and lighting.

Biophilia has been used in many environments for some time, although it's not always recognised as such – which is as it should be: a natural part of the environment.

Studies have shown the introduction of biophilic design can have positive effects on productivity, creativity, wellbeing and even attendance in the workplace.

To test the principle in the classroom though, an area far less studied, PLN Group worked with a local primary school, designing and equipping one learning space using biophilic principles and using an 'original' classroom as a control space to measure the relative effects.

This paper outlines the results of this study and shows marked improvements in concentration and learning for the lucky children involved.





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# Introduction

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“There are many elements that affect diminishing attention, some of which we can directly affect e.g. taking breaks, nutrition, hydration etc. and some we can delicately provide support for e.g. emotional wellbeing. Those elements that we can directly affect, and control should be a ‘non-negotiable’. For example, ensuring students take a break, eat and drink to keep their bodies well fuelled and ready to learn is obvious, but to me, so should be providing an environment that provides the best opportunity to learn.”

-Heath Boot.

Although there has been a lot of study and many words written about the use of biophilic design in the workplace, there has been relatively little carried out for the classroom.

The pandemic has meant many children have simply got out of the habit of learning and despite the best intentions of teachers and parents alike, home learning delivered a far shorter school day, in varied surroundings and in most households, a willingness to simply cut learning short when children got bored or tired and just as likely, when parents reached the same point.

The issue of children’s attention diminishing during each school day and again across the week though, has been a problem ever since schools were a thing.

But today, attention decay seems to be more acute in a world of short digital bites and constant distractions from task by tech devices, fidget-spinners, other children, and even the classroom itself which can add an ‘extraneous cognitive load’ to an already pressured environment.

And it’s not just kids. A 2020 study for Kent State University using eye-tracking technology suggests that in a learning environment even adults’ attention will usually start to waver well before 15 minutes is up. And that finding was predicated on the knowledge that attention decay reduces (improves) with age. So, a primary aged child is likely to have a natural attention-span of far, far less.

A 2021 study (and associated 2022 report) carried out in concert with PLN Group by teachers Heath Boot and Rhian Storey at Silverdale School in Auckland began with the assumption that the classroom itself could exert its own extraneous cognitive load. Spaces with an unnatural façade, that are less than comfortable or even just with bland décor can distract. But many ‘traditional’ classrooms are extremely cluttered with ‘stuff’ maybe hanging from washing lines stretched across the room or around the walls that are covered with

# Introduction

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“There is a commonly voiced view in the staffroom that the first two hours of the day are the ‘golden hours’ of learning. We wanted to find out if this assertion was true.”

-Heath Boot

student generated work and teaching materials. Generally, none of these are curated and certainly aren't organised within a considered 'look and feel'. As a result, this creates an extreme volume of visual 'noise' and stimulus.


The team wanted to assess the 'extraneous cognitive load' within a distractive space and measure the impact of implementing a considered and biophilic design in the classroom on the children's attention span. In measuring their ability or willingness to learn in a well-designed environment, (as well as the impact on their general health and wellbeing) the study aimed to test if that cognitive load could be reduced through biophilic design, thus enhancing the ability to learn.

It's clear that education of primary-aged children is a key to future success, happiness, and wellbeing both within school and in later life. A 2019 study by Office Depot in the USA, reported in Forbes Magazine, suggests getting good grades is one determinant factor at a young age of that future success - but that developing good learning habits is equally as important. The ability to sustain good attention will see you well throughout life at school, work and in life generally.

So, the provision of educational spaces that encourage and facilitate a child's attention span for longer should be a starting point for any school or college.

As the world returns to the new normal after a long period of pandemic-induced disruption, some of the most affected people are school children who have endured months of disruption at a highly formative time of their lives.



A photograph of a forest with tall, thin trees and a dirt path. The text is overlaid on a semi-transparent white box in the center.

An adult's attention span starts to decay before 15 minutes is up.

A child's attention span in the classroom is far less.



# Biophilic Design – in a Nutshell

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Biophilia is a concept based on the premise that the human brain has not really evolved that much in the last few thousand years and that innately we are still linked to the natural world in ways we don't consciously understand. But consider, that we are still wary of heights and shadows and can derive inspiration from a green space. We find running water relaxing and a windswept beach exhilarating.

This principle is the basis of biophilia, and biophilic design is the weaving of nature into our daily lives through design, architecture, products and the things and spaces around us.

According to Terrapin Bright Green, an environmental and sustainability B-Corp consulting firm, there are 14 patterns of biophilic design.

But these can be distilled down to just three key strategies:

- **Nature in the Space.**  
The presence of primary elements of nature. Plants, water, stone and wood for example or access to light, water, arrhythmic air flows and views of the natural world
- **Natural Analogues**  
... or representative elements of nature. Curves rather than straight lines, natural colour palettes, textures, graphics and fractal patterns – repeating and regressing forms found across the natural world. Artificial light and airflow could also fall into this category.
- **Nature of the Space**  
... perceived characteristics of the natural world, such as refuge or mystery, prospect or risk. This strategy is really the sum of the first two – difficult to implement on its own.

So, biophilic design is the bringing into our lives of any or all of these aspects. Using natural materials rather than man-made. Ensuring at the very least we have views of trees or sky while we inhabit our man-made spaces.



# Biophilic Design – in a Nutshell

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Designing using curves rather than ruler-straight lines, natural colours like yellows, blues and greens rather than fifty shades of grey and introducing texture where we can.

Bringing plants into our spaces, hanging pictures of nature on the walls, using water where appropriate and ensuring light and airflow is natural. Lastly in the non-residential parts of our lives, ridding ourselves of the Victorian-straight lines of desks on our school or office floorplans.

You can read more in PLN Group's collection of [biophilic design article](#) here.  
[www.plngroup.co.nz/biophilic-design-home](http://www.plngroup.co.nz/biophilic-design-home)





# Biophilic Design in The Classroom



# Biophilic Design in the Classroom

“Although biophilic design in the classroom is a relatively understudied area, there have been several studies that demonstrate the positive effects of biophilia in the workplace.

“A basis for the Silverdale School study was the supposition that it wouldn't be unreasonable to extrapolate these findings to a younger demographic in an educational setting. But in order to demonstrate that idea, only a practical, real-life investigation would suffice.”

- Blair McKolskey

## Benefits of Biophilia in the Workplace

Research shows biophilic design works on all levels.

Terrapin Bright Green have produced a report called “The Economics of Biophilia” which essentially shows if you make people happy, the returns are all positive.

Their study shows absenteeism is likely to fall by around 10% where biophilic aspects are present, where workers have views of trees and natural landscapes for example.

Another study in 2015 called “The Global Impact of Biophilic Design in the Workplace” showed a 15% productivity increase with nine out of ten workers reporting improved wellbeing in a more natural work environment.

Other studies show similar results. The “Human Spaces Report”, which surveyed 7,600 office employees in sixteen countries reported 6% productivity increases, 15% creativity improvement and a 15% hike in wellbeing.

Research carried out by professor of physics, psychology and art, Richard Taylor, has demonstrated - by measuring nervous system activity - a reduction of stress of up to 60% when people are exposed to fractal forms. Fractals are self-repeating patterns found throughout the natural world and a great starting point for taking on biophilic design.

Read about or watch PLN Group's video [explaining fractals here](#)

[www.plngroup.co.nz/fractals-in-design](http://www.plngroup.co.nz/fractals-in-design)

So, many designers and architects now designing buildings for the future are incorporating biophilic principles as a matter of course.

An absenteeism fall of 10%  
where workers have views  
of trees

15% Productivity Increase

15% Creativity Improvement

15% Hike in Wellbeing

60% Reduction of Stress  
when exposed to  
Fractal forms



# Biophilic Design in the Classroom

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## Biophilic Studies in the Classroom

It would be wrong to say that no study has gone into the provision of healthy or effective classrooms of course.

An academic study in the UK identified seven key design characteristics that together can account for 16% of the variation in students' academic progress:

- Light
- Colour
- Temperature
- Air Quality
- Ownership
- Flexibility
- Complexity

Although not all biophilic in nature, certainly the first four could be construed as natural facets. The ownership characteristic appeared at Silverdale and is noted later in this paper as an organic result of the classroom conversion carried out for the study. We would probably also add acoustics to the UK study's list, an important determinant for a successful working (or learning) space - as also identified by [educationcorner.com](http://educationcorner.com) in their article on Classroom Design & Layout

Another study demonstrated a 25% impact on academic success based on the design of the classroom. Their list of design factors also included colour - expanded to include visual stimulation on walls, floors and furniture - and light, especially natural light.

Even closer to biophilic design was a 2015 study that identified 'The 3 Basics of Classroom Design', which included at top of the list, 'Naturalness'. This report, published on [sciencedirect.com](http://sciencedirect.com) says about naturalness that:

"This category accounts for around 50% of the impact on learning. It's about factors needed for physical comfort. These include light, sound,

# Biophilic Design in the Classroom

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temperature, air quality, and “links to nature.”

The other aspects of design that these and at least one other study cite are ownership or individualization (the flexibility to adapt the room to your own desires), and stimulation – the vibrancy of the classroom. More on those features later in this paper.

Complexity could easily be construed as providing these nature in space characteristics: refuge, mystery, prospect or risk.

It should also be noted that whilst these aspects account for positive effects on learning, the impacts can as easily be negative where these things are not present.



A photograph of a forest with tall, thin trees and a dirt path. The text is overlaid on a semi-transparent white box in the center.

“How a classroom  
is designed can  
significantly  
impact academic  
outcomes...” [educationcorner.com](http://educationcorner.com)

“[Naturalness]  
accounts for around  
50% of the impact  
on learning” [sciencedirect.com](http://sciencedirect.com)





# The Study



# The Study

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“Friday is the day children are least ready to learn and by 2pm on any day most kids’ readiness to learn has fallen markedly away”.

-Rhian Storey

The starting point for the study was the inherent knowledge that children are most ready to learn on a Monday but unsurprisingly, this readiness declines as the week progresses. But also, they are most ready to learn at 9am on any particular day, again with a decline as the day progresses.

In order to test the effects of classroom design on these patterns, two learning areas or classrooms were studied: one was redesigned with a host of biophilic elements and the other, left as originally designed, as the control space.

The biophilic design was not super-extensive, but the elements - based on a woodland theme - were chosen to have maximum impact. They included:

- Potted plants. The easiest and most common biophilic element – literally bringing nature indoors – Nature in Space. A mixture of table-top pots as well as larger, floor-standing pots were used.
- Forest or woodland themed floor to ceiling graphic wallpaper. This element probably had the biggest visual impact in the room. It was also carefully chosen and photographed in local bush and woodland to provide recognition amongst the children. This approach was based on the assumption that recognition of place, of home, and the provision of a ‘believable’ image for the children would be an important factor.
- Acoustic lighting fixtures - in this case, HUSH lighting along with smaller BIP Acoustic Pendants. The acoustics element was also a considered choice to work with the theme of the wall graphics. There is a natural noise-dampening effect in woodland that we wanted to mimic - the Natural Analogues strategy. However, attention to a room’s acoustics is also an important part of creating an effective learning or working environment.
- A colourful soft circular seating unit with curves designed to mimic those found in nature - PLN Group’s Camber seating. This unit also had proprietary sensors fitted to measure usage.

# The Study



The Classroom before conversion



After Conversion 1



# The Study

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## **The Children**

The study was carried out with Year-5 students – aged 9-10 years-old at a state primary school in the north of the Auckland region

## **The Measure**

To measure how the children were doing a scale was used that rated their mood and willingness to learn. The key learning zone is in the range 6 – 7.5. Outside of that is considered sub-optimal in terms of learning.

This scale is based on Kuyper's 'Zones of Regulation', an international resource designed for child self-assessment and recommended by RTLB (Resource Teacher Learning & Behaviour) – a service provided by the New Zealand Ministry of Education.

The scale had been used in the school for some time, but merely as a snapshot of children's mood. The innovation for this study was the use of Google Forms to measure that mood over time.

## **Data Collection**

Data was taken four times each day:

1. 9:00am – Just about to start learning for the day
2. 10:00am – Brain-snack time
3. 11:30am – Time to start learning again after morning break
4. 2:00pm – Just after taking the afternoon roll

Children entered their responses on Google Forms when logging in to their computers for each new session in the day. There was no teacher intervention in the collection of data.

In all, nearly 2,500 responses were returned from the children plus another 12,000 data points collected from the sensor-tech installed in a focus study seating unit.

# The Study

## Kuyper's 'Zones of Regulation Scale

1	2	3	4	5	6	7	8	9	10
Angry - Terrified - Yelling/Hitting Elated - Out of Control	Frustrated - Worried - Silly/Wiggly Excited - Loss of Control		Happy - Calm - Feeling OK Focussed - Ready to Learn			Sad - Sick Tired - Bored Moving Slowly			

### Key Findings

Across the whole study, there was a c.12% uplift in the number of children who scored in the 'Ready to Learn' zone in the biophilic room vs the standard room – 63.6% vs 56.9%.



# The Study

**12%** Increase in Children Ready to Learn

**11.6%** Fewer children in the biophilic room were in the 'lethargic' zones - 9-10 (sad/sick/tired/bored/moving slowly)

**55% vs 63%** Kids ready to learn after the 10:00am snack.

## Time of Day

In the biophilic room, there was a lot more stability in the kids' moods throughout the day - with the exception of the 11:30 break, when there was a marked spike in children scoring '7' - right in the heart of the key Ready to Learn zone.

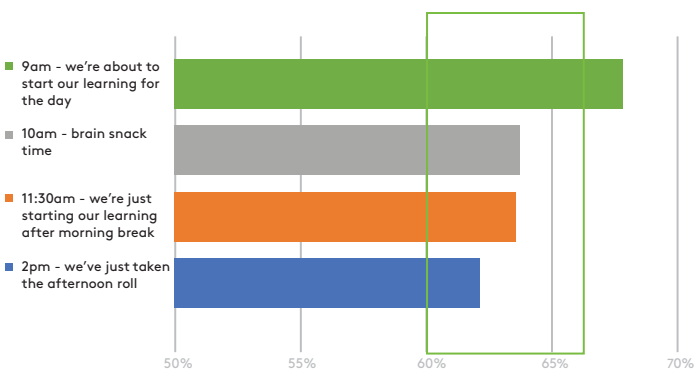
In the control classroom the big difference occurred after lunch at the 2:00pm start to the afternoon.

Across all data points there were a big difference in children reporting in the top end of the scale (8-10), which is the more lethargic, lacking energy end of the scale: 15.7% vs 27.3%.

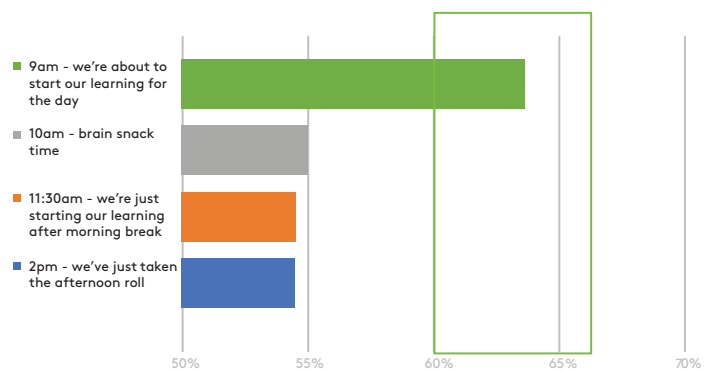
For all morning sessions in the control room, approximately 8.5% of kids were reported at a score of '7' (the learning purple patch). But, at the 2:00pm mark that dropped by half to only 4.3% scoring '7'. That's a lot of kids that teachers have to pull back for an afternoon of learning.

In the biophilic space however, the difference between the four key measurement time points was far less marked and seems to demonstrate an increasing willingness to learn as the day wore on - albeit peaking at the 11.30 post-break period.

Biophilic Classroom



Control Classroom

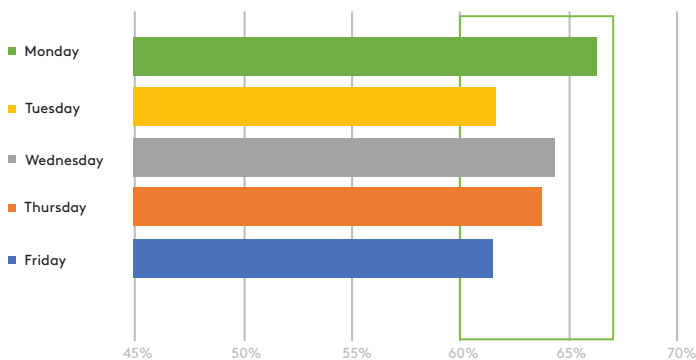


# The Study

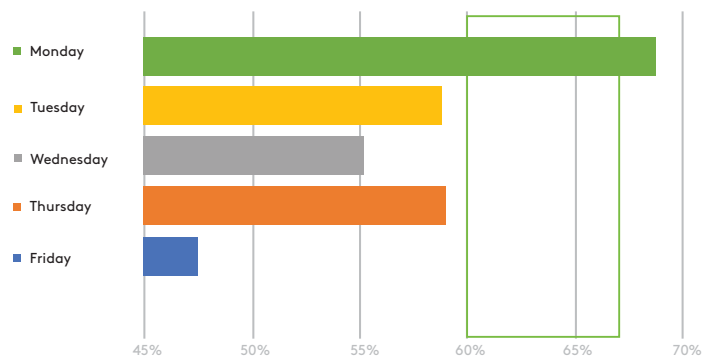
## Time of week

The time-of-week results were also positive, especially by Friday when the percentage of kids in the 'Goldilocks' zone dropped away dramatically in the non-biophilic classroom. In the biophilic classroom there was also a slight reduction in kids ready to learn after Monday, but the trend was pretty stable throughout the rest of the week above 60% versus the control class, where the average from Tuesday to Friday was only just above 45%

Biophilic Classroom



Control Classroom



There is a slight dichotomy between the children's moods at the start of the school day and the beginning of the school week between the two cohorts of children. Across the week, the biophilic class seemed to be more ready to learn at 9am than the non-biophilic-class kids, whereas, the non-biophilic control class children were slightly more ready to learn on Mondays mornings than the biophilic class.

Whilst we don't have a data-based answer for this, perhaps the children in the biophilic room anticipated a good day every day because yesterday was positive.



# The Study

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## Ownership of Space & Additional Learning Benefits

An important aspect of biophilic design and also recognised in a 2015 study on the effects of classroom design on learning is the concept of ownership of space and control over environment.

Anecdotal evidence from our study showed that the children involved quickly assumed ownership of the space and demonstrated a protective attitude towards the living elements - the plants - in the space.

They took care to not damage the plants when moving around the classroom, started to take an active role in watering and caring for them and then, unbidden, started bringing in their own plants to add to the scheme.

This ownership also extended to the teachers using the space as well as other staff within the school. As Heath Boot says, "Teacher wellbeing is important. The better the teacher feels, the better they will teach and the better the children are likely to learn."

Additionally, there was a feeling of pride and kudos from having such an innovative learning environment and visitors to the school were always brought into the biophilic classroom - and were never left unimpressed.

Additional learning opportunities arose from the elements used in the scheme too. From taking care of and understanding around the plants to the mathematical design elements of the acoustic lighting elements, PLN Group's Hush lights.

# The Study

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## Sensor Technology Study on Seating Module

As an interesting side-study, we installed proprietary compression sensors in the squab cushions of a large seating module with four seats to measure time-on-task. The sensors captured binary data, measuring when each seat was being used and for how long.

The Camber seating unit is designed with a strong nod to biophilic design – using natural curves and with acoustic properties.

The seating was designated as a focus study area in a separate room off the main learning area, so the experiment was to measure 'time on task' whilst the kids used this dedicated space.

Sometimes it was used as a small-group learning space with a teacher present, but often as an independent space children could use as required.

The findings were an interesting insight into human behaviour, although not totally in the way expected.

Of the four seats on the Camber unit, two (seats three and four) were utilised for 68% of the total sitting time across a whole month – whilst the other two only accounted for 32%. Of the two most popular seats 'Seat three' was used for 43% of the time.

Not only did the children use seats three and four more often, but they also stayed sitting in those seats for a longer duration than the other seats.

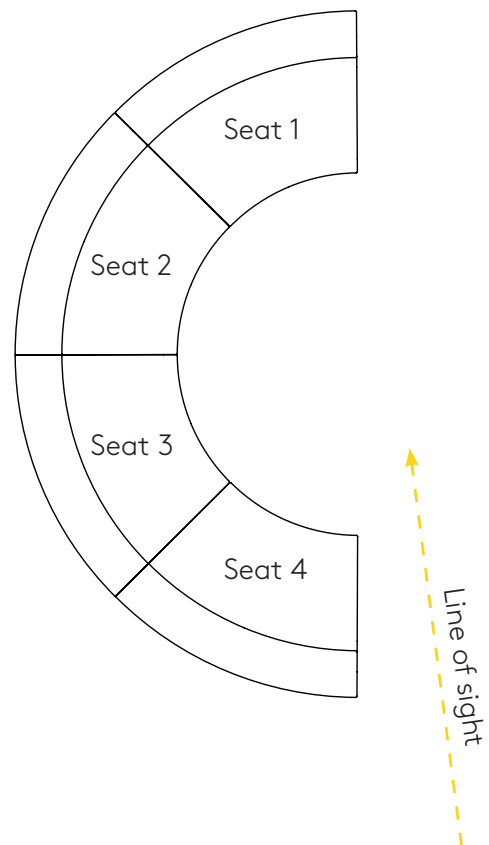
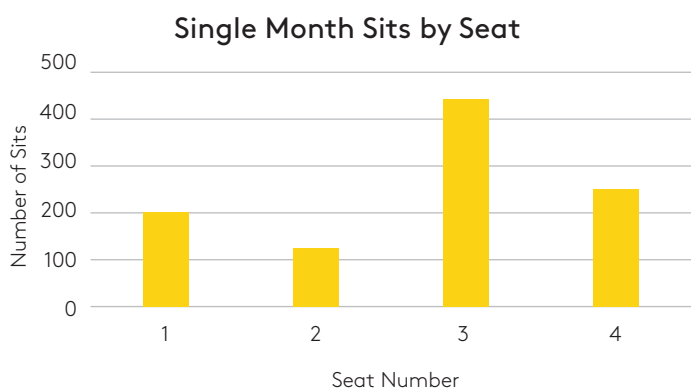


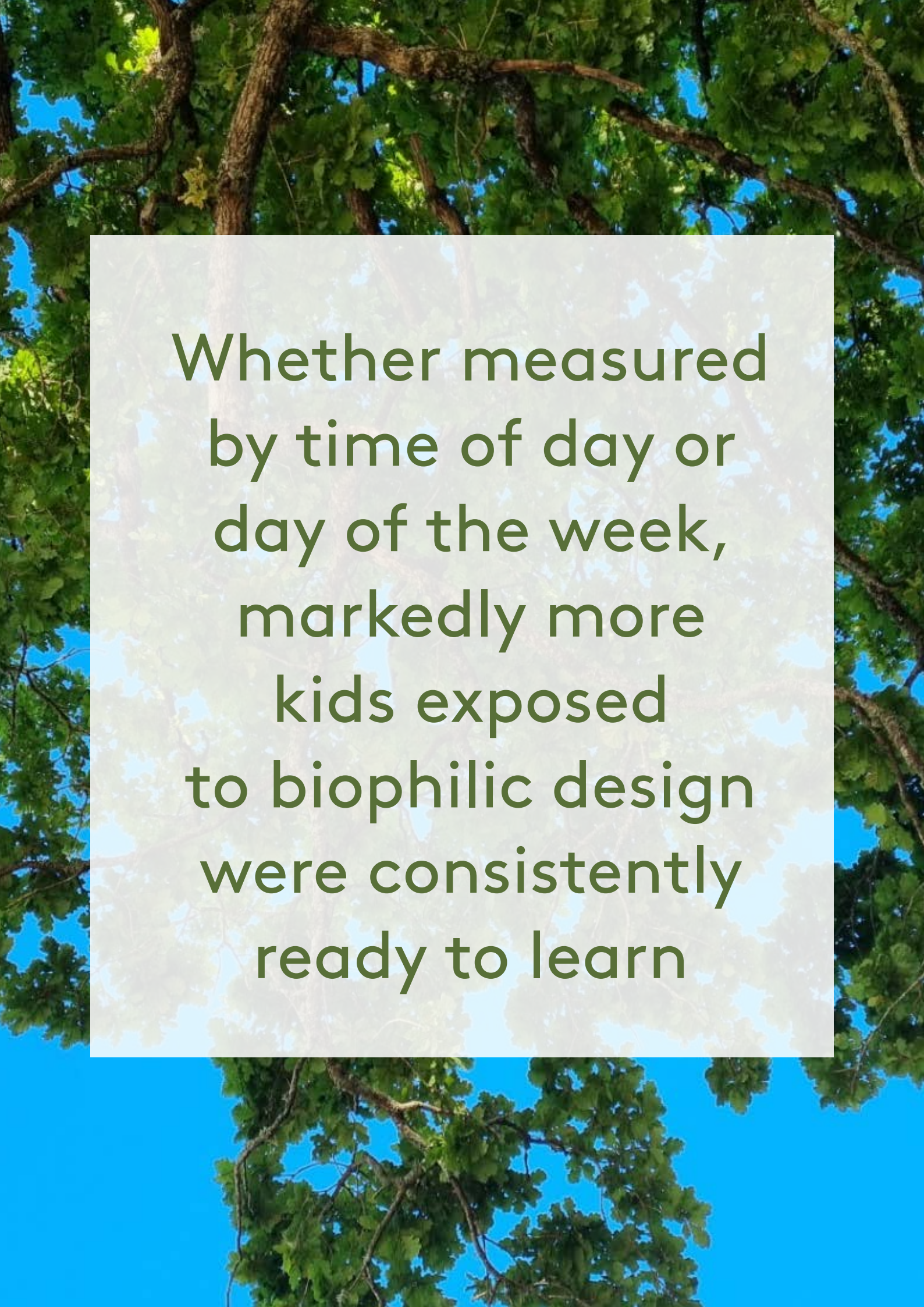
# The Study

Initially puzzled when considering these results, the team looked at the setup and quickly realised that seats three and four were largely hidden from the main learning space (and thus from the eyeline of any teachers present in that space), whilst the other spaces had a clear line-of-sight from the main space.

So, although more anecdote than scientific result, this experiment did produce actionable insight for the teachers.

Whilst the careful integration of biophilic design can have positive effects on the behaviour of children in school, it can only do so much before the kids will find a way to do their own thing.





Whether measured  
by time of day or  
day of the week,  
markedly more  
kids exposed  
to biophilic design  
were consistently  
ready to learn





# Biophilic Design is Everywhere



# Biophilic Design is Everywhere

Biophilic design has slowly but surely permeated our world – and will continue to do so.

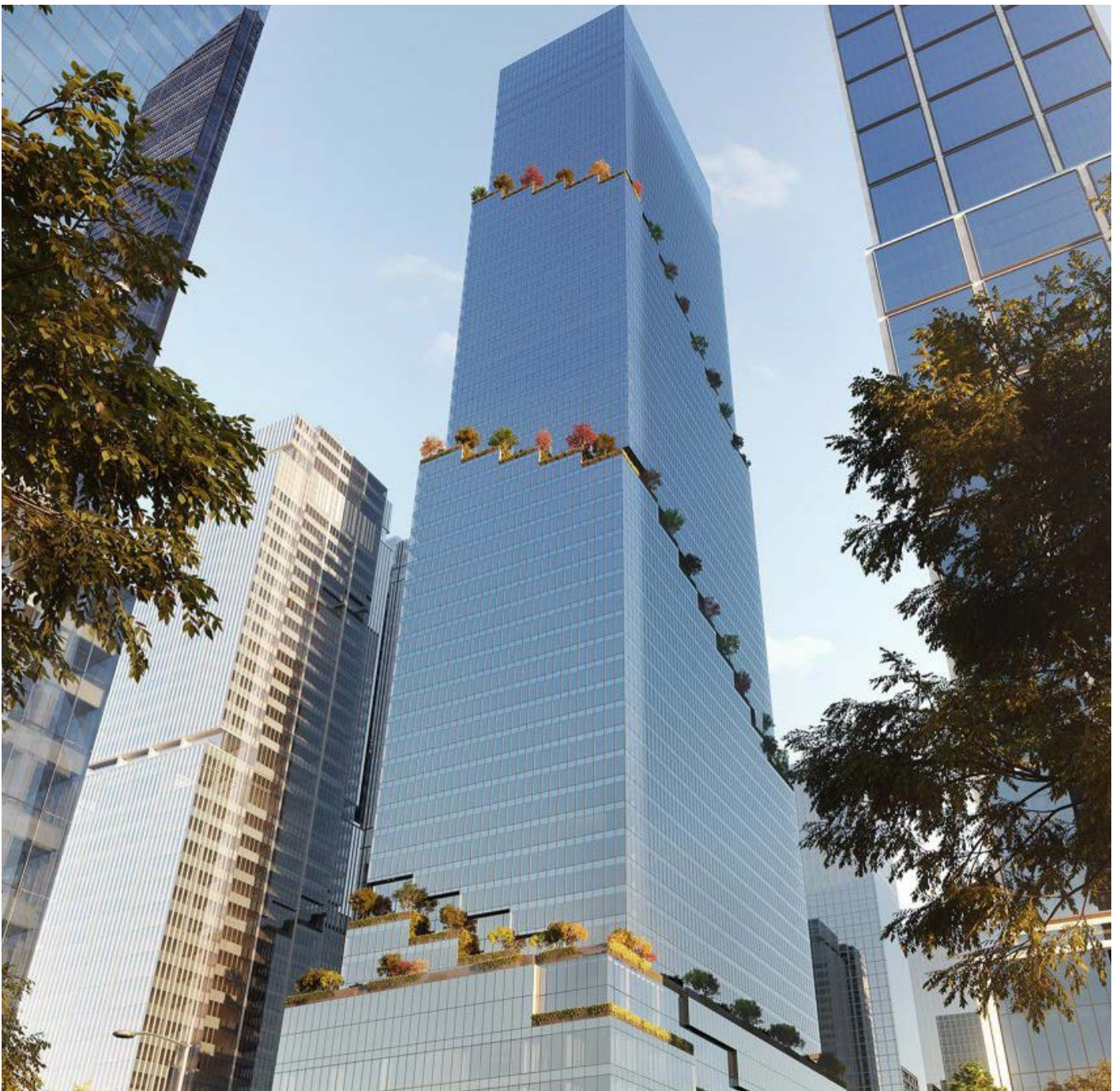
Some higher-profile examples include both the New Zealand TVNZ Breakfast show and The AM show backdrops, which have, since the start of 2022, become very nature driven.





# The Spiral - New York

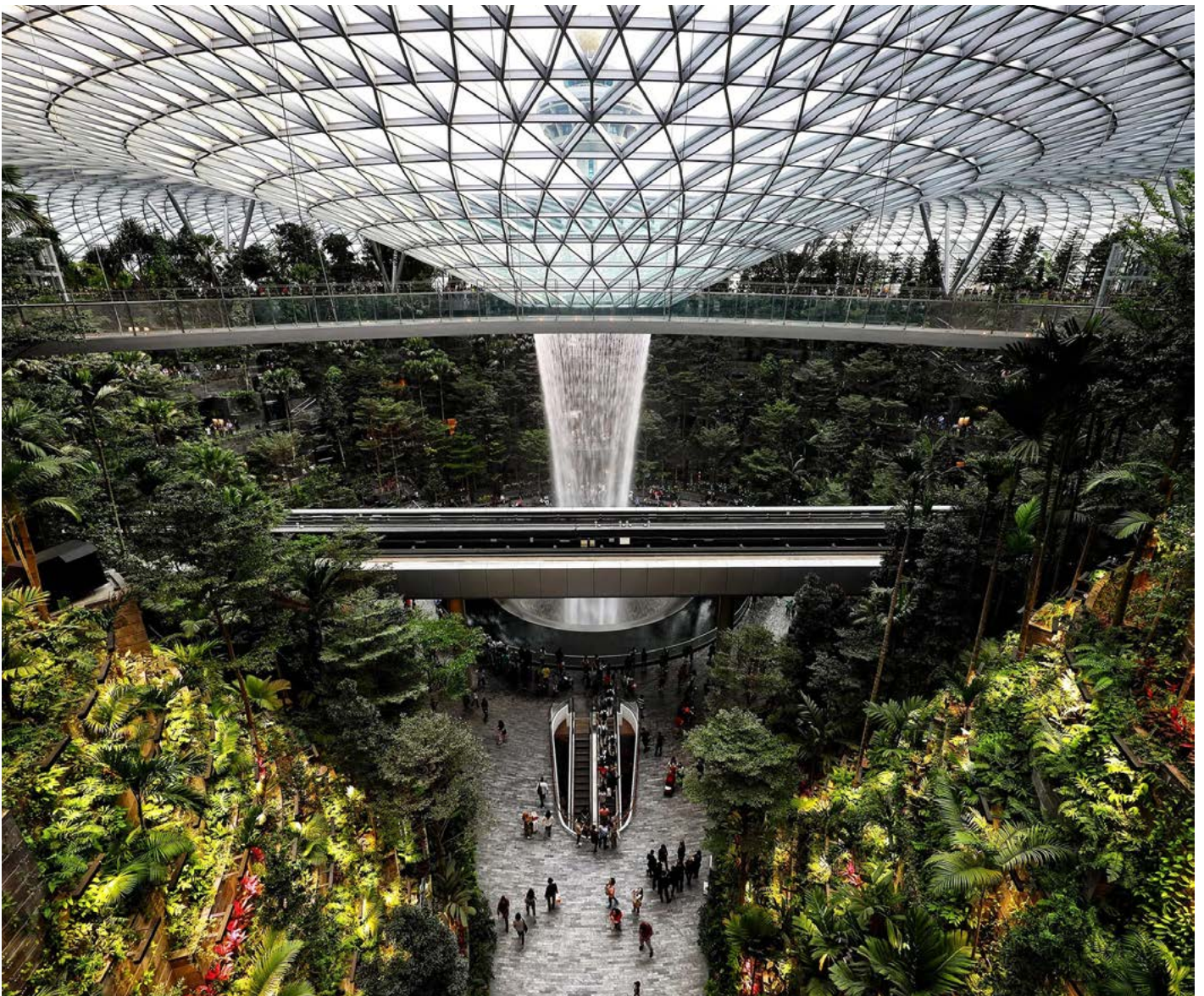
This latest sky-scraping building in New York's crowded skyline, stands out because of the winding avenue of trees and planting spiraling from bottom to top. The building's design means that every floor has access to an outdoor, landscaped, natural space.





# Changi Airport - Singapore

Just stick a pin in a map of Singapore and you will almost certainly hit a piece of biophilic design. Termed biophilic urbanism, an holistic approach has formed from a report in 2012, The Singapore Green Plan. From the Gardens by the Bay, with its iconic man-made super-trees, to increasing canopy cover – up 20% in the last couple of decades – to the Rain Vortex at Changi Airport and innumerable buildings sprouting greenery from every orifice, this is a city that has fully embraced the benefits of biophilic design.





# Auckland Airport

Airports can be stressful places, so many have started using biophilic elements to try and produce calming effects on passengers. Auckland airport is a good case, with natural textures, ceiling displays, soothing colours and the sound of the forest as you walk through to international arrivals.



# Conclusion

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“Irrespective of the data we collected as part of this study, there was a noticeable change in mood amongst the children in the biophilic space. There was more focus and engagement in the room. They took ownership of their space, the plants especially, which they became protective of and cared for. It was a lovely thing to see.”

-Heath Boot - Teacher

Whilst being careful not to claim conclusive results in a scientifically robust study, this limited exercise does seem to demonstrate what is being proven across other public space sectors, that the use of biophilic elements or biophilic design, has a positive effect on the people who occupy those spaces – in this case the children and teachers.

That a relatively small group of children were more ready to learn over such a short period in a school space where nature is given a place could arguably be extrapolated out across entire schools or nations. This could have a huge impact on educational outcomes, leading to enhanced lives for thousands of students and their families.

**The key number to take away from this study is the 12% uplift in children ready to learn where biophilic design is present.**

Given there are around 475,000 primary aged students in New Zealand alone, then something like 57,000 children would be better prepared to learn were biophilic design to be rolled out nationally.

The Office Depot study cited earlier in this paper showed that good results in early education leads to a higher gain of post-graduate degrees and thus higher paying jobs. The trend of early education leading to more success in life (assuming higher pay is a determinant of success of course) also grows as the child moves through education from primary to middle school. So, providing a better learning space becomes more important the further along their educational route the child travels.

The results shouldn't be surprising either. If you ask children to draw a picture of their favourite place, 96% will draw an outdoor space: most adults too.



# Conclusion

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The various studies in workplaces around the world that have shown sometimes dramatic results where biophilia was used demonstrate this is a real cause and effect. The natural human desire to be amongst nature is strong. Our brains have evolved very little over the past few hundred millennia and still feel most comfortable – and operate best - in the natural world.

To find out more about this research or to discover the benefits of biophilic design in your own school, work, recreation, home or health space, call Blair at PLN Group on +64 (0)9 828 4274.  
Or email [blair@plngroup.co.nz](mailto:blair@plngroup.co.nz).

There are a number of other articles about biophilic design on the PLN Group website - [www.plngroup.co.nz/biophilic-design-home](http://www.plngroup.co.nz/biophilic-design-home) as well as a section on acoustics - [www.plngroup.co.nz/noise-reduction](http://www.plngroup.co.nz/noise-reduction)

# About PLN Group

Biophilic designed pieces from PLN Group.

[Hush](#)



[BIP](#)



[Camber](#)



## Design with Purpose

The team at PLN Group understands that the world does not need just another piece of furniture.

We understand why a piece of design exists, not just that it does.

In other words, we design from purpose

The purpose of easing approaching challenges, creating innovative ideas and solutions that improve and enhance your life at work, at home, or in the classroom. Ideas that help you live better, focus and collaborate better or be better prepared to learn wherever in the world you find yourself.

We produce solutions that enhance the spaces created for the humans that inhabit them.

PLN Group's range spans lighting, soft and hard furniture as well as other items such as acoustic pendants and room dividers and can be seen in some of the most prestigious and recognised addresses and businesses in 17 different countries

**PLN Group. Life enhancing design**



# Sources & Further Reading

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