

# INTEGRATING NATURE-BASED INTERVENTIONS IN EARLY CHILDHOOD EDUCATION SETTINGS IN ONTARIO

*Submitted to OCAD University in partial fulfilment of the requirements for the degree of Master in Design in Inclusive Design*

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# ABSTRACT

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This Major Research Project (MRP) investigates the practical application and perception of nature-based interventions within Ontario's early childhood education settings. The study addresses a critical gap in research concerning the implementation of biophilic and plant-based strategies within regulated daycare interiors and exteriors. While the benefits of nature exposure for children's well-being and development are well-established, this research focuses specifically on how interventions such as planting, biophilic furniture, and sensory spatial design are perceived for supporting children's attention and well-being.

Employing a mixed methods approach grounded in research through design, this study gathers data through interviews with early childhood educators and administrators, questionnaires completed by parents, and observational notes taken during a guided interaction with a small biophilic prototype. A key activity involves the researcher facilitating a short play-based session in which children aged one to five engage with the prototype, with parental consent and child assent obtained. The resulting qualitative data is analyzed through thematic interpretation and affinity mapping to inform the development of adaptable and context sensitive design strategies. Rather than measuring developmental outcomes, the prototype is used as an exploratory design artifact to examine experiential qualities related to attention, engagement, and emotional regulation within regulated early childhood environments.

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The motivation for this research is deeply personal and is fueled by my experience as a parent and designer. I am committed to investigating the evident gap and recognized challenges in access to and implementation of nature-based interventions within regulated early childhood education settings in Ontario. My dedication is fueled by recognizing the potential positive difference biophilic environments can make in children's development and well-being.

I dedicate the driving force behind this commitment to my children, whose presence and constant motivation inspire me to advocate for healthier, nature-connected environments in early learning.

Finally, I thank the participants, the early childhood educators, administrators, and parents, whose willingness to share their valuable insights is essential to transforming learning environments for the benefit of all children.

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# 1. INTRODUCTION

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For the first time in human history, childhood is increasingly lived indoors. As urban populations grow and cities intensify through increased density and vertical development, children’s daily environments have become more spatially constrained and predominantly interior (United Nations, Department of Economic and Social Affairs [UN DESA], 2019). Concurrently, empirical research documents a decline in children’s outdoor play and independent mobility, alongside rising sedentary and screen-based indoor activities, particularly in urban contexts (Gray, 2011; Larouche et al., 2023; Statistics Canada, 2016). These intersecting trends have significantly reduced children’s everyday contact with natural environments, rendering nature an intermittent experience rather than a consistent condition of childhood. Within this context, nature becomes not only unevenly accessible but increasingly shaped by socio-spatial privilege. This research asks: how might nature be meaningfully reintroduced into the indoor environments where young children now spend the majority of their time?

## *Listening to the World – Background and Context*

On a typical weekday morning in Toronto, many young children begin their day not in a backyard or neighborhood park, but in a regulated childcare room. For increasing numbers of families, early childhood education (ECE) settings are where children spend most of their waking hours, form friendships, and encounter the material world that surrounds them. In these spaces, the presence or absence of nature quietly shapes how children feel, focus, and recover from everyday stresses. A growing body of research demonstrates that children’s engagement with nature supports emotional wellbeing, cognitive functioning, and stress recovery (Chawla et al.; Faber Taylor and Kuo; Ulrich et al.).

In Ontario, this recognition is partially reflected in policy. The Child Care and Early Years Act, 2014 (CCEYA) and its General Regulation require that children in care for six hours or more must spend at least two hours outdoors daily, weather permitting (Ontario Ministry of Education). These minimums acknowledge outdoor play as a developmental need rather than an optional enrichment. However, they do not fully address how much of children’s daily experience now unfolds indoors, nor the qualitative character of those indoor environments.

Canadian population-level research indicates that children attending licensed childcare engage in less parent-reported outdoor free play at home compared to children who do not attend daycare (Carsley et al., 2017). In their analysis of preschool-aged children across Canada, Carsley and colleagues found that enrolment in formal childcare was associated with a displacement of outdoor play from the home environment, rather than an overall increase in children’s daily outdoor activity. The authors suggest that this pattern may reflect parental perceptions that children’s physical and outdoor play needs are being adequately met within childcare settings. As reliance on formal childcare increases, responsibility for children’s everyday contact with outdoor and natural environments is therefore partially outsourced to institutional spaces, many of which were not originally designed to support sustained, biophilic, or unstructured engagement with nature.

This project starts from that tension. If young children are spending more time in highly regulated, safety-driven interiors, then those interiors become a critical frontier for nature connection. The question is no longer only how much time children spend outdoors, but how deeply nature can be woven into the textures, materials, and micro-experiences of the spaces where they actually live their days. This MRP responds to an emerging need to maximize the benefits of both outdoor and indoor nature-based engagement in order to address what is increasingly described as a “nature deficit” in contemporary childhood.

### **A Personal Seed – Why This Inquiry Grew**

This research is profoundly rooted in my commitment, as both parent and designer, to improving the environments where children learn and grow. As a mother, I have watched my own children settle, soften, and come alive in the presence of plants, soil, and sunlight. As a designer working within the constraints of real projects, I have also seen how difficult it can be for regulated Early Childhood Education (ECE) settings to provide consistent, meaningful contact with nature while meeting hygiene, supervision, and safety requirements.

These parallel experiences highlighted a recurring tension between what research suggests is possible in nature rich and biophilic environments and what many Ontario childcare centres can realistically implement within existing buildings, regulations, and daily routines. Rather than positioning this literature as proof of outcomes, it serves here as contextual grounding for identifying a design opportunity shaped by constraint. This inquiry takes root within that tension, focusing on how biophilic principles might be translated into feasible, adaptable design approaches that respond to the spatial, material, and operational realities of licensed early childhood environments.

### **Research Question and Objectives**

This research investigates the application and perception of nature-based interventions within Ontario early childhood settings, contributing to the fields of inclusive design, environmental psychology, and early childhood pedagogy. The study is guided by the following central research question:

**How can nature-based interventions, including planting activities, biophilic design elements, and sensory spatial affordances, be applied within Ontario early childhood settings, and how are they perceived in relation to children’s attention and well-being?**

This study does not aim to redesign entire childcare facilities or establish causal developmental outcomes. Instead, it explores whether small-scale, materially feasible biophilic micro-interventions implemented at the level of objects and contained spatial structures may support behaviors associated with children’s regulation, engagement, and interaction patterns. By testing and projecting interventions across three levels of integration, this research examines how incremental design strategies may provide accessible entry points for nature-based integration within existing daycare environments.

To answer this question, the research pursues these interconnected objectives:

- Explore how biophilic principles identified in the literature and how can be interpreted as design-relevant mechanisms within regulated early childhood environments

- Examine perceptions and observed patterns of engagement during interaction with small-scale biophilic prototypes
- Identify spatial, material, and operational constraints that shape the feasibility of nature-integrated design strategies in Ontario childcare settings
- Reflect on how research-through-design can support the translation of biophilic concepts into context-sensitive interior interventions.

### **What I Hope to Find – The Hypothesis**

Based on existing literature regarding the benefits of nature exposure for young children, this investigation is guided by the following hypothesis:

***Nature-based interventions are beneficial for children in Ontario early childhood settings, and their implementation is feasible for educators, administrators, and parents.***

More specifically, this study anticipates that nature-based interventions, including planting activities, biophilic design elements, and sensory spatial affordances, will be perceived by stakeholders as supportive of children's attention and emotional regulation. It further anticipates that participants will identify practical and context-sensitive pathways for integrating these interventions within existing regulatory, spatial, and operational frameworks of Ontario early childhood settings. Testing these assumptions establishes an evidence-based foundation for future design exploration and implementation.

The study proceeds by reviewing literature on biophilic design, environmental psychology, and early childhood spatial development. It then situates findings within stakeholder interviews and STEEPV analysis before presenting prototype-based inquiry and the resulting Biophilic Intervention Model.

## 2. LITERATURE REVIEW

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Children make sense of the world through their senses long before meaning is mediated through language. Touch, light, movement, texture, sound, and rhythm form the perceptual foundation of early experience and learning (Gibson, 1979; Shams & Seitz, 2008). When natural elements are present—such as vegetation, soil, daylight, and organic materiality—research consistently demonstrates supportive effects on children’s attentional capacity, emotional regulation, and psychophysiological restoration (Wells, 2000; Kuo & Taylor, 2004; Barbiero et al., 2017). These effects are not speculative: across environmental psychology, developmental science, and biophilic design research, exposure to nature has been shown to reduce stress, support self-regulation, and enhance cognitive functioning in children (Ulrich et al., 1991; Kellert & Calabrese, 2015). The literature makes visible what educators and parents often recognize intuitively—that contact with nature operates not only at the level of experience, but internally, shaping children’s physiological, emotional, and attentional states.

### **Biophilia and Human-Nature Connection**

Edward O. Wilson’s Biophilia hypothesis proposes that humans possess an innate tendency to affiliate with natural forms and living systems (Wilson). This framework has become foundational in contemporary research because it helps explain why nature consistently elicits restoration, fascination, and emotional grounding across cultures and age groups. For young children, whose sensory, emotional, and attentional capacities are still forming, biophilia is not a preference but a developmental condition. Kellert extends this idea by identifying three forms of biophilic experience: direct exposure to nature (plants, daylight, air), indirect cues (natural materials, organic patterns), and experiences of space and place (prospect, refuge, complexity, belonging) (Kellert 35). These categories become especially relevant in early learning environments where “direct” nature is limited by weather, regulation, or infrastructure, making indirect and spatial cues powerful proxies for connection.

Biophilia, as defined by Wilson (1984), suggests an innate human tendency to affiliate with natural systems. Kellert (2008) operationalizes this theory through design principles that translate biological affinity into spatial strategies. However, much of this translation has occurred at architectural or landscape scales.

### **Environmental Psychology and Regulation**

Kaplan’s Attention Restoration Theory (ART) proposes that natural environments replenish directed attention by offering “soft fascination” stimuli that gently attract without requiring effort (Kaplan 171). This is crucial for young children, who experience constant cognitive fatigue in overstimulating environments. Ulrich’s Stress Reduction Theory (1984) proposes that exposure to natural elements can produce measurable physiological calming effects. Similarly, Kaplan and Kaplan’s Attention Restoration Theory (1989) argues that natural environments support

recovery from directed attention fatigue. Prospect-Refuge Theory (Appleton, 1975) further suggests that environments offering enclosure and protection while maintaining outward visibility can foster psychological comfort. These frameworks collectively support the hypothesis that small-scale spatial interventions may influence emotional regulation patterns.

Multiple studies confirm these restorative effects:

- Children’s attention improves after exposure to green play settings (Faber Taylor and Kuo).
- Even brief contact with natural elements supports attentional performance (Li and Sullivan).
- Living plants and natural views in classrooms reduce mental fatigue and improve focus (Doxey et al.; Han).

These findings reveal a key insight for childcare: restoration does not require wilderness. Small interventions such as a window overlooking trees, a plant on a shelf, a wooden object with visible grain, can meaningfully support children’s attentional rhythms.

### **Emotional Regulation: Nature as a Calming Co-Regulator**

Ulrich's Stress Reduction Theory (SRT) demonstrates that natural environments elicit rapid psychophysiological recovery, lower cortisol levels, reduced anxiety, and improved mood (Ulrich et al.). This mechanism has profound implications for children learning to navigate overwhelming sensory and emotional worlds. Studies show:

- Green schoolyards function as buffers against stress and improve resilience (Chawla et al.).
- Contact with natural textures enhances calm attention and reduces negative affect (Fell; Burnard et al.).
- Simple exposure to plants lowers anxiety and increases positive emotions (Doxey et al.).

For preschool-aged children, whose regulatory capacities are still developing, exposure to natural environments has been associated with patterns of physiological calming and emotional stabilization described in environmental psychology literature. Gibson’s (1979) theory of affordances posits that environmental forms signal action possibilities to users. In early childhood contexts, spatial geometry and material properties influence how children interpret whether an object can be climbed, entered, or manipulated. Additionally, Piaget’s framework of sensorimotor and preoperational development suggests that young children engage through embodied interaction prior to abstract reasoning.

### **Benefits of Light, Views, and Living Systems**

While biophilic theory broadly emphasizes the human affinity for nature, research in environmental psychology and design suggest that specific environmental variables, particularly natural light, views of nature, and interaction with living systems, play distinct and measurable roles in supporting children’s attention, emotional regulation, and well-being within indoor environments. These variables are especially relevant for early childhood settings, where children spend extended periods indoors and where architectural, regulatory, and operational constraints limit direct access to outdoor natural spaces.

Natural light has been consistently linked to cognitive performance, mood regulation, and physiological functioning. Studies show that daylight exposure supports circadian rhythm alignment, improves alertness, and contributes to emotional stability in children, with implications for attention and learning (Figueiro & Rea, 2010; Küller & Lindsten, 1992). In educational environments, access to daylight has been associated with improved student performance and reduced fatigue, underscoring its relevance as a foundational design consideration in early learning spaces (Heschong Mahone Group, 2003). Within childcare contexts, the strategic use of daylight through window placement, light diffusion, and material reflectance, represents a practical and scalable intervention that does not rely on additional programmatic time or resources.

Visual access to nature, even in the absence of direct physical contact, has also been shown to produce restorative effects. Research grounded in Attention Restoration Theory demonstrates that views of natural elements can reduce cognitive fatigue, support attentional recovery, and lower stress levels (Kaplan & Kaplan, 1989; Ulrich et al., 1991). For children in dense urban environments, where outdoor access may be limited, visual connections to vegetation, sky, and seasonal change function as an important proxy for direct nature exposure (Wells & Evans, 2003). These findings suggest that integrating framed views, indoor plant visibility, or visual corridors toward outdoor greenery can meaningfully contribute to children's emotional and attentional regulation within constrained indoor settings.

Living systems, such as plants, soil, and small-scale ecological elements, introduce a dynamic and temporal dimension to interior environments that static representations of nature cannot replicate. Empirical studies indicate that interaction with living plants supports psychological restoration, reduces stress, and fosters sustained attention in children (Bringslimark et al., 2009; Barbiero et al., 2017). Unlike decorative or symbolic uses of nature, living systems require care, observation, and adaptation over time, aligning with developmental processes of curiosity, responsibility, and sensory engagement. In early childhood settings, living systems, whether through planting activities, integrated planters, or small-scale indoor growing, offer a flexible and low-cost pathway for embedding biophilic principles within existing spatial and regulatory frameworks.

Taken together, the literature indicates that light, views, and living systems function as complementary biophilic variables that can be considered in the design of early learning environments. Rather than relying on idealized or outdoor-dependent models of nature exposure, these variables provide a grounded foundation for translating biophilic research into feasible design strategies for Ontario childcare centres.

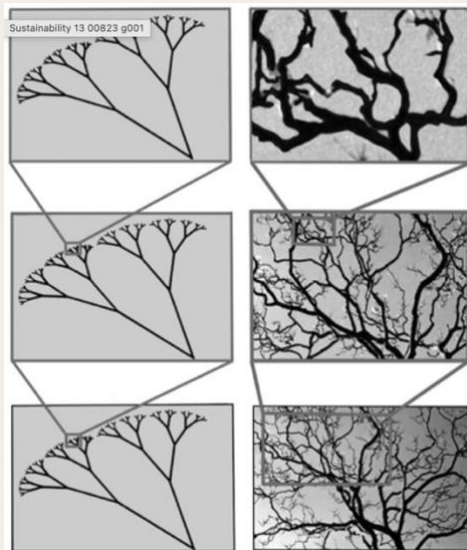
### **The Texture of Life – Materials**

Children do not encounter materials as static objects but as fields of sensory and action-oriented possibilities, commonly described in the literature as affordances (Gibson, 1979). Where adults may perceive discrete objects, children experience textures, temperatures, weight, resistance, sound, and opportunities for movement and manipulation. Research in ecological psychology and child development demonstrates that materials communicate meaning through what they allow the body to do, inviting grasping, stacking, balancing, touching, listening, and exploration (Heft, 1988; Gibson, 1979). Natural materials such as wood, soil, and plants offer variable, responsive, and multi-sensory affordances, supporting exploratory play, motor development, and perceptual learning

(Nicholson, 1971; Kellert, 2008). By contrast, highly synthetic and uniform materials tend to limit sensory variation and action possibilities, constraining the range of affordances available for open-ended engagement. In early childhood environments, material choice therefore shapes not only aesthetic experience, but the depth and quality of children’s interaction with space, objects, and their own developing bodies.

The literature consistently reinforces this distinction. Natural materials have been associated with reduced physiological stress responses, calmer attentional states, and affective warmth when compared to more uniform synthetic materials. Research on wood, for example, shows measurable impacts on stress recovery, including lower blood pressure, improved mood, and enhanced comfort (Burnard et al.; Zhang et al.). This aligns with what Kellert describes as “material authenticity,” a perceptual sense of connection to living systems that supports both emotional and cognitive development in children (Kellert 57).

Materials are only one component of the biophilic tapestry. Children also respond strongly to patterns, particularly the self-similar geometries and scaling relationships commonly found in natural systems. Research on fractal patterns demonstrates that mid-range fractal complexity, typically characterized by a dimensionless fractal dimension (D) between approximately 1.3 and 1.5, is associated with the greatest reductions in physiological stress. These effects have been empirically measured through decreases in skin conductance, lower stress indicators, and improvements in positive affect (Taylor et al., 2005; Taylor, 2006). Importantly, fractal dimension does not describe physical size or units of measurement, but rather the degree of visual complexity across scales. Neurophysiological research suggests that human perceptual systems process fractal patterns with greater efficiency because they mirror the statistical structure of ancestral natural environments, resulting in calmer and more fluent visual processing (Taylor, 2006). These responses reflect neurological and physiological mechanisms rather than subjective aesthetic preference.



Further research reveals that people respond more positively to fractal patterns that exhibit structured repetition and proportional scaling, rather than randomness. Robles et al. demonstrate that ordered fractal hierarchies promote perceptual comfort and emotional stability, an effect attributed to “processing fluency,” the cognitive ease experienced when stimuli match the statistical properties of natural scenes (Robles et al. 5). This aligns with Kaplan’s work, which identifies “coherence and complexity” as key contributors to environmental preference, fascination, and restoration (Kaplan 180).

From a design research perspective, this body of evidence is significant. It means that biophilic benefits do not require literal

Natural Examples Of Fractals (Taylor, Richard P.)

natural materials. Fractal-like patterning, organic linework, natural color gradients, and textured surfaces can replicate many of nature’s neurological effects, even when licensing requirements prohibit soil, bark, untreated wood, or other porous elements. In Ontario childcare centers, where The Child Care and Early Years Act, 2014 (CCEYA) and Infection Prevention and Control (IPAC) guidelines restrict such materials, fractal surfaces, warm color palettes, patterned acoustic panels, or biomorphic furniture forms can deliver biophilic value without regulatory conflict.

The implications for early childhood environments can be interpreted through this body of research. Young children, whose executive functioning and emotional regulation systems are still developing, benefit from interiors that reduce overstimulation, anchor attention, and promote sensory balance. Biophilic patterning provides “soft fascination”—a core mechanism of both Attention Restoration Theory and Stress Reduction Theory—by engaging perception without demanding effort (Kaplan 183; Ulrich et al. 204). When incorporated into textiles, spatial layouts, ceiling grids, or modular partitions, these patterns help create interiors that feel both alive and comprehensible, a balance shown to enhance curiosity, emotional stability, and calm attention.

Ultimately, biophilic design for early childhood is not about spectacle. It is about sensory literacy, creating environments that speak to children in the languages their bodies instinctively understand, warmth, grain, rhythm, pattern, movement, and gentle unpredictability. When thoughtfully embedded in the built environment, these cues become part of a child’s lived sensory field, offering grounding, fascination, and comfort in the indoor spaces where they spend most of their time.

### ***Children’s Emotional Regulation, Safety, and the Materiality of Care***

Emotional regulation in early childhood is not a single skill but a choreography of signals, co-regulation, sensory grounding, and environmental feedback loops. Children borrow stability from their caregivers, but they also borrow it from their surroundings. Rooms characterized by harsh lighting, echoing acoustics, and highly uniform artificial materials can contribute to sensory conditions that place increased regulatory demands on young nervous systems.

The literature on nature and emotion consistently suggests associations between exposure to natural environments and reduced physiological arousal, attentional recovery, and stress buffering (Ulrich et al., 1991; Faber Taylor & Kuo, 2009; Chawla et al., 2014). Emotion regulation in early childhood, however, is inherently relational, emerging through processes of co-regulation between children and caregivers rather than through individual self-control alone (Thompson, 2011). Within early learning environments, spatial and material conditions can either support or intensify the emotional demands placed on educators. Biophilic design elements such as plants, natural materials, soft visual patterns, and access to daylight, do not replace adult care or relational responsiveness. These elements, instead, function as environmental supports that help stabilize children’s emotional states, reduce baseline stress, and create conditions more conducive to co-regulation. In this way, biophilic cues may contribute to environmental conditions that support emotional regulation and co-regulation, complementing rather than substituting human caregiving.

Ontario's regulatory environment complicates this picture. Sanitation protocols limit the use of porous materials; safety requirements dictate furniture proportions; limited windows and high-rise layouts constrain daylight. These realities mean that emotional regulation cannot depend solely on "bringing nature in" literally. Instead, it requires interpreting nature through design, creating environments that echo natural rhythms in ways that are realistic, compliant, and attuned to children's sensory needs.

In this sense, biophilic design becomes a form of care. It is not only about exposure to nature but about creating emotional climates where children can feel safe, grounded, and capable.

### ***Spatial Configuration, Child-Scale Environments, and Micro-Affordances***

Children experience space through micro-affordances including corners, edges, nooks, pathways, and material textures that invite exploration, refuge, movement, or sensory grounding. Research in ecological psychology and child environment studies demonstrates that children perceive and engage with environments primarily through these action oriented spatial cues rather than through abstract spatial layouts (Gibson, 1979; Heft, 1988). Within biophilic and environmental design research, spatial patterns such as prospect and refuge, enclosure with visibility, variation in scale, and opportunities for retreat have been associated with children's emotional regulation, attentional restoration, and sense of safety (Kaplan & Kaplan, 1989; Kellert, 2008; Chawla et al., 2014). These findings suggest that small scale spatial features play a critical role in shaping how children regulate emotion and attention within indoor learning environments.

Biophilic research highlights several spatial characteristics that meaningfully support children's sensory and emotional development. Environments that offer a balance of prospect and refuge help children feel both open to exploration and protected when they need moments of withdrawal (Kellert). Likewise, spaces with an intentional balance of complexity and order provide enough sensory richness to stimulate curiosity while maintaining the coherence children need to stay regulated (Kellert; Kaplan). Subtle movement cues, including natural light gradients and directional patterns, help young learners orient themselves intuitively and reduce cognitive effort as they navigate the room ("Heschong Mahone Group"; Li and Sullivan). Finally, thoughtful material sequencing, such as the use of warm natural materials like wood across different spatial zones, has been shown to lower stress responses and enhance perceptual comfort (Burnard et al.; Zhang et al.). Together, these spatial elements create an environment that supports children's attention, emotional regulation, and sense of security.

A growing body of literature supports the cognitive, emotional, and attentional benefits of nature exposure in educational environments. For example, Barbiero et al. (2017) found that biophilic classroom elements were associated with increased attentional performance and perceived restorativeness among students. Similarly, Browning et al. (2014) outline architectural biophilic design patterns that enhance occupant well-being at building scale. However, much of this research examines outdoor access, classroom-wide spatial redesign, or architectural integration. Comparatively less attention has been given to small-scale, materially feasible micro-interventions that can be incrementally introduced within existing daycare environments without structural renovation. This study

explores such interventions through object-based and contained spatial prototypes designed for operational childcare settings.

### 3. MAKING SENSE OF THE EVIDENCE

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The evidence reviewed in Section 2 converges around a striking insight: children’s well-being is not only influenced by their environments, but is closely shaped through ongoing interaction with them. Sensory qualities, material conditions, patterns of light, and the presence of living or life-like elements are not background variables; they form the scaffolding through which children regulate emotion, develop attention, interpret safety, and build early cognitive maps of the world (Kellert 57; Kaplan 180).

Empirical studies have documented associations between exposure to nature rich environments and reduced cortisol levels, improved autonomic stability, smoother attentional rhythms, lower aggression, and increased prosocial behavior in children (Ulrich et al. 204; Chawla et al. 4; Li and Sullivan 155). These findings indicate that the effects of nature exposure are physiological, neurological, and behavioral rather than abstract. For young children whose internal regulatory systems are still developing, biophilic environments have been described as contributing to external conditions that support nervous system regulation when internal resources are limited.

Yet, as compelling as this evidence is, the realities of licensed childcare environments complicate its application. Ontario’s CCEYA and IPAC regulations emphasize safety, hygiene, durability, and supervision, priorities that often result in interiors dominated by smooth plastics, high visibility, bright artificial lighting, and easily sanitized materials. These choices are not illogical; they respond to real operational pressures. They create sensory environments that can be sharply misaligned with what developmental science tells us children need.

This tension reveals one of the central findings of this review:

**The literature on early childhood environmental design and regulated childcare settings indicates a persistent misalignment between children’s developmental needs and the operational structure of childcare environments, positioning design as a mediating factor between the two (Moore, 2014; Barrett et al., 2015; Kellert & Calabrese, 2015).**

The literature makes clear that biophilic benefits often arise not from dramatic or immersive exposure to nature, but from small, repeated encounters with sensory cues that echo natural systems. These include organic textures, warm materials, fractal lines, indirect daylight, soft movement, and child-height natural elements, which have been associated with physiological regulation and attentional restoration. (Taylor et al., 2005; Robles et al., 2021; Burnard et al., 2022). Such cues do not replace direct contact with nature; rather, they recreate some of its regulatory mechanisms within constrained environments.

This distinction is particularly significant for early childhood education. While outdoor play is essential, young children spend the majority of their day indoors, especially in Canadian climates, high-density urban buildings, or childcare centres with limited outdoor yards. In Ontario, licensed childcare centres are required to provide a minimum of two hours of outdoor play per day, weather permitting, typically scheduled in fixed blocks (Ontario

Ministry of Education, 2015). In practice, however, outdoor play is commonly restricted when wind chill reaches  $-10^{\circ}\text{C}$  or colder, during periods of extreme heat, or when air quality reaches levels considered unsafe for young children, in accordance with public health guidance (Toronto Public Health; OPHEA). Climate data for the Greater Toronto Area indicate that these conditions occur on approximately 35–50 days per year, not including additional days affected by heavy snow or ice hazards (Environment and Climate Change Canada, 2023). As a result, the indoor environment becomes the primary sensory landscape for much of early childhood, underscoring the importance of indoor environments that support attentional restoration and stress regulation.

In this context, biophilic design can be interpreted as contributing to developmental equity rather than functioning solely as an aesthetic preference. Children in childcare, particularly those from urban, low-income, or nature-restricted families, may have limited access to restorative natural experiences outside of school. The classroom becomes a critical site of intervention, a place where design can either buffer stress or compound it.

The question, then, is not whether biophilic principles matter, they do, but which of these principles are feasible, impactful, and sustainable within the constraints of Ontario childcare settings.

Five key insights emerge from the evidence:

1. Children benefit most from CONSISTENT, not occasional, biophilic cues.

Small-scale, daily exposure to natural textures, warm materials, and daylight creates more stable regulatory patterns than occasional outdoor experiences (Han 666; Kaplan 172).

2. Indirect biophilic elements can be as impactful as direct nature.

Fractal patterns, organic forms, and material warmth generate real physiological responses, even without literal plants, soil, or foliage (Taylor, “Fractals and the Gestalt” 86; Robles et al. 5).

3. The interior environment has disproportionate influence on children’s development.

Because children spend most hours indoors, the sensory climate of the classroom becomes a major determinant of self-regulation, mood, and attentional resilience (Ulrich et al. 204; Faber Taylor and Kuo 406).

4. Biophilia can coexist with regulatory constraints when adapted appropriately.

CCEYA guidelines limit certain natural elements, but indirect cues—textures, patterns, surfaces—fit within sanitation requirements and still deliver tangible benefits (Burnard et al. 495; Zhang et al. 149).

5. Biophilic design offers an under-recognized opportunity for emotional infrastructure.

Environments that soothe children reduce emotional load on educators, support co-regulation, and create climates of psychological safety (Chawla et al. 9; Kellert 63).

Together, these insights suggest that biophilic design represents a functional and evidence-informed approach to supporting children's emotional and cognitive development. The challenge is not proving that nature matters, it does, but identifying how to translate its benefits responsibly, realistically, and ethically in Ontario early childhood settings.

## 4. EXPLORING CHILDREN'S EXPERIENCES - METHODS

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This study adopts a Research through Design (RtD) methodology, in which design prototypes function as inquiry instruments rather than final products (Zimmerman et al., 2007). Within this framework, the act of designing and testing spatial interventions generates knowledge through iterative material engagement, observation, and reflection. The prototypes developed in this study were therefore not intended as finalized solutions, but as exploratory tools used to examine how small-scale biophilic interventions may influence regulation and engagement in early childhood environments. Within this framework, the act of designing and testing spatial interventions generates knowledge through iterative material engagement, observation, and reflection. The prototypes developed in this study were therefore not intended as finalized solutions, but as exploratory tools used to examine how small-scale biophilic interventions may influence regulation and engagement in early childhood environments. Data collected in this study were qualitative and observational in nature. No physiological measurements were taken. Observations focused on behavioral patterns, interaction duration, posture, verbal expressions, and engagement dynamics. Field notes were recorded following each session.

This project sits at the intersection of children's sensory lives, the regulatory structures that shape early childhood environments, and the emotional labor carried by educators who support young learners every day. Exploring how biophilic cues are perceived and interpreted within regulated early childhood environments required a methodology capable of moving across scales, from material and sensory experience to the licensing policies that shape what can enter a classroom.

I approach this work as a designer-researcher, guided by an interpretive stance that values experiential knowledge, embodied ways of learning, and the tacit understandings educators develop through daily practice. Children are not abstract "users"; they are sensory beings who navigate the world through texture, rhythm, light, movement, and proximity. Within this framework, the built environment can be understood as a form of emotional and cognitive infrastructure that shapes sensory experience and interaction (Kellert, 2015, p. 57; Denzin & Lincoln, 2018, p. 13).

For this reason, the methodology draws from multiple forms of knowledge, acknowledging that no single method can capture the full complexity of children's experiences or the systems that shape them. This multimethod approach enabled the research to examine experiential patterns alongside feasibility considerations within Ontario's childcare context.

The research strategy combines scientific evidence, lived experience, regulatory analysis, environmental scanning, and design inquiry. This structure responds to tensions identified in the literature between children's developmental needs and the regulatory, sanitation, and supervision requirements that shape what is possible within childcare environments.

## **Research And Strategy Design**

To address this gap, the project integrates:

### **4.1.1 Secondary Research**

To understand the developmental, sensory, and psychological effects of biophilic cues, a comprehensive literature review was conducted (see Section 2). Works on attention restoration (Kaplan 171), stress recovery (Ulrich et al. 204), natural materials and affect (Burnard et al. 501), and fractal pattern perception (Taylor et al. 247; Robles et al. 5) formed the scientific foundation of the study.

### **4.1.2 Policy and Regulatory Analysis**

The Child Care and Early Years Act (CCEYA) and Infection Prevention and Control (IPAC) guidelines were reviewed to identify the material, spatial, and operational constraints that shape licensed childcare environments in Ontario. These frameworks establish requirements related to hygiene, safety, and supervision, including the use of cleanable, non-porous surfaces, the avoidance of materials that may harbor contaminants, and the need for environments that support visibility and risk mitigation (Ontario Ministry of Education, 2014; Public Health Ontario, 2018). Rather than prescribing specific design solutions, these regulations define the conditions within which design interventions must operate. In this study, they were interpreted as feasibility parameters, informing decisions related to material selection, form, and the integration of sensory elements. A synthesized summary of these constraints and their design implications is provided in Appendix G.

### **4.1.3 Semi-Structured Interviews**

Interviews with early childhood educators, parents and centre directors illuminated how sensory environments shape daily rhythms, emotional regulation, and instructional demands. These conversations provided the experiential layer the literature cannot capture, how it feels to soothe a dysregulated child in a fluorescent-lit room, or how certain materials quietly support calm.

### **4.1.4 Ethical considerations**

Written informed consent was obtained from all participating parents prior to the workshop. Children participated in open exploration without structured instruction or performance evaluation. No audio or video recordings were collected, and no identifying personal information was retained.

Following the workshop, both prototypes remained installed in the researcher's home for a two-week extended observation period involving the researcher's children. To address potential conflict of interest, written consent was obtained from the co-parent. Observations were limited to behavioral patterns and did not involve evaluative

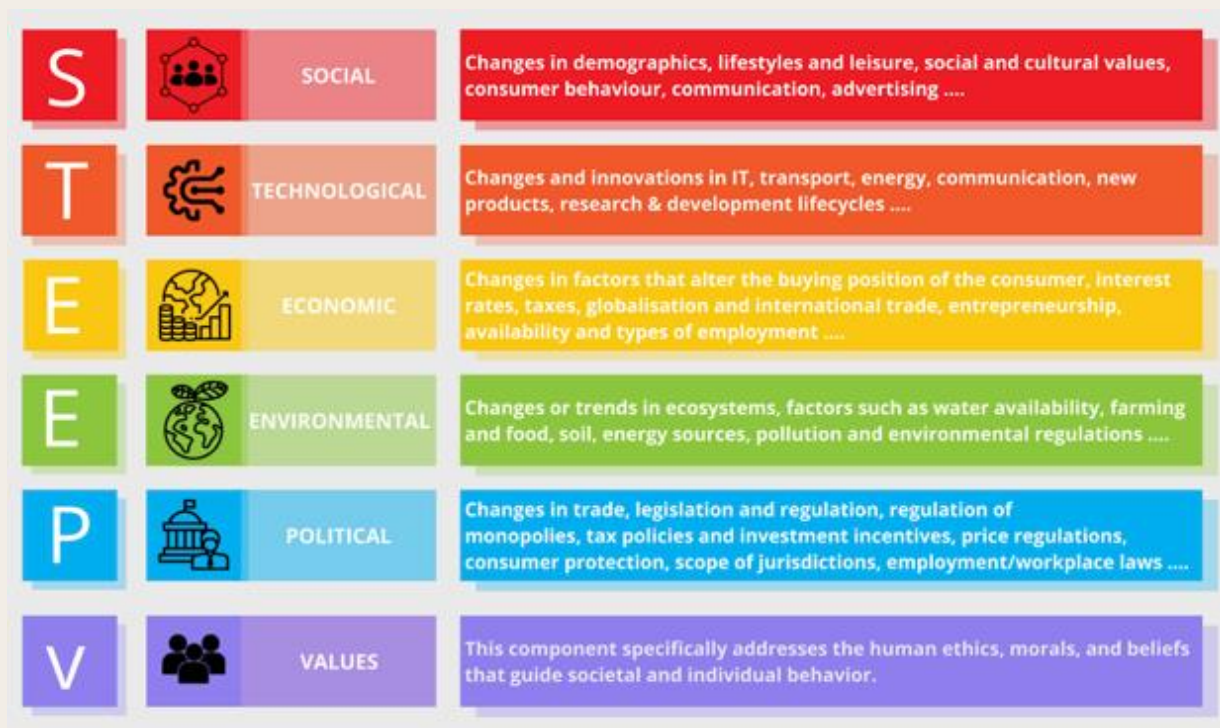
assessment. The extended observation was conducted to distinguish novelty-driven engagement from sustained interaction patterns.

#### 4.1.5 *Environmental Scanning and Signals of Change*

A light foresight-informed environmental scan identified early indicators relevant to indoor environments, children’s well-being, material technologies, and shifting societal values around nature and care. As Hiltunen explains, signals help reveal emerging patterns before they consolidate into trends (Hiltunen 59).

#### 4.1.6 *STEEPV Analysis*

The scan was organized using a STEEPV framework to understand how social, technological, economic, environmental, political, and values-based forces shape the future of biophilic design in childcare.



(AJ&Smart et al.)

#### **State of the Art Review**

Unlike the literature review, which examines academic research, the State-of-the-Art Review focuses on built environment precedents where biophilic principles have already been implemented in early childhood and school environments worldwide. These case studies, such as Fuji Kindergarten by Tezuka Architects, Reggio Emilia schools, Scandinavian Forest preschools, Ilima Primary School by MASS Design Group, and Japanese timber-based

kindergartens, offer practical insight into how nature-informed materials, spatial forms, light, and textures are incorporated within early learning environments. (Tezuka; Edwards; Wicken 44; MASS Design Group; Ando).

**The review identified five key precedents:**

- Fuji Kindergarten — Tezuka Architects (Japan)
- Reggio Emilia Schools (Italy)
- Scandinavian Nature-Based Preschools (Denmark, Finland, Sweden)
- Ilima Primary School — MASS Design Group (DRC)
- Japanese Timber-Based Kindergartens (Japan)

Each precedent is analyzed below with embedded images and citations.

**Analysis of Design Precedents**

Material Warmth & Emotional Regulation: Timber as a Calming Medium

Across Japanese and Scandinavian early childhood environments, natural timber is frequently employed to introduce warmth, acoustic softness, and sensory richness within interior spaces.

**Fuji Kindergarten, Tezuka Architects**

Timber is present in floors, ceilings, and structure, creating a soft, warm sensory environment. Tezuka Architects emphasize that wood was chosen for its emotional comfort and acoustic softness: “The great abundance of natural timber renders the space warm and emotionally calming for children, while absorbing sound and preventing reverberation.” (Tezuka Architects)



Fuji Kindergarten interior showing extensive use of timber (Tezuka Architects).

### **Design approaches**

- Supports use of sealed wood
- Suggests warm textures reduce overstimulation
- Aligns with research linking natural materials to calmer sensory environments (Fell 40; Browning et al.)
- Organized Complexity: Visual Order Supports Regulation

Fuji Kindergarten and Scandinavian preschools use repetitive timber elements, curved geometries, and predictable visual rhythm. Kaplan's environmental coherence theory explains why: "Coherence, a form of visual order, reduces cognitive load and supports self-regulation." (Kaplan 173)

### **Fuji Kindergarten, Timber Rhythm**



Rhythmic timber structure supporting visual coherence (Tezuka Architects).

### Design approaches

- Use mid-complexity natural patterns
- Avoid cluttered, high-stimulation surfaces
- Choose curves and repetition that help children interpret space effortlessly
- Nature as Spatial Logic: Prospect & Refuge Conditions
- Reggio Emilia centers and Scandinavian Forest schools use:
  - Child-height alcoves
  - Lowered shelves
  - Soft nooks
  - Curved refuge corners
  - Window seating

These spatial strategies align with Prospect–Refuge Theory as articulated within biophilic design literature. (Image

## Reggio Emilia Approach

The Reggio Emilia approach represents a spatial and pedagogical framework rather than a single built project. It emphasizes the environment as an active component of learning, where child-scale affordances, materiality, and light are intentionally designed to support exploration, autonomy, and moments of retreat. The following image illustrates how these principles translate into spatial conditions that enable both interaction and self-regulation.



Child-scale spatial affordances inspired by nature-like refuge spaces (Reggio Children).

## Design approaches

- Include curved, safe, semi-enclosed interaction surfaces
- Provide children with “micro-refuge” moments indoors
- Support emotional regulation through predictable spatial cues
- Light as a Primary Biophilic Cue
- In all precedents, light is a design priority, not decoration.
- Fuji Kindergarten uses a continuous skylight effect via its open-ring roof.
- Ilima Primary School uses timber louvers to filter light softly.
- Scandinavian schools use large windows that create a connection to outdoor rhythms.

## Ilima Primary School, Light Filtering

The Ilima Primary School, designed by MASS Design Group, illustrates how light can be intentionally filtered to create calm and responsive learning environments. Through the use of timber louvers and layered façades, daylight is softened and diffused, reducing glare while maintaining a strong visual and atmospheric connection to the surrounding landscape. This approach demonstrates how light operates as an active biophilic mechanism rather than a purely functional element.



Ilima Primary School showing filtered light through natural materials (MASS Design Group).

### Design approaches

- Prototype should complement natural light, not block it

- Use materials that reflect or soften light (sealed wood, curved edges)
- Placement near windows enhances sensory benefits
- Durability & Maintenance: Hygiene Requirements in Real-World ECE Spaces

Real childcare centers worldwide demonstrate:

- Daily disinfecting
- Wiping down surfaces
- Strict material guidelines
- Avoidance of porous or loose parts
- Scandinavian preschools and Reggio Emilia centers rely on:
  - Sealed hardwood
  - Laminated plywood
  - Smooth edges
  - Non-porous finishes

### **Synthesis — What the State of the Art Teaches Us**

Across all precedents, five consistent themes emerge:

- Natural materials → emotional comfort (Fell; Browning; Tezuka Architects)
- Organized complexity → predictable sensory field (Kaplan; Browning)
- Child-scale spaces → regulation through refuge opportunities
- Light → primary biophilic pathway
- Feasibility → sealed wood, smooth surfaces, easy cleaning

These constraints informed the material and construction considerations applied in the prototype.

### **Contribution to Prototype Development**

This review informed the development of the prototype by translating biophilic and developmental research into design criteria appropriate for regulated early childhood environments. This literature review directly informed the development of the prototype by translating biophilic and developmental research into concrete design criteria appropriate for regulated early childhood environments. Rather than treating biophilia as an aesthetic layer, the findings were operationalized into material, formal, and spatial inputs that could be realistically implemented within Ontario childcare settings.

- Material and sensory inputs were derived from research emphasizing the importance of tactile warmth, material variation, and multisensory engagement in early childhood. Sealed wood, defined as wood treated

with a protective finish such as a water-based, low volatile organic compound (VOC) coating that prevents moisture absorption and facilitates cleaning, was selected as a primary material due to its association with natural variability and sensory richness, while remaining durable and appropriate for high-use, regulated contexts. When specified with non-toxic, low VOC finishes compliant with indoor air quality standards, sealed wood is considered safe for early childhood environments (Kellert & Calabrese, 2015). Selective use of natural textile accents supports tactile exploration and sensory diversity, drawing on evidence that multisensory environments contribute to emotional regulation and learning (Shams & Seitz, 2008). Formal decisions prioritize soft, curved geometries, as curved forms have been shown to elicit more positive affective responses and lower perceptions of threat compared to sharp angles (Vartanian et al., 2013).

- Form and pattern decisions were guided by research on perceptual fluency and attentional restoration. Mid-complexity fractal patterns were integrated based on empirical findings linking these geometries to reductions in physiological stress and improved visual processing (Taylor, 2006; Taylor et al., 2005). Rhythmic repetition inspired by natural systems introduces visual predictability without monotony, supporting attentional stability rather than overstimulation (Kaplan & Kaplan, 1989). Child-height access was prioritized to ensure that materials and patterns were encountered at the scale of children’s bodies and perceptual fields, reinforcing agency and embodied interaction consistent with affordance-based theories of child–environment engagement (Heft, 1988).
- Spatial placement further shaped the prototype’s development. Positioning near sources of natural light was informed by evidence linking daylight exposure to improved alertness, mood regulation, and overall well-being in learning environments (Küller & Lindsten, 1992; Heschong Mahone Group, 2003). At the same time, placement strategies avoided high-traffic or disruptive zones to ensure that interaction with the prototype remained voluntary and non-intrusive. Establishing a predictable visual presence—through consistent location, form, and material language—supports emotional grounding by allowing children to recognize and return to the intervention as a stable element within their daily classroom environment (Moore, 2014).
- Together, these evidence-informed decisions shaped a prototype that was developmentally appropriate, compatible with regulatory requirements, and grounded in biophilic research. In this way, the literature review functioned not only as contextual grounding, but as an active driver of design development.

### **Data Preparation and Analytical Process**

This study employed a structured qualitative analysis process to ensure transparency, consistency, and interpretive rigor prior to insight generation and prototype development. Data collected through parent interviews, educator interviews, workshop observations, and post-activity reflections were prepared and synthesized through a multi-step analytical procedure before design decisions were formalized.

#### **4.1.7 Transcription and Translation**

All interviews were recorded using Microsoft Teams and transcribed using automated transcription software. Due to limitations in automated transcription accuracy, transcripts were manually reviewed and corrected to remove artifacts, incomplete phrases, and transcription errors.

Although most interviews were conducted primarily in English, some interviews were conducted partially in Spanish. All transcripts were translated into English to enable consistent cross-dataset analysis and reporting. Translation prioritized semantic and conceptual equivalence rather than literal phrasing. Particular attention was given to preserving emotional nuance and culturally specific expressions related to parenting practices, sensory experiences, and perceptions of nature.

#### *4.1.8 Data Cleaning and Segmentation*

Following transcription and translation, transcripts were cleaned to remove filler words, repetitions, and non-essential pauses while maintaining participant intent and voice. The data were then segmented into discrete meaning units. Each unit represented a single idea, observation, or experiential statement relevant to the research focus.

Participants were anonymized using qualitative research conventions and identified as P1–P4 to maintain confidentiality.

Workshop observations and longitudinal field notes were similarly segmented into discrete behavioral units. This allowed comparison between adult-reported experiences and child-observed interactions while maintaining methodological consistency across datasets.

#### *4.1.9 Affinity Mapping and Thematic Synthesis*

Affinity mapping was used as the primary synthesis tool to identify recurring patterns across qualitative datasets. Meaning units were iteratively clustered into first-order groupings reflecting shared observations, repeated experiences, and descriptive similarities across participants. These first-order clusters remained close to participant language and preserved the integrity of original statements.

Subsequently, clusters were examined comparatively and consolidated into second-order thematic patterns. This stage moved beyond descriptive repetition to identify underlying tensions, systemic misalignments, and latent needs implicit within participant narratives.

The analysis followed a layered interpretive approach, moving from descriptive organization to thematic abstraction. This structure enabled examination of themes both within and across parent interviews, educator interviews, and child-centered observational data, while maintaining traceability to original data sources.

Insight generation was informed by reflexive thematic analysis (Braun & Clarke, 2006; 2019), supported by qualitative coding frameworks (Saldaña, 2016), and design synthesis literature emphasizing the identification of latent needs and systemic misalignments (Kolko, 2011).

The outcomes of this analytical process directly informed the design criteria for the Proof of Concept interventions described in the following section.

### **Proof of Concept (POC) Design Logic**

The design of the Proof of Concept (POC) interventions emerged directly from the analytical process described in Section 4.6. Through first-order clustering and second-order thematic synthesis, recurring tensions were identified across parent and educator interviews, particularly related to overstimulation, limited access to outdoor environments, and the need for embodied, sensory-rich engagement within constrained indoor contexts.

The synthesis revealed two complementary opportunity areas: (1) the need for micro-scale spatial interventions that support immediate emotional regulation, and (2) the integration of visible, living systems that support longitudinal ecological engagement and care-based learning. These opportunity areas informed the development of a tiered intervention framework, allowing design responses to operate at varying scales of complexity and feasibility.

The POC was therefore structured across three tiers. Tier 1 focuses on wall-mounted, transparent root observation planters designed to embed visible ecological processes within everyday classroom environments. Tier 2 introduces a portable, partially enclosed biophilic nook intended to support self-directed regulation and imaginative reinterpretation. Tier 3 extends these principles into a full-room conceptual model, exploring how regulation-supportive and sensory-based design principles might scale within broader classroom ecosystems.

Each tier was developed as a response to synthesized qualitative insights rather than as an aesthetic proposal. Design criteria were grounded in observed stakeholder concerns and framed to allow iterative refinement through participatory testing.

The POC was therefore conceived not as a speculative future intervention, but as a grounded design inquiry situated within present day constraints. Its purpose was not to demonstrate effectiveness or measure developmental outcomes, but to explore feasibility, perception, and experiential qualities of biophilic cues when introduced through design. In this sense, the POC functioned as an exploratory artifact, translating abstract research into a tangible form that could be encountered, interpreted, and reflected upon by children and caregivers.

### **Prototype Strategy and Tiered Approaches**

Before defining a single prototype for testing, the research articulated a tiered strategy for translating biophilic principles into early childhood environments under varying levels of feasibility, investment, and institutional

readiness. This approach acknowledges that Ontario childcare centres operate across diverse conditions, including differences in funding, physical infrastructure, staffing capacity, and programmatic flexibility. Rather than assuming a singular design solution, the strategy explored three conceptual levels through which biophilic cues could be meaningfully introduced.

The first tier is an activity based biophilic encounter. This approach relies on facilitated sensory engagement rather than permanent objects or spatial modification. Biophilic cues are introduced through short duration activities involving natural textures, rhythmic movement, or sensory exploration. This tier represents the lowest barrier to entry, requiring minimal resources and no physical alteration of space. While highly accessible, it depends on adult facilitation and does not alter the everyday sensory baseline of the environment.

The second tier is a portable biophilic object or kit. This approach introduces biophilic cues through a self-contained, movable artifact designed for repeated use within existing spaces. Such an object can be placed, removed, and repositioned without disrupting routines or requiring architectural change. It allows for more persistent sensory presence than an activity alone, while remaining feasible within regulatory and budgetary constraints. This tier represents a balance between accessibility and environmental impact.

The third tier is an integrated furniture or spatial element. This approach embeds biophilic principles directly into the physical infrastructure of the classroom through fixed or semi fixed elements such as furniture, partitions, or built in features. While offering the greatest potential for long term impact, this tier requires higher levels of investment, regulatory negotiation, and institutional commitment.

All three tiers respond to the same evidence base and design principles. However, within the scope of this study, only one tier was selected for prototyping and exploration. The remaining tiers are presented as future pathways for application and further research.

While the tiered approach was initially articulated as three levels of intervention, further synthesis of the literature, stakeholder interviews, and regulatory analysis revealed that these tiers function less as discrete design options and more as a gradient of biophilic integration. Rather than representing isolated prototypes, they reflect escalating levels of environmental embedding, permanence, and systemic influence.

This gradient responds directly to tensions identified in the STEEPV analysis and qualitative findings. Social and environmental trends indicate increasing structural limitations on outdoor access. Economic and political constraints restrict large-scale architectural transformation. At the same time, both parents and educators described a persistent developmental need for sensory-rich, nature-connected environments. The gradient model therefore enables biophilic integration at multiple levels of feasibility, ranging from low-barrier activity-based engagement to whole-space transformation.

The three levels of the Biophilic Integration Gradient are defined as follows:

### **Tier 1 - Living System Activity Intervention**

This level introduces nature through facilitated interaction with living systems, such as planting activities or transparent-root planters that allow children to observe growth over time. It represents the lowest infrastructural threshold and emphasizes temporal engagement, care, and multisensory exploration. It does not alter the spatial baseline but inserts biophilic cues episodically through embodied activity.

### **Tier 2 - Portable Biophilic Spatial Object**

This level introduces biophilic principles through a movable, semi-enclosed object embedded within the classroom. Unlike Tier 1, it alters the micro-spatial experience by introducing refuge conditions, tactile materiality, and consistent visual presence. While still feasible within regulatory constraints, it operates at a higher level of environmental integration than activity alone.

### **Tier 3 - Integrated Spatial Environment**

This level represents systemic embedding of biophilic design principles within the architectural and spatial configuration of the entire classroom. It includes zoning strategies, prospect–refuge balancing, material sequencing, light modulation, and integrated living elements. This tier shifts the environmental baseline rather than inserting isolated interventions.

Within the scope of this study, Tier 2 was selected for empirical exploration through prototype testing. Tier 1 has been designed and prepared for subsequent testing, while Tier 3 is developed conceptually through drawings and renderings as a foresight-informed projection of scalable implementation.

Framing the tiers as a gradient clarifies that this research does not propose a singular solution, but rather a flexible framework adaptable across diverse institutional, economic, and regulatory contexts.

<b>Tier</b>	<b>Level of Intervention</b>	<b>Feasibility</b>	<b>Research Purpose</b>
<b>Tier 1</b>	Activity-based (planting, visible roots)	Low barrier	Sensory + living system engagement
<b>Tier 2</b>	Portable object (nook)	Medium	Spatial refuge + material regulation
<b>Tier 3</b>	Whole-space transformation	High	Environmental baseline shift

### **Selected Prototype Approach**

The study explored multiple intervention levels, including a Tier 1 living system activity (transparent root observation planter) and a Tier 2 portable biophilic object. The Tier 1 intervention involved a short, guided planting

activity, while the Tier 2 intervention functioned as an open-ended spatial element that children could approach independently.

Given the ethical constraints of working with young children, the parameters of the Research Ethics Board approval, and the workshop-based format of data collection, the second tier—a portable biophilic object—was selected as the primary focus of the Proof of Concept. This approach allowed the research to engage materially and spatially with biophilic principles within a neutral, non-institutional setting involving children and their parents or caregivers.

The portable object enabled observation of spontaneous, self-directed engagement without requiring sustained facilitation. It also provided a practical way to explore how a small-scale intervention could be introduced within existing childcare environments, despite the study not taking place in a licensed centre.

The selection of this tier reflects a methodological choice aligned with the scope and constraints of the study.

### **Prototype Development and Material Testing**

Material exploration formed a central component of the prototype development process. While the literature associates natural materials with emotional comfort, sensory richness, and stress reduction, many of these materials are restricted within Ontario childcare settings due to sanitation and safety requirements. This tension positioned material selection and testing as a critical design activity rather than a secondary technical step.

Rather than testing a wide range of materials, the process focused on a limited palette that could realistically be used in regulated environments. Materials such as sealed wood, acrylic, and soft textile elements were explored in relation to both sensory qualities and practical constraints. Although the prototype was implemented in a workshop setting, selections were made with consideration for potential translation into licensed childcare contexts.

The integration of plant elements within the Tier 2 nook was also carefully considered. Observations of young children's interaction patterns, characterized by tactile exploration and direct manipulation, informed the decision to limit the use of live plants within reach. While living systems are often central to biophilic design, their inclusion in this context introduced potential challenges related to durability, maintenance, and unintended damage during unsupervised interaction.

This approach aligns with broader interpretations of biophilic design, which extend beyond the presence of living organisms to include materiality, form, texture, and spatial conditions that evoke connections to nature (Kellert, 2008; Browning et al., 2014). As such, the design prioritized indirect expressions of nature through sensory cues and spatial qualities, rather than relying exclusively on live plant integration.

Testing was conducted through direct handling, cleaning trials, and assembly iterations. Materials were evaluated based on how they responded to repeated touch, exposure to cleaning products, and minor impact. Attention was

also given to tactile comfort, perceived temperature, edge conditions, and overall durability. Observations were informal and iterative, focusing on how materials performed during use rather than through controlled measurement.



Iterative Material Testing photos created by Paola Pieschacon

Note. Image by author. The figure documents iterative material testing through direct handling and cleaning trials.

Materials were evaluated based on their response to repeated touch, exposure to cleaning products, and minor impact. Observations focused on tactile comfort, perceived temperature, edge conditions, and overall durability, supporting an informal, research-through-design approach centered on use-based performance rather than controlled measurement.

This process informed decisions related to scale, surface treatment, and construction, while allowing flexibility in the final configuration of the prototype.

### **Workshop Based Interaction and Observation**

The Proof of Concept was introduced through a facilitated workshop involving children aged one to five and their parents or caregivers in a neutral setting. Two interventions were presented: a Tier 1 living system activity (transparent root observation planter) and a Tier 2 portable biophilic nook. The Tier 1 intervention was introduced as a short, minimally guided planting activity, while the Tier 2 intervention was presented as an open-ended spatial object, allowing children to engage voluntarily and at their own pace. Parents remained present throughout the session, in accordance with Research Ethics Board requirements.

The workshop was conducted as an open, unstructured exploration session lasting approximately three hours. No educator facilitation was provided beyond the initial introduction of the Tier 1 planting activity, allowing children to approach and interact with the interventions autonomously. Parents were present but did not direct interaction.

Data collection occurred in two phases: (1) a three-hour group workshop session and (2) a two-week longitudinal domestic observation period involving two children. While both interventions were introduced during the workshop, the Tier 2 biophilic nook was the primary focus of observation and analysis due to its sustained and self-directed use. The Tier 1 planter was explored as a complementary, activity-based intervention during the session but was not examined through extended behavioral observation. During the longitudinal period, the nook continued to be used spontaneously as part of everyday routines, while interaction with the planter occurred primarily during guided moments such as watering, with occasional independent checking for visible changes.

Observational data were documented through written field notes recorded immediately following the workshop session and through reflective documentation during the longitudinal observation period. Photographic documentation of the prototypes in use supported recall and spatial analysis. While some observations were recorded retrospectively, documentation focused on behavioral patterns rather than precise quantitative measures.

Observational notes focused on how children approached the interventions, how they used their bodies in relation to them, the duration and quality of engagement, and moments of pause, curiosity, or withdrawal. Attention was also given to how caregivers interpreted the interventions, including perceptions of safety, relevance, and potential applicability within everyday early learning environments.

Rather than evaluating behavioral outcomes or developmental change, the workshop emphasized experiential observation and reflection. The interventions functioned as prompts for interaction and discussion, supporting qualitative insight into how biophilic cues are perceived and engaged with at a young age.

The study does not claim statistical generalizability; rather, findings are presented as exploratory insights generated through situated design inquiry.

### ***Synthesis Across Methods***

Taken together, the methods used in this project form a layered approach to understanding how biophilic cues may be translated into early childhood environments under real world constraints. The literature review articulated the physiological and psychological mechanisms through which texture, light, pattern, and material warmth are associated with attention, stress recovery, and emotional regulation. Policy and regulatory analysis clarified the boundaries of what is permissible within Ontario childcare settings. Interviews with educators and parents contributed lived experience, highlighting both emotional and operational realities.

Environmental scanning and STEEPV analysis situated these findings within broader social, technological, economic, environmental, political, and values-based forces shaping early childhood environments. Design precedents demonstrated that biophilic principles can be structurally embedded rather than applied decoratively, even across differing regulatory contexts.

The Proof of Concept emerged at the intersection of these insights. Rather than functioning as a deployed intervention, the prototype operated as an exploratory design artifact within a workshop setting, allowing the research to examine perception, engagement, and feasibility while remaining ethically and methodologically aligned with the scope of the study.

## 5. SYSTEM FORCES SHAPING THE FINDINGS (STEEPV)

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Building systemic forces shaping early childhood environments in Ontario and comparable urban contexts. Using a STEEPV framework, this analysis examines how social, technological, economic, environmental, political, and values-based dynamics influence both the necessity and feasibility of biophilic design interventions. Rather than functioning as isolated contextual categories, these forces interact dynamically and collectively shape the conditions under which early childhood environments operate.

### *Social Trends*

#### **Emerging Trend: The Indoor Childhood Shift**

A growing body of research documents a decline in children's independent outdoor mobility and unstructured outdoor play. Karsten (2005) describes generational changes in urban childhood, noting that contemporary children experience greater spatial restriction compared to previous generations. Clements (2004) similarly reports a reduction in outdoor play time relative to earlier decades. Gill (2014) situates these patterns within broader social shifts including urbanization, heightened parental risk perception, and increasingly structured schedules. He argues that reduced opportunities for self-directed outdoor play have measurable implications for emotional resilience and self-regulation.

Urban form intensifies these dynamics. The City of Toronto (2022) reports inequities in parkland distribution, identifying that neighborhoods with higher population density tend to have lower access to green space. Empirical research reinforces the developmental significance of this disparity. McCormick (2017), in a systematic review, concludes that greater access to green space is associated with improved emotional and behavioral outcomes, while limited exposure correlates with increased risk of attention and stress related challenges.

Parents in this study echoed these documented trends, describing a contrast between their own childhood experiences of nature and the more constrained environmental conditions available to their children. These intergenerational reflections align with broader literature describing a structural shift in everyday childhood ecology.

The implication of this social trend is that early childhood institutions increasingly function as primary sites for sensory, restorative, and ecological experiences that were historically embedded within daily outdoor life.

### *Technological Trends*

#### **Attention Fragmentation and Mediated Experience**

Digital exposure in early childhood has become a growing concern within public health and developmental research. The Canadian Paediatric Society (2019) reports associations between excessive screen time and poorer attention outcomes as well as increased emotional reactivity in young children.

Environmental psychology offers an alternative framework. Attention Restoration Theory proposes that natural environments support recovery of directed attention (Kaplan & Kaplan, 1989). Experimental research further demonstrates stress reduction and cognitive benefits following exposure to natural settings (Ulrich et al., 1991). Sobel (2014) argues that meaningful engagement with nature depends on direct sensory immersion and cannot be fully replicated through digital simulation.

The technological trend suggests that as digital immersion increases, physically immersive and non-digital environments may serve a restorative function within early learning contexts.

### **Economic Trends**

#### **Operational Constraints and Environmental Investment**

Economic conditions strongly shape early childhood infrastructure. Cleveland and Krashinsky (2019) document that staffing costs account for many operational expenditures in Canadian childcare centres, limiting discretionary investment in environmental enhancements. The OECD (2020) notes that capital investment in early learning environments is often deprioritized relative to immediate operational demands. Elliott (2015) argues that sustainability initiatives frequently depend on available financial flexibility, potentially reinforcing inequities between institutions.

These economic conditions suggest that incremental, low cost, and modular environmental strategies are more feasible than comprehensive architectural redesign. Financial compression increases the relevance of micro scale interventions such as those explored in this study.

### **Environmental Trends**

#### **Climate and Seasonal Constraints on Outdoor Engagement**

Seasonal and weather conditions significantly influence children's physical activity patterns. Tucker and Gilliland (2007) demonstrate through systematic review that season and weather are associated with measurable variations in outdoor activity levels. Carson et al. (2015) similarly identify environmental conditions as influencing physical activity in early childhood populations.

In Canada, public health guidance recognizes that children are particularly vulnerable to extreme heat and wildfire smoke exposure due to physiological sensitivity, recommending protective responses that may include limiting outdoor activity during high-risk events (Health Canada, 2021). As climate variability intersects with urban densification, indoor environments assume greater importance in supporting daily movement and sensory engagement.

This environmental trend indicates that indoor learning spaces must increasingly absorb functions traditionally fulfilled outdoors.

## **Political Trends**

### **Regulation and Institutional Standardization**

Childcare environments in Ontario operate under regulatory frameworks that emphasize hygiene, safety, and surface cleanability (Ontario Ministry of Education, 2023). Public health guidance reinforces infection prevention protocols and material standardization within childcare settings (Toronto Public Health, 2018). Friendly et al. (2022) caution that expansion of childcare access without parallel investment in environmental quality may reproduce environments that meet capacity goals but not developmental best practices.

These regulatory conditions require that biophilic integration align with hygiene standards and institutional risk management expectations.

## **Values Trends**

### **Intergenerational Ecological Nostalgia**

Parents in this study described nature not only as developmental support but as a source of meaningful childhood memories. Several participants referenced formative outdoor experiences that shaped their sense of freedom and identity. Kahn (2012) introduces the concept of environmental generational amnesia, suggesting that successive generations may normalize diminished ecological conditions. This framework contextualizes parents' concern that contemporary children may experience reduced everyday contact with nature.

At the same time, consumer research indicates growing interest in sustainability and wellbeing-oriented products for children (NielsenIQ, 2022). However, cultural attitudes toward risk, cleanliness, and messy play vary (Little & Wyver, 2008), shaping expectations within early childhood institutions.

Values based forces therefore reflect both developmental aspirations and institutional negotiation.

## **Cross System Themes and Strategic Tensions**

Across STEEPV forces, intersecting tensions become visible. Developmental evidence emphasizes the benefits of nature exposure, while regulatory frameworks prioritize hygiene and risk mitigation. Ecological aspiration intersects with economic compression. Digital immersion contrasts with sensory embodiment. Climate variability increases reliance on indoor environments, yet infrastructure remains largely static.

These interacting forces suggest that integration of nature within early childhood settings is not a singular design issue but a systemic challenge embedded within broader social and environmental transitions.

## **Integrative Reflection: Why These Themes Matter**

The themes identified in this analysis matter because they reveal why evidence supporting nature-based learning has not translated more fully into everyday early childhood education practice. Despite strong empirical support for the developmental benefits of nature exposure, systemic conditions continue to limit how, where, and to what extent such experiences can be implemented within regulated childcare environments.

From a design and foresight perspective, these tensions signal a critical opportunity space. Rather than treating nature integration as an additive feature or aesthetic layer, the findings suggest the need to reframe nature-based elements as functional, regulatory-aware components of early learning infrastructure. This reframing aligns with environmental psychology research emphasizing the restorative and regulatory functions of natural environments (Kaplan & Kaplan, 1989; Ulrich et al., 1991) while acknowledging the institutional realities shaping childcare operations.

The analysis also highlights the importance of shifting from outdoor-dependent models of nature exposure toward hybrid and indoor strategies that respond to climate variability and urban constraints (Gill, 2022; Health Canada, 2021). As environmental conditions increasingly restrict outdoor play, interior environments become critical sites for supporting children’s emotional regulation and sensory balance (UNICEF, 2020). This shift has significant implications for how early childhood spaces are designed, evaluated, and funded.

Furthermore, the identified economic and regulatory tensions underscore the need for scalable and equitable design interventions. Approaches that rely on specialized products or premium materials risk reinforcing existing inequities across the childcare sector (Elliott, 2015). In contrast, design strategies that leverage modularity, durability, and regulatory compliance may offer more viable pathways for system-wide adoption.

Finally, the values-based tensions identified in this study emphasize the role of design as a mediating tool between diverse expectations. By translating abstract values such as sustainability, calmness, and well-being into tangible, understandable, and safe design elements, nature-integrated interventions can help bridge gaps between parental aspirations, educator practices, and institutional requirements (Kahn, 2012; Little & Wyver, 2008).

In sum, these themes matter because they clarify that the challenge of integrating nature into early childhood education is not one of awareness or evidence, but of alignment. Addressing this misalignment requires design approaches that operate at the intersection of developmental research, policy constraints, economic realities, and cultural values. This integrative understanding provides the foundation for the design criteria and intervention strategies developed in the subsequent chapter.

## **6. FINDINGS FROM QUALITATIVE INQUIRY AND PROTOTYPE ENGAGEMENT**

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This chapter presents findings derived from qualitative data collected through semi-structured interviews with early childhood educators and administrators, parent perspectives gathered through questionnaires and informal conversations, and observational data from an off-site, workshop-based interaction with two prototype interventions: a Tier 1 transparent root observation planter and a Tier 2 portable biophilic nook proof of concept. Findings are

presented chronologically, beginning with stakeholder interviews conducted prior to prototype development, followed by workshop observations and a two-week longitudinal evaluation period. Data sources are presented descriptively, with cross-dataset interpretation reserved for subsequent sections. The Tier 1 and Tier 2 prototypes are presented separately to reflect their distinct functional intentions: Tier 1 as a curriculum-embedded ecological intervention and Tier 2 as a regulation-supportive spatial intervention.

### **Stakeholder Interview Findings**

Interviews conducted prior to prototype development revealed recurring themes related to overstimulation, limited access to outdoor environments, and a desire for nature-based integration within existing daycare structures. Educators and administrators described increasing sensory load within indoor environments, particularly in urban settings where outdoor access is weather-dependent and time-constrained. Several participants expressed concern that children often experience difficulty transitioning between high-energy play and rest periods.

Parents similarly noted behavioral fluctuations on days with limited outdoor exposure. They described increased irritability, difficulty with transitions, and heightened energy levels when children were confined indoors for extended periods. At the same time, both educators and parents expressed strong interest in incorporating nature-based elements into daily routines, though material constraints, spatial limitations, and safety regulations were identified as barriers to architectural modification.

Parents also reflected nostalgically on their own childhood experiences in nature. Several described unstructured outdoor play, proximity to green space, and sensory immersion as formative memories that shaped their sense of freedom, identity, and belonging. In contrast, they expressed concern that contemporary urban conditions, safety perceptions, and climate limitations may reduce similar experiences for their children. This contrast was framed not as preference but as perceived environmental loss, revealing an intergenerational awareness of shifting childhood ecologies.

A recurring theme across interviews was the need for practical, low-cost interventions that could be integrated into existing classrooms without structural renovation. Participants emphasized feasibility, safety, and adaptability as critical design considerations. These early insights informed the development of the Tier 1 and Tier 2 prototypes described below.

### **Prototype Workshop Observations**

A three-hour open exploration workshop was conducted in a domestic setting with five children aged 2, 2, 3, 4, and 5 years old. Written parental consent was obtained prior to participation. The workshop occurred without educator facilitation. Parents were present but did not direct or structure interaction. Parental comments documented during the session were informal and conversational rather than structured interview responses.

All children were introduced to both prototypes and allowed to interact freely. Observations focused on behavioral patterns, verbal expressions, posture, duration of engagement, and interaction dynamics.

#### *6.1.1 Tier 1 – Transparent Root Observation Planter*

Children participated in soil preparation and seed placement. Immediate expectations regarding visible root growth were expressed by multiple participants. Verbatim statements included: “I want to see the roots now,” “Can I add more water so it grows fast?” and “Can I speak to the plant?”

Children remained engaged throughout the planting activity and returned intermittently during the session to inspect the chamber for visible changes. Interaction included touching the acrylic surface, checking soil moisture, and discussing plant needs. Younger participants primarily engaged through tactile exploration of soil and materials, while older children asked questions about growth processes.

Engagement during the workshop was sustained for the duration of the activity. However, visible frustration emerged when root growth was not immediately observable. The desire for accelerated growth was expressed verbally by several participants.

#### *6.1.2 Tier 2 – Portable Biophilic Nook*

Children approached the nook immediately and without hesitation. Engagement periods ranged from approximately 20–25 minutes at a time, followed by intermittent disengagement and return. Observed behaviors included lying down inside the structure, bringing blankets to increase enclosure, and inviting peers to join.

At one point during the workshop, three older children simultaneously occupied the nook, reclining quietly and smiling. Voice volume decreased noticeably while children were inside, and posture shifted from upright movement to reclined or semi-reclined positions. Minor spatial negotiations occurred when multiple children entered at once, though no significant conflict was observed.

During the session, a 3-year-old participant entered the nook independently and remained inside for approximately 25 minutes. The child partially covered the single opening of the structure to increase enclosure and placed a small dog toy and additional objects inside as companions. The child remained seated and engaged in solitary play for the duration of this period without external prompting.

Verbal expressions during use included, “Let’s grab a blanket and rest,” “I want it to be bigger so more of us can fit,” and “I want to sleep here tonight.” These statements occurred during moments of reclined posture and reduced voice volume.

Children also brought toys into the space, incorporating the nook into ongoing play narratives.

### **Longitudinal Observations (Two-Week Period)**

Following the workshop, both prototypes remained installed in the researcher's home for a two-week observation period involving two children (ages 2 and 4). Observations were documented through field notes and photographic records. The two-week home observation was not structured as a controlled behavioral study but as naturalistic observation to assess sustained engagement beyond novelty effects.

During this period, differentiated patterns of interaction emerged.

The 2-year-old independently entered the nook approximately once daily prior to nap time, verbally indicating tiredness before reclining inside. The structure was used as a quiet pre-rest space.

The 4-year-old interacted with the nook in more varied ways. In addition to reclining inside, the child integrated toy vehicles into the structure. Cars were driven into the nook, positioned inside as if in a garage, and at times placed along the upper greenery. The structure was reinterpreted as a cave, a vehicle garage, a ramp, and a contained play zone. Cushions and blankets were added to expand the enclosure, and the child expressed a desire to make the structure larger.

At other times, the older child lay quietly inside, touching the plants and remaining still for several minutes. Interaction fluctuated across days; the nook was not continuously used but remained visibly integrated within the play environment and was approached intermittently during moments of fatigue or imaginative engagement.

Interaction with the Tier 1 planter during the longitudinal period occurred primarily during watering routines or when prompted through discussion. On days without structured engagement, the planter was less frequently approached independently. Children returned to inspect the chamber particularly during watering moments and when visible changes in soil or sprouting were anticipated.

Neither prototype replaced existing play patterns; rather, both were incorporated intermittently within the broader daily activity flow.

## 7. ANALYSIS & INTERPRETATION

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While Section 5 presented descriptive findings from interviews and prototype interactions, this section synthesizes insights across all data sources to identify emerging patterns and theoretical implications. The analysis integrates stakeholder concerns, workshop observations, and longitudinal interaction patterns to examine how small-scale biophilic interventions may function within early childhood environments. This study contributes evidence that small-scale, portable biophilic micro-interventions can produce measurable shifts in children’s spatial behavior and self-directed regulation without requiring architectural redesign.

### *Integrated Insights Across Stakeholders and Prototypes*

Analysis across all datasets reveals a consistent structural tension: children’s developmental and regulatory needs exceed what many indoor early childhood environments currently provide. Parents and educators independently described nature as foundational to emotional regulation, sensory engagement, and embodied learning. However, access to outdoor environments was consistently constrained by climate, urban density, scheduling, and institutional limitations.

This pattern suggests that the “nature gap” identified by participants is not merely a preference for outdoor enrichment but a structural mismatch between developmental needs and everyday environmental conditions.

Beyond regulatory and sensory implications, the data reveal an intergenerational dimension. Parents’ nostalgic reflections suggest that access to nature functions not only as developmental support but as a carrier of memory and identity. The concern that children may not accumulate comparable “core memories” in nature signals a broader ecological transition in childhood experience. Biophilic interventions, therefore, may operate not only as regulatory supports but as partial responses to perceived environmental and cultural shifts.

Prototype findings provide behavioral validation of this tension.

The Tier 2 nook demonstrated immediate behavioral modulation. Children independently entered the structure, reduced voice volume, adopted reclined postures, and remained inside for sustained periods. The 3-year-old participant’s act of partially covering the opening to increase enclosure indicates active boundary modulation and spatial self-regulation. The 2-year-old’s repeated pre-nap use suggests the structure functioned as a transitional regulation zone.

Importantly, the nook did not dominate play; it functioned as an optional retreat within a shared environment. This supports the idea that regulation-supportive micro-spaces can coexist within classrooms without isolating children from group activity.

The Tier 1 planter operated differently. Engagement was curiosity-driven during planting and sustained when supported by watering routines. While less spontaneously approached than the nook, it facilitated process-based engagement, care routines, and repeated observation over time. The need for scaffolding suggests that ecological learning objects require intentional integration within curriculum structures.

Together, these findings reveal two complementary intervention types:

1. Immediate Regulation Through Spatial Refuge
2. Longitudinal Engagement Through Living Systems

This distinction provides a strategic foundation for implementation.

### **Design Strategy Implications for Daycare Implementation**

The findings indicate that biophilic integration does not require full architectural renovation to influence children's experience. Instead, incremental, micro-scale interventions can introduce regulatory and ecological affordances within existing spatial constraints.

#### *7.1.1 Designing for Immediate Regulation*

Portable refuge structures similar to the Tier 2 nook can support self-directed regulation within shared classroom environments. Observed behavioral patterns suggest that effective refuge-based interventions should include:

- Partial enclosure with maintained visibility
- Soft surfaces supporting reclined posture
- Flexible boundaries that allow children to modulate enclosure
- Forms that signal refuge rather than climbability



Tier 2 concept variants (organic enclosure options) image created by Paola Pieschacon.

Tier 2 tested prototype (fold-flat triangular frame with greenery). Photo By Paola Pieschacon

Note. Forms that signal refuge rather than climbability are communicated through geometry and surface continuity. Pyramidal structures with horizontal elements may be interpreted as ladder-like and invite climbing behavior. In contrast, curved upper geometries and the absence of horizontal footholds reduce climbability cues and instead communicate enclosure, supporting use as a refuge space.

### 7.1.2 *Embedding Living Systems Within Curriculum*

The Tier 1 planter demonstrates the feasibility of integrating visible ecological processes into indoor environments at low material cost. However, sustained engagement depended on routine incorporation. For daycare implementation, this implies:

- Defined watering and observation cycles
- Small-group rotation structures
- Explicit connection to curriculum themes
- Placement at child eye level for visibility

The transparent root chamber provided process visibility, supporting curiosity and longitudinal attention. While not producing immediate behavioral modulation, it introduced sustained engagement with biological systems.

### 7.1.3 *Incremental Adoption Model*

The tiered framework developed in this study suggests a scalable adoption pathway:

- Tier 1: Wall-mounted ecological engagement units
- Tier 2: Portable regulation-supportive micro-spaces
- Tier 3: Whole-room biophilic thematic integration (long-term vision)

This structure allows daycare operators to adopt nature-based strategies progressively, aligning implementation with budget, space, and regulatory constraints.

Biophilic design is thus reframed not as an aesthetic upgrade but as a modular infrastructure for regulation and embodied learning.

#### *7.1.4 Validation Through Research-Through-Design*

The workshop and longitudinal observation functioned as a research-through-design validation phase. While adult stakeholders articulated systemic concerns, children's embodied interaction with the prototypes provided experiential confirmation and refinement.

The immediate use of the nook as a retreat space validates interview claims regarding overstimulation and the need for contained calm zones. The slower, scaffold-dependent engagement with the planter aligns with adult descriptions of the importance of guided ecological learning.

However, prototypes did not produce broad behavioral transformation beyond moments of interaction. Instead, they operated as integrated components within daily routines. This suggests that micro-scale interventions contribute to environmental modulation without replacing broader spatial or pedagogical systems.



Tier 2 tested prototype (fold-flat triangular frame with greenery). Photo By Paola Pieschacon



Tier 2 tested prototype (fold-flat triangular frame with greenery). Photo By Paola Pieschacon

### **Implementation Constraints**

While findings suggest that micro-scale biophilic interventions may support emotional regulation and embodied engagement, practical implementation within licensed daycare environments requires careful consideration.

First, material and structural compliance must align with institutional safety standards, including fire regulations, stability requirements, and supervision visibility. Although the Tier 2 nook was constructed using sealed plywood and soft removable felt cushioning, adaptation to institutional settings would require formal safety validation and potentially additional reinforcement depending on jurisdictional guidelines.

Second, spatial allocation within classrooms presents a constraint. Even portable structures occupy floor area that must be balanced against circulation, group activity zones, and supervision sightlines. The observed perception of climbability in the pyramid-like geometry underscores the importance of form language in institutional settings, where unintended affordances may create risk management concerns.

Third, curriculum integration is necessary for sustained engagement with living systems such as the Tier 1 planter. While the transparent root chamber facilitated curiosity and observation, longitudinal interaction depended on routine incorporation, such as watering schedules and guided discussion. Without intentional embedding within daily practice, ecological installations risk becoming decorative rather than pedagogically active.

Finally, financial feasibility varies across daycare contexts. While the material cost of Tier 1 units supports scalability, broader adoption would require cost modeling aligned with institutional procurement practices. The Tier 3 whole-room concept remains a speculative design exploration and would require context-specific adaptation, cost assessment, and regulatory review prior to implementation.

These constraints do not undermine the viability of micro-scale interventions but highlight the need for context-sensitive adaptation and phased adoption strategies.

### **Study Limitations**

Several limitations must be acknowledged in interpreting the findings of this study.

First, the workshop and longitudinal observations were conducted in a domestic environment rather than within an operational daycare setting. Although parental consent was obtained and observational documentation maintained, institutional conditions, including peer group size, educator facilitation, and regulatory frameworks, may influence interaction patterns differently.

Second, the sample size was limited. Parent interviews and educator interviews provided depth of qualitative insight but do not represent a statistically generalizable population. Observational findings from five workshop participants and two children in extended home interaction provide behavioral indication rather than population-level validation.

Third, the longitudinal component spanned approximately two weeks. While this duration allowed preliminary assessment of novelty effects, it does not capture long-term integration or sustained behavioral change across developmental stages.

Fourth, behavioral observations relied on field notes, photographic documentation, and memory-based recall rather than structured behavioral coding or physiological measurement. As such, findings reflect qualitative interpretation rather than quantified regulation metrics.

Finally, Tier 3 was developed as a conceptual design exploration and was not empirically tested. Its inclusion serves to illustrate potential scalability rather than to provide validated outcomes.

Despite these limitations, the study provides exploratory evidence that small-scale, portable biophilic interventions can influence children's spatial behavior and engagement patterns. The findings should therefore be interpreted as indicative and generative rather than conclusive.

## 8. FORESIGHT FRAMING AND FUTURE TRAJECTORIES

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The previous chapters examined present system forces shaping early childhood environments. This section shifts from analysis of current conditions toward structured exploration of plausible futures. Rather than predicting a single outcome, this section draws on established foresight theory to explore alternative trajectories and assess how biophilic design interventions may perform under uncertainty (Inayatullah, 2008; Voros, 2003).

Following a generic foresight process framework (Voros, 2003), this section moves from environmental scanning to interpretation and strategic implications. It incorporates horizon scanning, identification of key uncertainties, scenario construction, and stress testing of design interventions across multiple futures. This approach aligns with futures studies methodology, which emphasizes plural futures rather than linear forecasting (Dator, 2009; Inayatullah, 2008).

### *Horizon Scanning: What Is Changing?*

Across the STEEPV analysis in chapter 5, multiple signals converge.

Children are spending more time indoors and have reduced independent outdoor mobility compared to previous generations (Karsten, 2005; Clements, 2004). Urban densification and limited access to green space further constrain daily contact with nature (City of Toronto, 2022).

Environmental conditions also affect access. Weather and season significantly influence outdoor physical activity (Tucker & Gilliland, 2007). In Canada, increasing frequency of extreme heat and wildfire smoke events can require limiting outdoor exposure (Health Canada, 2021).

Digital immersion shapes attentional patterns. The Canadian Paediatric Society (2019) reports associations between excessive screen exposure and attention challenges, while environmental psychology research demonstrates that exposure to natural environments supports attentional recovery and stress reduction (Kaplan & Kaplan, 1989; Ulrich et al., 1991).

At the values level, parents in this study expressed nostalgia for their own childhood experiences in nature. This aligns with Kahn's (2012) concept of environmental generational amnesia, which suggests that each generation may gradually normalize reduced ecological contact.

Taken together, these signals suggest that childhood environments are becoming more interiorized, more regulated, and more mediated.

### **Key Drivers and Uncertainties**

From a foresight perspective, the future depends not only on trends but on how uncertainties unfold.

Two uncertainties stand out:

1. Will regulatory frameworks evolve to incorporate developmental and environmental research, or will hygiene and standardization continue to dominate design decisions?
2. Will nature in early childhood settings become materially embedded through living systems and sensory integration, or remain symbolic and decorative?

These uncertainties interact with social, environmental, and economic drivers. The way they resolve will shape the future ecology of early childhood environments.

### **Scenario Matrix: Four Plausible Futures**

Using scenario planning principles (Ramírez & Wilkinson, 2016), a 2×2 matrix was constructed based on the interaction of the two uncertainties described above. Scenario planning does not predict outcomes but constructs structured alternative futures to test strategic robustness (Inayatullah, 2008).

- Uncertainty 1: Regulatory adaptation

Low versus high integration of developmental and ecological evidence

- Uncertainty 2: Ecological integration

Symbolic representation versus embedded living systems

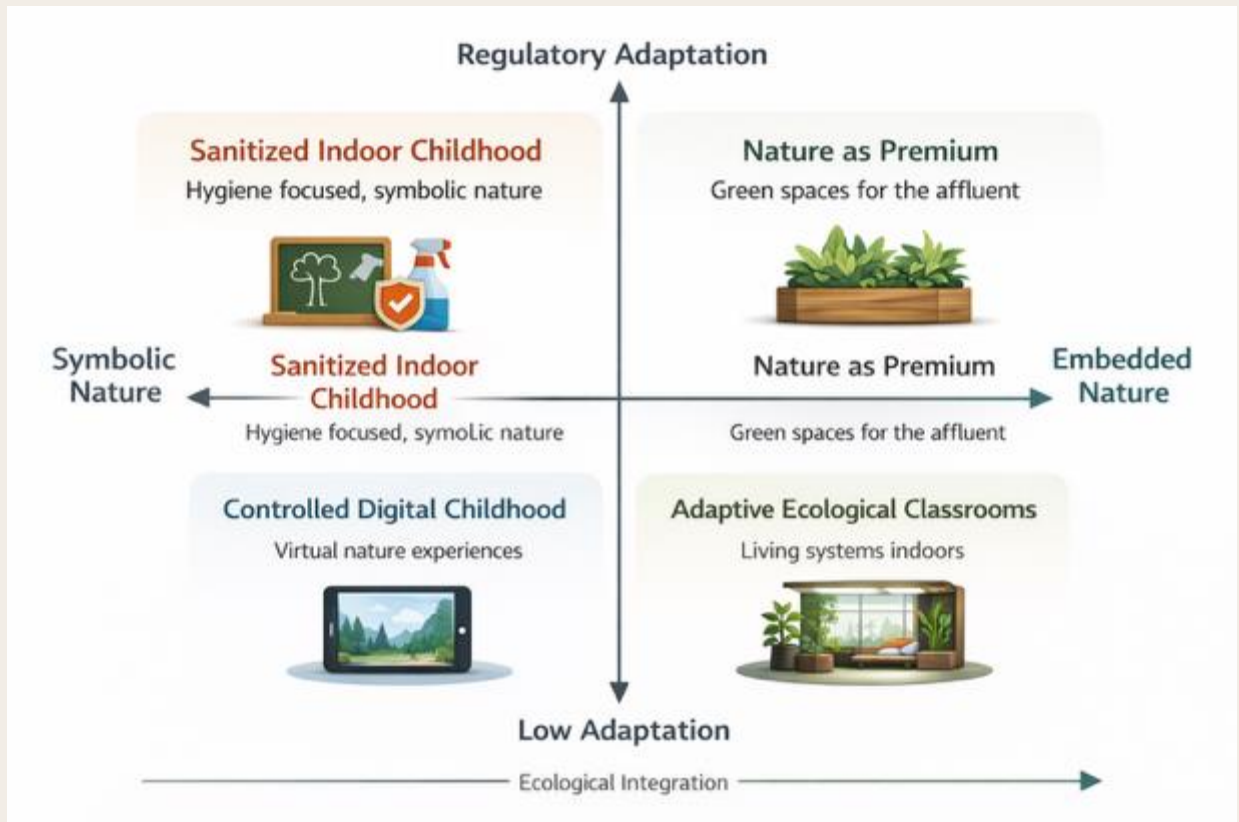


Image Created By Paola Pieschacon

The following scenarios imagine how early childhood environments in Ontario could plausibly look five years from now under different regulatory and ecological conditions. They are not predictions but structured explorations grounded in current system drivers:

### 1. Sanitized Indoor Childhood

It is 2031. A childcare centre in a dense urban neighbourhood operates under tightened hygiene protocols shaped by years of public health sensitivity. Floors are seamless vinyl. Furniture is molded plastic with rounded edges and antimicrobial coatings. Materials are selected primarily for cleanability and compliance.

Large digital panels replace traditional windows in some rooms where outdoor views are obstructed by adjacent towers. These panels display forest scenes that change throughout the day. Artificial intelligence systems adjust lighting to simulate daylight cycles. Speakers emit subtle bird sounds during quiet time.

On the wall, a mounted environmental dashboard tracks air quality and surface sanitation metrics. A compact disinfection robot quietly circulates between tables after activity transitions.

Nature is present visually but not materially. Children see trees, but they do not touch soil. Plants are artificial or preserved moss panels sealed behind glass. Educators focus on behavioral regulation strategies rather than environmental modulation.

The room feels controlled, safe, and efficient. But ecological experience is curated and distant. Childhood unfolds indoors, carefully monitored and sanitized.



OpenAI's ChatGPT. (2026). Sanitized early childhood environment with digital forest panels [AI-generated digital image]. By Paola Pieschacon

## 2. Nature as Premium

In another part of the city, a privately funded centre presents a different reality. The entrance opens into a light-filled atrium with a living green wall extending two stories high. Indoor trees sit in built-in planters with automated irrigation. Sunlight is maximized through architectural glazing.

Classrooms feature natural wood furniture, visible grain textures, and plant-based acoustic panels. Children participate in scheduled gardening sessions in a rooftop greenhouse. Environmental sensors monitor soil moisture and humidity, supporting maintenance but remaining invisible to children.

Marketing materials highlight sustainability, biophilic design, and emotional wellbeing. Parents select this centre specifically for its nature-rich identity.

However, tuition reflects the cost of maintaining living systems. Access is limited to families who can afford it. Ecological integration becomes a marker of prestige rather than baseline infrastructure.



Gemini 3 Flash. (2026). [AI-generated image] (Nano Banana 2). By Paola Pieschacon

In this future, regulatory frameworks have evolved to incorporate developmental research. Guidelines clarify how living materials can be safely integrated. Inspectors are trained not only in sanitation but in environmental quality.

Classrooms are organized as micro-ecosystems. Planters are embedded at child height. Roots are visible through acrylic chambers. Seasonal change is experienced indoors through small rotating ecological installations.

Biophilic nooks are integrated into spatial layouts as recognized regulation supports. Children independently retreat to these spaces during transitions. The geometry clearly communicates refuge.

Technology is present but discreet. Sensors monitor air quality and light levels to support plant health and ventilation efficiency. Digital screens are minimal. Instead, tactile engagement dominates.

The room feels alive. Not decorative, but operational. Nature is not an image. It is a relationship.



OpenAI. (2026). [AI-generated image]. DALL·E. by Paola Pieschacon

### 3. Digital Nature Substitution

In high-density districts where space and maintenance budgets are constrained, immersive technology fills the gap.

Walls double as projection surfaces. Interactive floors simulate shallow water or forest paths. Artificial intelligence adapts projected environments based on lesson themes or behavioral analytics.

Children walk through digital jungles and oceans rendered in high resolution. They can “grow” virtual plants by touching interactive panels. Climate and biodiversity are explored through immersive simulation.

Yet there is little soil. Few real plants. Maintenance simplicity and digital scalability have replaced biological unpredictability.

The environment is dynamic and visually stimulating. But nature is experienced through interface rather than embodiment.



Google. (2026). [AI-generated image], by Paola Pieschacon

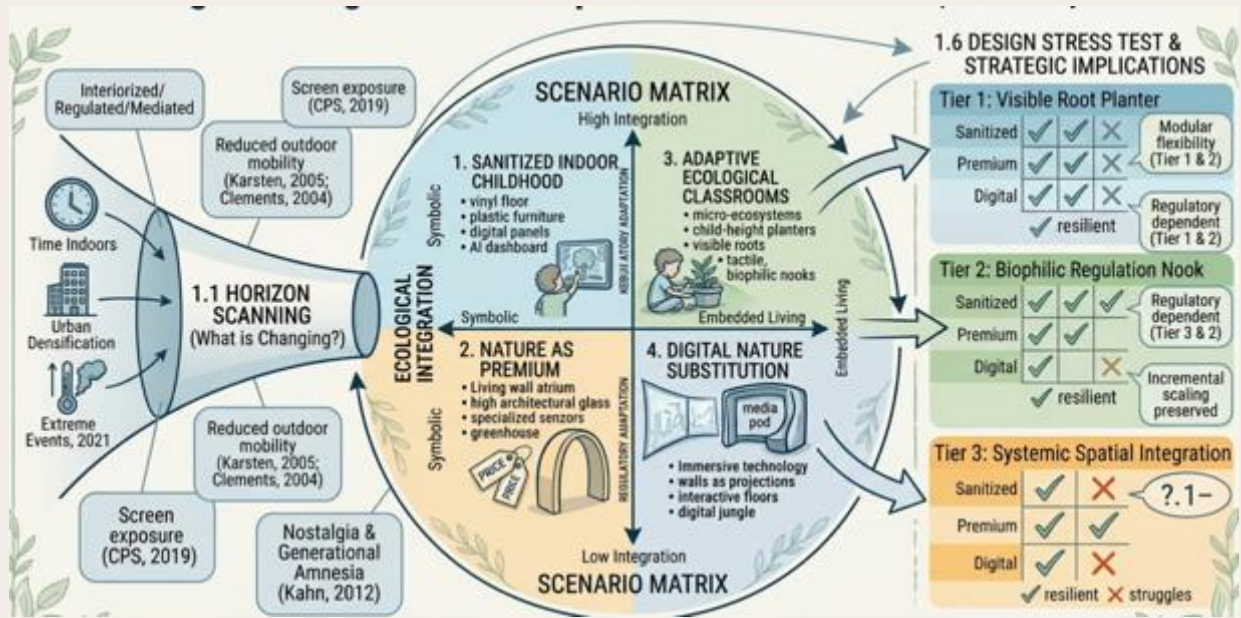
### **Cross Scenario Reflection**

Across these scenarios, artificial intelligence plays different roles. It may function as simulation, as maintenance support, or as environmental monitoring. The critical distinction lies not in whether AI is present, but in whether ecological experience remains embodied and material.

Similarly, nature imagery on windows may evolve into digital augmentation in some futures. However, the difference between viewing a forest on a screen and touching a living plant remains significant from a developmental perspective.

These scenarios illustrate that the future of early childhood environments will not be determined by a single force. It will emerge from the interaction of regulation, economics, climate, digital culture, and societal values regarding childhood.

The tiered intervention model explored in this research is most aligned with the Adaptive Ecological Classrooms scenario. However, its modular structure allows partial implementation across multiple futures, preserving strategic flexibility under uncertainty.



Google. (2026). [AI-generated image], by Paola Pieschacon

### Strategic Implications

From a foresight perspective, the importance of this research lies in optionality.

- If regulatory conditions remain rigid, Tier 1 and Tier 2 provide low risk ecological integration within existing systems.
- If regulation evolves, these interventions can scale toward deeper systemic redesign. The model therefore operates across multiple futures.

Beyond regulation and cognition, this research also engages with cultural memory. Parents' nostalgic reflections suggest that nature is not only a developmental resource but part of how childhood identity is formed. If every day ecological contact continues to diminish, the nature of childhood memory itself may shift. Early learning environments may therefore play a role not only in regulation and learning, but in preserving forms of ecological experience that shape identity across generations.

In this way, biophilic intervention is positioned not as a design trend, but as a long-term adaptive strategy within shifting social, environmental, and institutional conditions.

## *Design Stress Test Across Scenarios*

To assess the strategic robustness of the proposed interventions, the three design tiers were examined across the four plausible futures described above. Rather than assuming a single preferred trajectory, this stress test evaluates how each intervention would perform under different systemic conditions.

### **Tier 1: Visible Root Planter**

- Sanitized Indoor Childhood

In a highly regulated and hygiene-focused environment, the planter may face scrutiny due to soil, moisture, and maintenance requirements. However, because it is modular, small in scale, and easily supervised, it could potentially survive as a contained micro-ecological unit if designed with clear cleaning protocols. Its educational framing as a science tool may increase institutional acceptance. Success would depend on material compliance and clear maintenance guidelines.

- Nature as Premium

In this future, the planter aligns strongly with institutional values. It would likely be integrated as part of a broader environmental design strategy, possibly supported by automated irrigation systems or AI-assisted monitoring of plant health. The planter could scale into multi-unit installations.

Success likelihood: high in well-resourced contexts, uneven across socioeconomic settings.

- Adaptive Ecological Classrooms

In this scenario, the planter becomes foundational rather than supplementary. It directly supports embodied ecological literacy, patience, and observational learning. As regulation has adapted to allow living systems indoors, barriers are reduced. The intervention could expand into integrated planting stations across classrooms. Success likelihood: very high and scalable.

- Digital Nature Substitution

In a technologically immersive environment, the planter risks being perceived as low-tech or inefficient compared to AI-simulated growth experiences. However, precisely because it is real and tactile, it may serve as a counterbalance to digital saturation. Its success would depend on institutional willingness to preserve embodied experiences alongside digital systems.

Success likelihood: moderate but symbolically important.

## **Tier 2: Biophilic Regulation Nook**

- Sanitized Indoor Childhood

The nook may face concerns regarding visibility, supervision, and climbability. However, if geometry clearly communicates refuge rather than risk, and materials comply with hygiene standards, it could survive as a behavioral regulation tool framed within social emotional learning language.

Success likelihood: moderate, dependent on form signaling and supervision protocols.

- Nature as Premium

In affluent centres, the nook could evolve into a designed architectural feature with integrated lighting, acoustic panels, and curated planting. It would function as a signature spatial identity element.

Success likelihood: high but potentially aestheticized.

- Adaptive Ecological Classrooms

In this future, the nook functions as a spatial regulation infrastructure. It supports self-regulation, autonomy, and sensory decompression. Its role is recognized as environmental support rather than optional furniture.

Success likelihood: very high and deeply integrated.

- Digital Nature Substitution

The nook may be augmented with projection systems or immersive lighting effects. However, there is risk that digital overlay reduces tactile intimacy. Its success would depend on maintaining material integrity rather than becoming a media pod.

Success likelihood: moderate, dependent on restraint in digital integration.

## **Tier 3: Systemic Spatial Integration**

- Sanitized Indoor Childhood

This tier would struggle significantly under rigid regulatory dominance. Large-scale ecological integration would likely be limited to symbolic imagery.

Success likelihood: low without regulatory reform.

- Nature as Premium

Tier 3 becomes possible but financially exclusive. Architectural integration of nature occurs in high-resource centres, increasing inequality.

Success likelihood: high but uneven.

- Adaptive Ecological Classrooms

Tier 3 represents the natural evolution of this scenario. Indoor ecosystems, daylight prioritization, and sensory diversity become normative.

Success likelihood: transformative.

- Digital Nature Substitution

Tier 3 risks becoming fully simulated rather than materially ecological. Real nature may be replaced by immersive projection systems.

Success likelihood: conceptually present but materially diluted.

### **Strategic Reflection**

This stress test demonstrates that Tier 1 and Tier 2 function as resilient interventions across multiple futures. Even under restrictive conditions, they retain partial viability. Tier 3, however, depends strongly on regulatory and economic evolution.

From a foresight perspective, the strength of the proposed framework lies in its scalability. It allows incremental ecological integration without requiring systemic overhaul, while remaining expandable if institutional conditions shift.

This positions the design strategy as adaptive rather than prescriptive.

# 9. DESIGN OUTCOME - A BIOPHILIC INTEGRATION GRADIENT

This chapter translates the findings of the literature review, STEEPV analysis, stakeholder interviews, and prototype testing into a structured design framework for integrating biophilic principles within regulated early childhood environments. Rather than proposing a singular intervention, the outcome is articulated as a scalable gradient of integration. This model acknowledges institutional constraints while maintaining developmental and ecological aspirations.

The Biophilic Integration Gradient operates across three levels:

- Tier 1 — Living System Activity Intervention
- Tier 2 — Portable Biophilic Spatial Nook (Tested Prototype)
- Tier 3 — Integrated Classroom Ecosystem (Conceptual Projection)

This model is intentionally progressive: it begins with low-barrier, curriculum-embedded nature engagement (Tier 1), advances to micro-spatial refuge (Tier 2), and culminates in a whole-environment projection (Tier 3). The three tiers reflect increasing levels of permanence, cost, operational complexity, and systemic impact.

This approach aligns with Ontario’s early years pedagogy, which emphasizes conditions that support children’s learning and development particularly belonging, well-being, engagement, and expression. (Ontario Ministry of Education, 2014)

### Biophilic Intervention Model diagram

TIER	INTERVENTION TYPE	PRIMARY FUNCTION	IMPLEMENTATION LEVEL	EVIDENCE BASIS IN THIS STUDY
<b>TIER 1</b>	Living system activity object(transparent root observation planter)	Ecological literacy + care routines + perceptible living processes	Educator-led small group curriculum activity	Designed + fabricated; outcomes reported in Section 5 (planned/iterated)
<b>TIER 2</b>	Portable refuge object (fold-flat reading/regulation nook)	Sensory refuge, emotional regulation, child-scale retreat	Inserted into existing classroom layout	Prototyped and tested; outcomes reported in Section 5
<b>TIER 3</b>	Whole-room ecosystem concept (themed classrooms: forest/ocean/jungle)	System-level biophilic embedding + sensory zoning + nature identity	Full classroom redesign (concept projection)	Foresight-driven projection; not physically tested

Biophilic Intervention Model (Tiered progression).

## *Tier 1 — Living System Activity Intervention*

### *9.1.1 The Designed Prototype: Transparent Root Observation Planter*

Tier 1 introduces biophilic integration through curriculum-led interaction with living systems, rather than spatial enclosure. The intervention consists of a modular, wall-mounted planter system designed so children can observe root growth through a transparent acrylic chamber. The chamber is intentionally narrow, making the hidden biological processes of rooting and moisture movement visible and legible at a child's scale.

The system is designed to be installed as multiple units across a classroom wall, enabling repetition, comparison, and group-based observation. It is delivered as a kit containing the wooden wall frame, removable acrylic chamber, soil, and seeds, supporting daycares in embedding the intervention directly into routine programming.

This tier emphasizes:

- Longitudinal attention (growth over time rather than instant stimulation)
- Care-based participation (watering, monitoring, stewardship)
- Ecological literacy (roots as a normally unseen system made visible)
- Educator-led small group learning integrated into daily schedules

### *8.2.1 Construction and Materials*

Dimensions: Structure:

- Wall-mounted wooden frame (sealed plywood), designed to hold a removable acrylic chamber.
- The wooden frame supports stability, safe edges, and repeatable installation across a wall grid.
- Root chamber:
  - Removable narrow acrylic container that slides/lifts out of the frame for filling and maintenance.
  - Soil is fully visible through the acrylic face to support observation.
- The current configuration prioritizes bottom-root visibility, with the narrow depth ensuring roots are likely to travel along the visible plane.

Finishes and safety intent:

- Wood sealed with non-toxic Water-based, low-VOC clear protective finish to support durability and wipeable maintenance.



Tier 1 reference concept (rooting planters) image created by Paola Pieschacon.



Tier 1 reference concept (wall grid of rooting planters) image created by Paola Pieschacon.



Tier 1 Prototype, Photo by Paola Pieschacon.



Tier 1 Prototype, Photo by Paola Pieschacon.

Children are introduced to the kit as a “root-watching station.” They begin by planting seeds together, predicting what will happen underground, and returning daily to observe small changes. Over time, children compare units (“which one rooted first?”), notice patterns (“roots stretch toward moisture”), and contribute to care routines. The system turns plant growth into an ongoing classroom relationship rather than a decorative element.

### 9.1.2 *Tier 1 cost-per-unit estimate (materials + finish allocation)*

Cost Item	Spec / Assumption	Quantity (per unit)	Unit Price (CAD)	Extended (CAD, incl. HST)
12.7 mm (1/2") sanded plywood	From 1220 × 2440 mm (4' × 8') sheet	~0.14 m <sup>2</sup> (~1.5 sq ft)	\$72.98 / 2.97 m <sup>2</sup> = \$24.57/m <sup>2</sup> (\$2.28/sq ft)	~\$3.87
4.5 mm (3/16") clear acrylic sheet	610 × 914 mm (24" × 36") (cut for front + sides + bottom)	~0.17 m <sup>2</sup> (~1.8 sq ft) (incl. waste)	\$89.98 / 0.56 m <sup>2</sup> = \$160.68/m <sup>2</sup> (\$15.00/sq ft)	~\$30.51
Water-based polyurethane	Interior wood protection	~0.28 m <sup>2</sup> (~3 sq ft) surface	\$44.98 / 11.6 m <sup>2</sup> = \$3.88/m <sup>2</sup> (\$0.36/sq ft)	~\$1.22
Screws (allocation)	Example pack pricing used for allocation	~6–10 screws	\$9.99 / 100-pack	~\$1.13
Mounting hardware (allocation)	Wall-safe mounting varies by site (stud/anchors)	1 set	(allocation)	~\$2.26 – \$5.65
Estimated material total (per unit)	(excludes soil + seeds kit; excludes labour)	—	—	~\$38.99 – \$42.38

Note: The acrylic sheet is the dominant cost driver at small scale; per-unit cost decreases if acrylic is purchased in larger sheets and nested efficiently. Costs are estimated based on retail pricing in Ontario, Canada, and include a 13% Harmonized Sales Tax (HST). Quantities are approximated per unit and account for typical material usage and minor waste. Labour, soil, and seed kits are excluded.

### 9.1.3 *Conceptual Positioning*

Tier 1 is educator-led and designed for small group interaction. Children participate from planting to maintenance, engaging in:

- Soil preparation
- Seed placement
- Watering routines

- Daily observation
- Comparative growth discussions
- The intervention supports:
- Longitudinal attention development
- Care-based responsibility
- Visible cause-and-effect learning
- Ecological literacy
- Early systems thinking

Unlike decorative classroom plants, the root chamber system intentionally reveals normally hidden processes, reinforcing biological awareness and relational care.

(Behavioral and observational findings are presented in Section 5.)

### ***Tier 2 — Portable Refuge Object***

#### **Fold-Flat Biophilic Nook (Prototype Tested)**

Tier 2 is a child-scale refuge and regulation space, designed as a portable structure that can be inserted into existing classroom layouts. The tested prototype is a fold-flat triangular wooden frame that maintains visual permeability (daylight can pass through), while the addition of overhead greenery introduces biophilic cues without requiring architectural renovation.

Key design logic: Because children physically interact with the nook, the intervention uses faux greenery integrated on the structure, paired with real plants placed in the surrounding environment for safe sensory engagement and care-based routines.

The tested prototype consists of a fold-flat triangular plywood frame structure incorporating overhead greenery elements.

#### *9.1.4 Physical Specifications*

##### **Dimensions:**

Approx. 1.02 m (H) × 1.02 m (W) × 0.58 m (D) (40 in × 40 in × 23 in)

##### **Structure:**

- Plywood frame
- Water-based sealed finish

- Fold-flat design for storage and portability

**Greenery Integration:**

- Faux plants integrated into upper canopy structure (durability and safety)
- Natural plants placed externally around the structure

**Cushion:**

- 1.02 m × 0.38 m seating surface (40 in × 15 in)
- 76 mm thickness (3 in)
- Removable wool-blend felt cover

**Capacity:**

Designed for 1–3 children

**Function:**

Refuge, regulation space, reading nook, quiet small-group interaction

The structure allows daylight permeability while visually framing a contained micro-environment.



Tier 2 tested prototype (fold-flat triangular frame with greenery) photography by Paola Pieschacon.



Tier 2 concept variants (organic enclosure options) Render created by Paola Pieschacon.

### 9.1.5 Construction + specification (from your details)

Cost Item	Spec / Assumption	Quantity (per nook)	Unit Price (CAD)	Extended (CAD, incl. HST)
<b>12.7 mm (1/2") sanded plywood</b>	Primary structure panels + base (prototype scale)	~½ sheet equivalent (1220 × 2440 mm (4' × 8'))	\$72.98 / sheet (Home Depot)	~\$41.23
<b>Water-based polyurethane</b>	Seal + durability (wipeable surface)	~1.9–2.8 m <sup>2</sup> (20–30 sq ft) surface	\$44.98 / 11.6 m <sup>2</sup> (125 sq ft) = \$3.88/m <sup>2</sup> (\$0.36/sq ft) (Home Depot)	~\$8.14–\$12.20
<b>Hinges (fold-flat)</b>	Example hinge pricing (pack)	1 pack	\$12.48 (Home Depot)	~\$14.10
<b>Latch / safety closure</b>	Barrel bolt exemplar	1	\$11.18 (Home Depot)	~\$12.63
<b>Screws (allocation)</b>	Example pack pricing used for allocation	~30–50 screws	\$9.99 / 100-pack (Home Depot)	~\$3.39–\$5.65
<b>Faux greenery (canopy)</b>	Low-cost garland reference	2–4 garlands	\$5.40 each (Walmart.ca)	~\$12.20–\$24.41
<b>Foam insert (seat)</b>	Closest “pad” reference near 457 × 1016 mm (18" × 40") (proxy for 400 mm (~40 cm) width)	1	\$43.98 (Home Depot)	~\$49.70
<b>Wool-blend felt cover</b>	Wool-blend felt by yard (~0.91 m)	~1 yard	\$34.00 (thefeltstore.ca)	~\$38.42
<b>Estimated material total (per nook)</b>	(excludes labour + tools; excludes shipping)	—	—	~\$179.81 – \$198.34

Note: Tier 2 cost is driven by (1) foam cushion material, (2) wool-blend felt, and (3) larger plywood usage. Costs are estimated based on retail pricing in Ontario, Canada, and include a 13% Harmonized Sales Tax (HST). Quantities are approximated per unit and account for typical material usage and minor waste. Labour and shipping are excluded.

### **Tier 3 — Whole-Environment Biophilic Projection**

#### **The Nature Pathway: Developmental Ecosystem Classrooms**

Tier 3 projects a full-daycare ecosystem model in which classrooms are differentiated through nature-based identities aligned with developmental stages.

This proposal conceptualizes the daycare as a progressive environmental journey:

- Infant Classroom — Ocean Room
  - "Calm Currents"

- Soft blue tonal palette
- Rounded forms
- Lower visual complexity
- Emphasis on soothing sensory modulation

Supports regulation, attachment, and predictable engagement



Ocean Classroom (Infant). Render By Paola Pieschacon.

- **Toddler Classroom — Forest Room "Root & Reach"**

- Grounded greens and wood textures
- Tactile surfaces
- Climbing and grounded seating areas
- Emphasis on exploration and autonomy



Forest Classroom (Toddler). Render By Paola Pieschacon.

- **Preschool Classroom — Jungle Room "Canopy Builders"**
  - Layered greenery
  - Increased visual complexity
  - Collaborative play zones
  - Roleplay and imaginative affordances
  - Emphasis on social interaction and expressive development



Jungle Classroom (Preschool). Render By Paola Pieschacon.

Tier 3 is presented as a conceptual projection rather than a tested intervention. It reflects a systemic application of the research findings across architectural scale.

Costing is intentionally not included for Tier 3 within this chapter, as whole-room implementation costs are highly dependent on site conditions (room dimensions, existing inventory, procurement pathways, safety requirements, and labour), and would require a separate scoped estimate per daycare context.

## 10. CONCLUSION

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This research began with a tension: the environments in which children develop are no longer fully aligned with the conditions they need to thrive. While decades of research have established the importance of nature for attention, emotional regulation, and well-being, contemporary childhood is increasingly shaped by interior, regulated, and highly controlled environments.

The findings of this study suggest that the challenge is not evidential, but systemic. Nature is widely recognized as beneficial, yet it remains unevenly integrated into the spaces where children spend most of their time. Although policies such as Ontario's requirement for daily outdoor play acknowledge its importance, access to nature is often scheduled, weather-dependent, and limited in duration. This reveals a critical gap between developmental knowledge and the everyday conditions of early childhood environments, one that cannot be addressed through outdoor access alone.

Within this gap, design takes on a different role. Rather than enhancing environments, it becomes a mechanism for translation, converting the qualities of nature into forms that can exist within constraint. The interventions explored in this study demonstrate that even small-scale, biophilic micro-environments can influence how children occupy space, regulate themselves, and engage with their surroundings. These effects are not transformative in isolation, but they are meaningful in accumulation, shaping the sensory and emotional conditions of daily experience.

From a foresight perspective, this work points to a broader shift in how childhood must be understood. Nature is no longer something children consistently inhabit throughout the day. Instead, it is increasingly encountered in intervals, structured by schedules, environmental conditions, and institutional constraints. As outdoor access becomes more variable due to climate, urbanization, and social change, the interior environment assumes a new responsibility: to support forms of sensory and ecological experience that were once more continuously embedded in everyday life.

The biophilic integration gradient proposed in this study responds to this shift by offering a model that is not dependent on a single future. It allows for incremental adoption under restrictive conditions, while remaining scalable in more adaptive systems. Its value lies not in prescribing a singular solution, but in maintaining flexibility across uncertainty and enabling multiple pathways for integration.

As the research progressed, the framing of the initial research question evolved. While the study began by asking how nature-based interventions could be applied within early childhood settings and how they are perceived in relation to children's attention and well-being, the findings point toward a more fundamental inquiry. The challenge is not only how to introduce nature into these environments, but how to translate its sensory, spatial, and regulatory

qualities into systems where direct access is intermittent and context-dependent. This shift reframes the role of design from insertion to mediation, positioning it as a tool for navigating the constraints that shape contemporary childhood environments.

Ultimately, this research argues that the future of early childhood environments will not be defined by whether nature is included, but by how it is translated. If current trajectories continue, nature will not disappear, but it may become increasingly fragmented, shifting from a continuous condition of childhood to a scheduled and context-dependent activity. In this context, even modest interventions take on strategic importance. They become ways of preserving and embedding sensory, emotional, and ecological experiences within the environments where children spend most of their time.

The question, then, is no longer whether children benefit from nature. It is how the environments we design will sustain those conditions as part of everyday childhood.

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# 13. APPENDICES

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## APENDIX A Interview Guides

### 'Data collection 1: interview guide – early childhood educators / administrators

**PROJECT TITLE:** Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

**OCAD U REB Approval #:** 102801

**Student Investigator:** Maria Paola Pieschacon,  
Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

**Faculty Supervisor:** Prof. Colleen Reid  
Faculty of Design  
OCAD University  
cmreid@ocadu.ca

## PURPOSE

To understand how daycare professionals perceive nature-based interventions in early childhood settings, including barriers, benefits, and their implementation.

### **FORMAT**

Semi-structured interviews (45–60 minutes) conducted via Zoom or in person. Audio recording optional (with consent).

### **INTERVIEW GUIDE**

1. Can you describe the current use of nature-based activities or materials (e.g., plants, natural play) in your daycare's learning environment?
2. What benefits do you associate with integrating nature into indoor or outdoor programming?
3. Are there challenges or barriers you face when trying to implement nature-based approaches?
4. How do you think nature-based activities affect children's attention or emotional well-being?
5. What are your thoughts on children's screen time and how it influences behavior and engagement?
6. How do you perceive the impact of outdoor or nature-inspired activities on children's attention span, mood, or behavior compared to screen time?
7. Are there any indoor activities or objects that you believe simulate or mimic the outdoor experience effectively?
8. How do you perceive furniture or spatial designs inspired by nature? For example, items made from natural materials or shaped in organic forms – do you think these influence children's mood, learning, or behavior?
9. (Optional visual prompt) Here are a few examples of biophilic furniture – what are your first impressions? Could you see these being used in your daycare environment?

10. What kinds of support (training, funding, tools) would help you and your team incorporate nature-based practices more consistently?
11. Would you be interested in testing a future prototype or design intervention that supports this kind of learning environment?

**Note:**

This interview guide serves as a framework. The conversation may include additional questions or follow-up prompts that emerge naturally and are relevant to the study goals. All additions will remain within the scope of the approved research protocol.

## **Data collection 2: interview guide – parents and guardians**

**PROJECT TITLE:** Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

**OCAD U REB Approval #:** 102801

**Student Investigator:** Maria Paola Pieschacon,  
Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

**Faculty Supervisor:** Prof. Colleen Reid  
Faculty of Design  
OCAD University  
cmreid@ocadu.ca

### **PURPOSE**

To understand how parents perceive nature-based activities in early childhood, their values around outdoor play, and their observations of their child’s emotional or attentional states related to such experiences.

### **FORMAT**

Semi-structured interview (30–45 minutes)

Location: Zoom or in-person (as preferred)

Consent Form: See Questionnaire 2.

### **INTERVIEW GUIDE**

1. Can you tell me a bit about your child’s relationship with nature or outdoor play?
2. What kinds of nature-based activities do you engage in as a family (e.g., park visits, gardening, nature walks)?
3. Have you noticed any changes in your child’s behavior, mood, or attention after spending time outdoors?
4. What are your perceptions of indoor activities that try to mimic outdoor experiences? Do you have examples (e.g., indoor gardening, nature-themed play)?
5. What are your thoughts about screen time and how it relates to your child’s attention or emotional wellbeing?
6. Do you feel there are enough opportunities for your child to engage with nature—either at home, daycare, or in public settings?
7. How do you feel about integrating natural materials, shapes, or sensory elements (like soil or plants) into indoor environments for children?
8. If I showed you images of furniture or activities inspired by natural environments (e.g., leaf-shaped chairs, wooden planting tables), would you find these relevant or helpful for your child’s experience?
9. What hopes or concerns do you have about incorporating more nature-based elements into daycare or learning spaces?

### **Note:**

This interview guide serves as a framework. The conversation may include additional questions or follow-up prompts that emerge naturally and are relevant to the study goals. All additions will remain within the scope of the approved research protocol.

## **Data collection 4: prototype testing feedback**

**PROJECT TITLE:** Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

**OCAD U REB Approval #:** 102801

**Student Investigator:** Maria Paola Pieschacon,  
Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

**Faculty Supervisor:** Prof. Colleen Reid  
Faculty of Design  
OCAD University  
cmreid@ocadu.ca

### **PARTICIPANTS:**

Parents/Guardians

Early Childhood Educators

### **METHOD:**

Individual feedback sessions (in person). Estimated Duration: 30–45 minutes

### **PURPOSE**

The purpose of this stage is to collect feedback from adult participants regarding the design, functionality, usability, and perceived impact of a nature-integrated prototype developed as part of this study. The prototype will be designed to encourage engagement with nature indoors or in mixed environments. Participants may observe their child interacting with the prototype or engage with it themselves and share insights related to:

- Relevance to early childhood learning and well-being
- Sensory, emotional, or cognitive responses observed
- Suggestions for improvement or adaptation

This prototype will be in a low-fidelity or exploratory format and may involve child-safe materials such as wood, felt, live plants, containers, or interactive parts.

### **STRUCTURE OF THE SESSION PART 1:**

- Observation of Child Interaction
- The researcher will take field notes while observing how children interact with the prototype in a calm, familiar environment.
- Observations will focus on attention span, emotional expression, motor interaction, and verbal/non-verbal engagement.
- No audio, photo, or video recordings will be made.
- Parents or guardians will remain present and supervise the child throughout the activity.

### **SAMPLE OBSERVATION PROMPTS:**

1. What are the first actions or reactions the child has with the prototype?

2. Does the child explore materials with touch, smell, movement, or sound?
3. Are they focused and curious, or distracted and disinterested?
4. Are there signs of joy, relaxation, confusion, or frustration?
5. Does the prototype hold their attention longer than other indoor objects?

## **PART 2: PARENT/EDUCATOR INTERVIEW**

Participants will be asked open-ended questions about the observed session and their general impressions of the prototype. The researcher will take notes during the conversation.

### **FEEDBACK PROMPTS / QUESTIONS A.**

#### **A. Initial Perceptions**

1. What is your first impression of the prototype's purpose and usability?
2. Does it remind you of any other materials or activities familiar to children?

#### **B. Design Features**

1. Do you find the design engaging and inviting for children? Why or why not?
2. Do any specific features (e.g., textures, colors, scale, materials) stand out to you?
3. Would you consider the design safe and appropriate for children aged 1–5?

#### **C. Nature Connection**

1. Does this prototype successfully evoke or simulate nature-based experiences?
2. Would this kind of object or activity work as a supplement to outdoor time?
3. Do you believe it encourages sensory exploration or calming engagement?

#### **D. Child Interaction (if observed)**

1. How did your child interact with the prototype?
2. Did they seem focused, curious, excited, or hesitant?
3. What kinds of movements, verbal expressions, or emotional responses did you notice?
4. Was their engagement sustained or brief?

#### **E. Contextual Fit**

1. Can you see this type of object or activity being used in a daycare or home setting?
2. What support or guidance would be needed to implement it successfully?
3. Would space, supervision, or maintenance be concerns?

#### **F. Suggestions for Improvement**

1. What changes or enhancements would you recommend?
2. Would you add or remove any features?
3. Do you have ideas for complementary activities that could be added?

### **CLOSING PROMPT**

1. Would you be willing to test or observe future iterations of the prototype?
2. Would you like to be informed about the findings or development outcomes?

**NOTE: This guide is flexible. If new relevant questions emerge during the session that align with the study's scope, the researcher may explore them to deepen understanding.**

## **ETHICS & CONSENT NOTES**

- All prototype testing is voluntary and can be stopped at any time without penalty.
- Data collected will be de-identified and coded.
- No video, photo, or audio recordings will be made.
- Field notes will be taken during and immediately after the session.
- Feedback may inform further iterations of the prototype or final reporting.

## **APENDIX B — Consent Forms and REB Documentation**

### **Information letter**

**PROJECT TITLE:** Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

**OCAD U REB Approval #:** \_102801

Student Investigator: Maria Paola Pieschacon,  
Student-M.Design  
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OCAD University  
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Faculty Supervisor: Prof. Colleen Reid  
Faculty of Design  
OCAD University  
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### **PURPOSE**

This study explores how biophilic design prototypes—objects or spaces inspired by nature—can support children’s attention, curiosity, and emotional well-being in early learning environments.

As a parent or legal guardian of a child aged 1–5, you are invited to provide consent for your child to participate in a short, guided interaction with a biophilic prototype designed for young learners.

Your participation is voluntary will contribute to the researcher’s Major Research Project (MRP).

### **WHAT’S INVOLVED**

If you agree:

- Your child will participate in one guided play session (approx. 15-30 minutes) exploring a small biophilic prototype designed for young children.
- The researcher will guide and observe how your child interacts with the object through play, using natural textures and materials (e.g., smooth wood, fabric, soft elements).
- You or another trusted guardian must always be present.
- If your child has allergies or sensitivities to materials such as wood, soil, or water, please inform the researcher in advance. All materials will be non-toxic and inspected for safety.
- No photos or video recordings will be taken.
- You or your child may stop participation at any time.

### **POTENTIAL BENEFITS AND RISK**

- Possible benefits include offering your child a creative, sensory-based experience and contributing to research about healthier learning environments.
- Risks are minimal and similar to everyday play. Minor discomfort or mild allergic reactions may occur (e.g., touching natural textures).
- The researcher will ensure materials are non-toxic and will stop the activity immediately if a child shows discomfort or distress.

- A parent or guardian will always be present. The researcher has completed child-safeguarding awareness training.

### **CONFIDENTIALITY**

- The following materials will be handled as confidential: interview transcripts, demographic responses, and any contact information (e.g., email address). The participant has the right to review/edit the recordings or transcripts.

- Your name will not be included in reports. Pseudonyms such as “Educator 1” or “Administrator A” will be used where quotations are presented.

- You may review or edit your transcript before final analysis.

- Data will be securely stored in a password-protected OCAD University’s OneDrive, accessible only to Paola Pieschacon and her supervisor, Ms. Colleen Reid.

- All research data will be retained for 5 years after the study’s completion. This timeframe allows for thorough analysis and reporting while ensuring compliance with research data management guidelines. After 5 years, data will be securely deleted to maintain confidentiality and adhere to best practices.

- All raw data will be retained for 5 years after the study concludes, and then permanently deleted to ensure confidentiality.

- In rare and exceptional circumstances, confidentiality may be broken in compliance with mandatory reporting requirements (e.g., suspected child abuse or imminent risk of harm), or if legally required (e.g., court subpoena).

### **INCENTIVES FOR PARTICIPATION**

The participant will not be paid to participate in this study.

### **VOLUNTARY PARTICIPATION**

Your involvement in this study is entirely voluntary. You may refuse to answer any question or withdraw at any time before January 31, 2026, with no negative consequences. If you choose to withdraw, your data will be removed and deleted from all records.

### **CHILD ASSENT**

Before beginning, the researcher will explain the activity to your child in simple language (e.g., “Would you like to play with this nature toy with me?”).

Your child’s willingness will be respected at all times.

If your child declines or appears uncomfortable, participation will not proceed.

### **PUBLICATION OF RESULTS**

Study findings may be presented in the researcher’s Major Research Project or future academic presentations and publications. Only anonymized data will be included. You may request a summary of results by contacting the student investigator.

You will be able to see the final Major Research Project at: <https://openresearch.ocadu.ca/>

Feedback about this study will be available to the participant on request (Contact Paola Pieschacon via email: [mariap@ocadu.ca](mailto:mariap@ocadu.ca)) by the end of July 2026.

### **CONTACT INFORMATION AND ETHICS CLEARANCE**

If you have questions about this study:

Paola Pieschacon (Student Investigator) – mariap@ocadu.ca

Ms. Colleen Reid (Faculty Supervisor) – creid@faculty.ocadu.ca

OCAD University Research Ethics Board – research@ocadu.ca | 416 977 6000 x4368

This study has received clearance from the Research Ethics Board at OCAD University 102801

## Consent Form Parent Or Legal Guardian

PROJECT TITLE: Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

OCAD U REB Approval #: 102801

Student Investigator: Maria Paola Pieschacon,  
Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

Faculty Supervisor: Prof. Colleen Reid  
Faculty of Design  
OCAD University  
cmreid@ocadu.ca

### PURPOSE

This study explores how biophilic interventions like indoor plants, nature-based activities, and spatial design can be incorporated into early childhood daycare settings in Ontario. The goal is to understand their potential influence on children's attention, emotional well-being, and screen-related fatigue.

You are invited to participate because you are a parent or legal guardian of a child aged 1 to 5 in the Greater Toronto Area.

Approximately 8–10 families will be involved in this study.

Your participation is voluntary will contribute to the researcher's Major Research Project (MRP).

### WHAT'S INVOLVED

You will take part in a one-on-one semi-structured interview lasting 30–45 minutes, either in person or via Zoom.

The interview will explore your perceptions of your child's relationship to nature, experience with planting or outdoor activities, and screen time behavior.

With your consent, the interview will be audio recorded to support accurate transcription.

No identifiable information will appear in any reporting.

You may decline to answer any question or stop the interview at any time.

You will be asked to complete a brief, confidential demographic questionnaire.

Demographic information (e.g., age range, child's age, general background) will be collected only to provide context for understanding participant perspectives.

This information will be summarized descriptively to illustrate the diversity of experiences among parents and will not be used for statistical or quantitative analysis.

### POTENTIAL BENEFITS AND RISK

Possible direct benefits of participation include:

Contribute your voice to research shaping the future of early childhood education environments.

Reflect on your child's experiences with nature and play.

Gain insights into alternative educational tools.

No known risks.

#### CONFIDENTIALITY

The following materials will be handled as confidential: interview transcripts, demographic responses, and any contact information (e.g., email address). The participant has the right to review/edit the recordings or transcripts.

Your name will not be included in reports. Pseudonyms such as “Educator 1” or “Administrator A” will be used where quotations are presented.

You may review or edit your transcript before final analysis.

Data will be securely stored in a password-protected external hard drive and OCAD University’s OneDrive, accessible only to Paola Pieschacon and her supervisor, Ms. Colleen Reid.

All research data will be retained 5 years after the study’s completion. This timeframe allows for thorough analysis and reporting while ensuring compliance with research data management guidelines. After 5 years, data will be securely deleted to maintain confidentiality and adhere to best practices.

All raw data will be retained for 5 years after the study concludes, and then permanently deleted to ensure confidentiality.

In rare and exceptional circumstances, confidentiality may be broken in compliance with mandatory reporting requirements (e.g., suspected child abuse or imminent risk of harm), or if legally required (e.g., court subpoena).

#### INCENTIVES FOR PARTICIPATION

The participant will not be paid to participate in this study.

#### VOLUNTARY PARTICIPATION

Your involvement in this study is entirely voluntary. You may refuse to answer any question or withdraw at any time before January 31, 2026, with no negative consequences. If you choose to withdraw, your data will be removed and deleted from all records.

#### PUBLICATION OF RESULTS

Study findings may be presented in the researcher’s Major Research Project or future academic presentations and publications. Only anonymized data will be included. You may request a summary of results by contacting the student investigator.

You will be able to see the final Major Research Project at: <https://openresearch.ocadu.ca/>

Feedback about this study will be available to the participant on request (Contact Paola Pieschacon via email: [mariap@ocadu.ca](mailto:mariap@ocadu.ca)) by the end of July 2026.

#### CONTACT INFORMATION AND ETHICS CLEARANCE

If you have questions about this study:

Paola Pieschacon (Student Investigator) – [mariap@ocadu.ca](mailto:mariap@ocadu.ca)

Ms. Colleen Reid (Faculty Supervisor) – [creid@faculty.ocadu.ca](mailto:creid@faculty.ocadu.ca)

OCAD University Research Ethics Board – [research@ocadu.ca](mailto:research@ocadu.ca) | 416 977 6000 x4368

This study has received clearance from the Research Ethics Board at OCAD 102801.

## AGREEMENT

By signing below, you confirm that you understand the purpose and procedures of this study, have had an opportunity to ask questions, and voluntarily consent to participate in the interview. You understand that the Student Investigator will be observing your child, possibly asking them questions and asking yourself questions regarding your child.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

I consent to being audio recorded during the interview.

I would like to review my transcript once available.

Thank you for your contribution to this project. You will receive a copy of this form for your records.

### ADDITIONAL DETAILS:

*You may be contacted again to give feedback on early research findings or design prototypes.*

*There is no financial compensation for participating.*

*Any audio recordings will be used solely for transcription and then securely deleted.*

*In rare cases, it will not be possible to ensure confidentiality because of mandatory reporting laws (e.g. suspected child abuse) or the possibility of third-party access to data (e.g., court subpoena of records) or to provide emergency assistance (such as participants' identification of severe, risky or urgent mental health situations). When this is the case, the prospective research participant should be aware of any potential limitations.*

### CONFIDENTIAL QUESTIONNAIRE:

*You will be asked to complete a brief questionnaire. This information will not be linked to your name and will be anonymized in all analyses and reports.*

### MEMBER CHECK OR PROTOTYPE FEEDBACK:

*Your responses will remain confidential. If quoted in reports or publications, pseudonyms will be used unless you provide explicit permission otherwise. If you would like to be contacted again to review findings or provide input on design prototypes, you may opt in below:*

*Yes, I wish to be contacted again*

*Email:* \_\_\_\_\_

*Phone:* \_\_\_\_\_

*No, I do not wish to be contacted again*

**Consent Form parent or legal guardian**

PROJECT TITLE: Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

OCAD U REB Approval #: 102801

Principal Investigator: Maria Paola Pieschacon, Student-M.Design (Strategic Foresight Innovation)	Faculty Supervisor: Prof. Colleen Reid Faculty of Design OCAD University cmreid@ocadu.ca
OCAD University Mariap@ocadu.ca	

I have read the information presented in the *information letter* about a study being conducted by Maria Paola Pieschacon of the Department of Strategic Foresight Innovation at OCAD University, under the supervision of Professor Colleen Reid. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that my child will participate in the study if he/she agrees to participate and I agree to his/her participation.

I acknowledge that all information gathered on this project will be used for research purposes only and will be considered confidential. I am aware that permission may be withdrawn at any time (by either the parent and/or the child) without penalty by advising the researchers.

I acknowledge that all information gathered in this project will be used for research purposes only and will be treated as confidential.

I am aware that permission may be withdrawn at any time (by either the parent and/or the child) without penalty, including during the activity itself, by informing the researcher verbally or by contacting Maria Paola Pieschacón (mariap@ocadu.ca) or Professor Colleen Reid (creid@faculty.ocadu.ca).

If permission is withdrawn, any related data (notes, transcripts, or recordings) will be deleted and excluded from analysis.

Requests to withdraw data will be accepted until January 31, 2026, after which the data will be anonymized and cannot be identified or removed.

I realize that this project has been reviewed by, and received ethics clearance through the Office of Research Ethics at OCAD U. I was informed that if I have any comments or concerns about my child's rights as a participant this study, I may contact the OCADU Research Ethics Board:

Research Ethics Board c/o Office of the Vice President, Research and Innovation  
OCAD University  
100 McCaul Street  
Toronto, M5T1W1  
416 977 6000 x4368

research@ocadu.ca

Child's Name: \_\_\_\_\_ Child's Birth Date: \_\_\_\_\_

I agree to have my child's interview audio recorded to ensure an accurate recording of his/her responses. This material will be treated as confidential.

YES  NO

I also agree to the use of anonymous quotations in any thesis or publication that comes of this research, with the understanding that all quotations will be anonymous.

YES  NO

Name of Parent or Guardian: \_\_\_\_\_ (Please print)

Signature of Parent or Guardian: \_\_\_\_\_ Date: \_\_\_\_\_

## **Consent Form - Prototype**

**PROJECT TITLE:** Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

**OCAD U REB Approval #:** 102801

Student Investigator: Maria Paola Pieschacon,

Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

Faculty Supervisor: Prof. Colleen Reid

Faculty of Design  
OCAD University  
cmreid@ocadu.ca

### **PURPOSE**

You are invited to participate in a voluntary research activity that seeks feedback on a biophilic design prototype developed as part of a graduate research project at OCAD University.

This prototype is an early design concept created to explore how nature-inspired environments and objects can enhance children's attention, emotional well-being, and sensory engagement in early learning spaces.

Your feedback will help evaluate the design's relevance, safety, usability, and educational potential, supporting future development of practical, nature-based interventions for early childhood education settings.

### **WHAT'S INVOLVED**

You will be asked to participate in a 30-60 minute in-person session to review and discuss the biophilic prototype.

Depending on the format, this may include:

Viewing visual materials such as renderings, photos, or models of the prototype, and/or

Gently interacting with a physical prototype made with safe, natural materials (e.g., wood, fabric, or textured elements) designed for young children.

You will be asked a short set of questions about the prototype's design, sensory qualities, and potential use in childcare environments.

The session may be audio-recorded (with your consent) solely for transcription purposes.

Your participation is completely voluntary and confidential.

### **POTENTIAL BENEFITS**

Possible direct benefits of participation include:

Opportunity to contribute to innovation in early childhood education settings.

Influence the development of design solutions that may enhance children's well-being.

Gain early insight into research findings related to nature-based learning strategies.

### **CONFIDENTIALITY**

The following materials will be handled as confidential: interview transcripts, demographic responses, and any contact information (e.g., email address). The participant has the right to review/edit the recordings or transcripts.

Your name will not be included in reports. Pseudonyms such as “Educator 1” or “Administrator A” will be used where quotations are presented.

You may review or edit your transcript before final analysis.

Data will be securely stored in a password-protected external hard drive and OCAD University’s OneDrive, accessible only to Paola Pieschacon and her supervisor, Ms. Colleen Reid.

All research data will be retained for 5 years after the study’s completion. This timeframe allows for thorough analysis and reporting while ensuring compliance with research data management guidelines. After 5 years, data will be securely deleted to maintain confidentiality and adhere to best practices.

All raw data will be retained for 5 years after the study concludes, and then permanently deleted to ensure confidentiality.

In rare and exceptional circumstances, confidentiality may be broken in compliance with mandatory reporting requirements (e.g., suspected child abuse or imminent risk of harm), or if legally required (e.g., court subpoena).

#### INCENTIVES FOR PARTICIPATION

The participant will not be paid to participate in this study.

#### VOLUNTARY PARTICIPATION

Your involvement in this study is entirely voluntary. You may refuse to answer any question or withdraw at any time before January 31, 2026, with no negative consequences. If you choose to withdraw, your data will be removed and deleted from all records.

#### PUBLICATION OF RESULTS

Study findings may be presented in the researcher’s Major Research Project or future academic presentations and publications. Only anonymized data will be included. You may request a summary of results by contacting the student investigator.

Feedback about this study will be available to the participant on request (Contact Paola Pieschacon via email: [mariap@ocadu.ca](mailto:mariap@ocadu.ca)) by the end of July 2026.

#### CONTACT INFORMATION AND ETHICS CLEARANCE

If you have questions about this study:

Paola Pieschacon (Student Investigator) – [mariap@ocadu.ca](mailto:mariap@ocadu.ca)

Ms. Colleen Reid (Faculty Supervisor) – [creid@faculty.ocadu.ca](mailto:creid@faculty.ocadu.ca)

OCAD University Research Ethics Board – [research@ocadu.ca](mailto:research@ocadu.ca) | 416 977 6000 x4368

This study has received clearance from the Research Ethics Board at OCAD University 102801

AGREEMENT

I have read the above information and consent to participate in this prototype review.

Name: \_\_\_\_\_ Signature: \_\_\_\_\_

\_\_\_\_\_ Date: \_\_\_\_\_

I agree to be audio recorded for transcription purposes only.

I would like to be contacted with final results or follow-up opportunities.

Email: \_\_\_\_\_

Thank you for your assistance in this project. You will receive a copy of this form for your records.

## Consent Form Feedback

PROJECT TITLE: Integrating Nature-Based Interventions in Early Childhood Education Settings in Ontario

OCAD U REB Approval #: 102801

Student Investigator: Maria Paola Pieschacon,  
Student-M.Design  
(Strategic Foresight Innovation)  
OCAD University  
Mariap@ocadu.ca

Faculty Supervisor: Prof. Colleen Reid  
Faculty of Design  
OCAD University  
cmreid@ocadu.ca

### PURPOSE

The purpose of this discussion is to gather your personal reflections as a parent about your child's experience interacting with a biophilic design prototype created for this study.

Your feedback will help the researcher understand how nature-inspired design features can support children's attention, curiosity, and emotional well-being in early learning environments.

### WHAT'S INVOLVED

If you agree to participate:

You will take part in an individual feedback session (20-30 minutes) after your child's guided activity.

The session will be held in person at the daycare site or online via Zoom, depending on your preference.

You will be asked a few short questions about your observations, perceptions of the activity, and your child's engagement.

With your consent, the session may be audio recorded for transcription.

You may review your transcript or request its deletion at any time before January 31, 2026.

### POTENTIAL BENEFITS

There are no anticipated risks beyond normal conversation.

Benefits include contributing valuable insight to research about nature-integrated learning environments and helping inform future designs that support children's well-being.

### CONFIDENTIALITY

The following materials will be handled as confidential: interview transcripts, demographic responses, and any contact information (e.g., email address). The participant has the right to review/edit the recordings or transcripts.

Your name will not be included in reports. Pseudonyms such as "Educator 1" or "Administrator A" will be used where quotations are presented.

You may review or edit your transcript before final analysis.

Data will be securely stored in a password-protected external hard drive and OCAD University's OneDrive, accessible only to Paola Pieschacon and her supervisor, Ms. Colleen Reid.

All research data will be retained for 5 years after the study’s completion. This timeframe allows for thorough analysis and reporting while ensuring compliance with research data management guidelines. After 5 years, data will be securely deleted to maintain confidentiality and adhere to best practices.

All raw data will be retained for 5 years after the study concludes, and then permanently deleted to ensure confidentiality.

In rare and exceptional circumstances, confidentiality may be broken in compliance with mandatory reporting requirements (e.g., suspected child abuse or imminent risk of harm), or if legally required (e.g., court subpoena).

### INCENTIVES FOR PARTICIPATION

The participant will not be paid to participate in this study.

### VOLUNTARY PARTICIPATION

Your participation is entirely voluntary. You may withdraw at any time before January 31, 2026, and your data will be deleted without consequence.

Declining will not affect your or your child’s participation in any way.

### PUBLICATION OF RESULTS

Study findings may be presented in the researcher’s Major Research Project or future academic presentations and publications. Only anonymized data will be included. You may request a summary of results by contacting the student investigator.

Feedback about this study will be available to the participant on request (Contact Paola Pieschacon via email: mariap@ocadu.ca) by the end of July 2026.

### CONTACT INFORMATION AND ETHICS CLEARANCE

If you have questions about this study:

Paola Pieschacon (Student Investigator) – mariap@ocadu.ca

Ms. Colleen Reid (Faculty Supervisor) – creid@faculty.ocadu.ca

OCAD University Research Ethics Board – research@ocadu.ca | 416 977 6000 x4368

This study has received clearance from the Research Ethics Board at OCAD 102801

.

### AGREEMENT

I have read the above information and consent to participate in this prototype review.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_


I agree to be audio recorded for transcription purposes only.

I would like to be contacted with final results or follow-up opportunities.

Email: \_\_\_\_\_


Thank you for your assistance in this project. You will receive a copy of this form for your records.

Flyer



OCAD University Research

## Reimagine Nature in Early Learning Spaces



### Join Our Study on Nature and Learning

We invite parents of children aged 1–5 and early childhood educators to participate in a study exploring how nature-based activities and environments can influence children's attention, well-being, and engagement in early learning settings.


#### What's Involved?

- A 45–60 minute interview (virtual or in person) to share your experiences and perspectives.
- Optionally, you may also participate in a planting activity or observation session to provide further insights.

#### Why Your Participation Matters

Your experiences are essential to ensure this research reflects the realities of families and educators directly engaged in early learning. This study is designed to be inclusive, respectful, and grounded in real-world practice.

If you are interested in participating or would like more information,



Please contact:  
Maria Paola Pieschacón Fonrodona  
Graduate Student, OCAD University  
✉ [mariap@ocadu.ca](mailto:mariap@ocadu.ca)

Approved by the OCAD University Research Ethics Board  
Image credit: Canva

Email Invitation – Educators/Administrators

Subject: Share Your Insights on Nature-Based Learning in Early Childhood

Dear [Name],

My name is Paola Pieschacon, and I am a Master of Design (MDes) candidate in the Strategic Foresight & Innovation program at OCAD University. As part of my Major Research Project (MRP), I am conducting a study approved by the OCAD University Research Ethics Board that explores how nature-based interventions—such as planting activities, biophilic furniture, and outdoor play environments—can support young children’s attention, and emotional regulation, in early learning settings.

I am inviting early childhood educators and daycare administrators to share their insights and experiences in a 45–60 minute semi-structured interview, which can be conducted virtually or in person, based on your preference. Your professional perspective will help identify practical challenges, opportunities, and design strategies for incorporating nature-integrated approaches in licensed early learning settings across Ontario.

Participation is entirely voluntary, and your identity and responses will remain confidential. All collected data will be stored securely and anonymized in reporting.

If you're interested in contributing to this important dialogue—or if you have any questions—please feel free to reach out to me directly at [mariap@ocadu.ca](mailto:mariap@ocadu.ca).

Your experience and voice are essential to shaping inclusive, well-being-centered early learning environments. Thank you for considering this invitation.

Paola Pieschacon  
MDes Candidate, Strategic Foresight & Innovation  
OCAD University

Email Invitation – Parents

Subject: Invitation to Participate in Early Childhood Nature Play Research

Dear [Parent's Name],

My name is Paola Pieschacon, and I am a Master of Design (MDes) candidate in the Strategic Foresight & Innovation program at OCAD University. I am currently conducting my Major Research Project (MRP), which has been reviewed and approved by the OCAD University Research Ethics Board.

This research explores how nature-based activities—such as planting, outdoor sensory play, and biophilic design—can support young children's attention regulation, emotional well-being, and screen-related cognitive fatigue. The study aims to better understand how both parents and educators perceive these nature-integrated experiences in early childhood contexts, and how they might be introduced more meaningfully into everyday learning and care environments.

I am inviting parents or legal guardians of children aged 1–5 to participate in one or more of the following voluntary research activities:

A short interview (30–45 minutes, online or in person) exploring your perspectives and experiences with nature-based play and screen time

Optional participation for your child in a simple planting activity or unobtrusive observation during free outdoor play in a public park (with your consent and presence at all times)

All participation is voluntary, confidential, and fully aligned with OCAD University's research ethics standards. You may withdraw at any point without any consequence. Your insights will contribute meaningfully to the development of future early learning environments that support well-being and development.

If you're interested in participating or would like more information, please feel free to email me at [mariap@ocadu.ca](mailto:mariap@ocadu.ca)

Warmly,

Paola Pieschacon  
MDes Candidate, OCAD University

***APENDIX D — Horizon Scan (STEEP/Analysis)***

- STEEPV table

S	T	E	E	P	V
Social	Technological	Economic	Environmental	Political	Values
<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Increased global inequality</li> <li>• Rapidly increasing global inequality</li> <li>• Rapidly increasing global inequality</li> </ul>	<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> </ul>	<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> </ul>	<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> </ul>	<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> </ul>	<ul style="list-style-type: none"> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> <li>• Rapidly increasing global population</li> </ul>

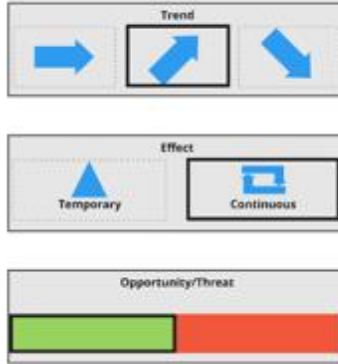
(AJ&Smart et al.)

- Issue & Impact Analysis

Card-ID: Soc-01

Social

Impact Analysis



Evidence/Examples

**Unequal access to parkland in Toronto:**  
Several neighbourhoods fall below the city's per-capita parkland provision standards, disproportionately affecting low-income and newcomer families.  
**Source:** City of Toronto. (2022). *Parkland Strategy: Growing Toronto's Parkland*.

**Nature access predicts child mental and physical health outcomes:**  
Research shows children with less access to nature experience higher stress, poorer attention, and less frequent opportunities for recreational play.  
**Source:** McCarroll, B. (2017). *Does Access to Green Space Impact Children's Mental Well-being?* *International Journal of Environmental Research and Public Health*.

**High-rise living reduces children's nature exposure:**  
Families living in dense, vertical housing have significantly fewer daily nature interactions, this is particularly acute in immigrant and low-income communities.  
**Source:** Evans, G., & McCoy, J. (1998). *When Buildings Don't Work: The Role of Architecture in Human Health*, *Journal of Environmental Psychology*.

**Increased reliance on children as the primary source of nature contact:**  
In dense urban centres, early learning settings become the primary location where children experience greenery or nature-based play.  
**Source:** Gill, T. (2020). *Urban Playground: How Child-friendly Planning and Design Can Save Cities*.

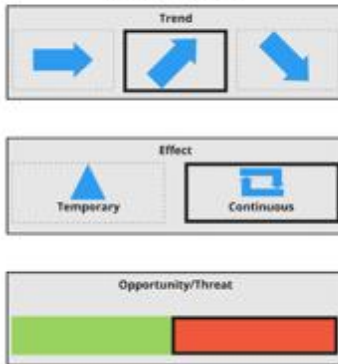
**Equity concerns: limited access to nature for urban families in Toronto**

Toronto's rapid urban densification has created neighbourhoods where access to parks and green space is significantly below the city average. Families living in high-rise buildings—especially newcomers, low-income households, and renters—often rely heavily on childcare centres for children's exposure to nature. Unequal distribution of nature access contributes to disparities in children's emotional regulation, physical activity, and overall well-being. This inequality increases the importance of integrating biophilic elements inside childcare environments.

Card-ID: Soc-02

Social

Impact Analysis



Evidence/Examples

**Nature interaction improves emotional regulation:**  
Direct contact with plants and natural systems reduces physiological stress markers in children.  
**Source:** Chawla, L. (2011). *Benefits of Nature Contact for Children*, *Journal of Planning Literature*.

**Increase in sensory processing challenges among young children:**  
Studies show a significant rise in sensory regulation issues, making sensory-supportive environments essential.  
**Source:** Ahn, B. et al. (2004). *Prevalence of Sensory Processing Disorders*, *American Journal of Occupational Therapy*.

**Educators report more dysregulation in post-pandemic cohorts:**  
ECEs indicate higher rates of behaviour dysregulation, attention difficulties, and emotional overarousal since 2020.  
**Source:** Pappas, C., & Reardon, C. (2021). *Reopening Early Childhood Education after COVID-19*, *European Early Childhood Education Research Journal*.

**Natural materials reduce overstimulation compared to plastic or bright coloured environments:**  
Research shows that natural tones and natural textures reduce cognitive load and support calmer behaviour.  
**Source:** Kus, M. (2015). *How Light Contact with Nature Promotes Human Health?* *Frontiers in Psychology*.

**Issue: Demand for Emotional Regulation & Sensory Well-being in Children**

**Description:**  
Educators report increasing numbers of children struggling with self-regulation, emotional overwhelm, social anxiety, and sensory processing difficulties. The post-pandemic environment has intensified awareness of children's emotional needs. Biophilic elements—plant interaction, natural textures, fractal patterns, and calming sensory cues—are strongly aligned with evidence-based strategies for supporting regulation in early childhood.

Card-ID: Soc-03

Social

Impact Analysis



Evidence/Examples

**Cultures differ in comfort with messy, nature-based, or risk-taking play:**  
Some parents avoid messy play due to cleanliness or safety norms, while others encourage it.  
**Source:** Little, H., & Meyer, S. (2006). *Outdoor Play and Risk-taking*, *Journal of Early Childhood Research*.

**Family cultural background shapes expectations of early childhood environments:**  
Different cultures hold distinct norms around child autonomy, outdoor exposure, and structured vs. unstructured play.  
**Source:** Bergin, B. (2002). *The Cultural Norms of Human Development*.

**Nature is not universally interpreted as "safe" or "clean":**  
Cross-cultural studies show variation in parental trust of soil, plants, insects, and outdoor play.  
**Source:** Tsourou, L. (2020). *Children, Nature and Culture*, *Ecopsychology*.

**Immigrant families in Canadian cities often experience "nature loss" after relocation:**  
Studies indicate that migration can reduce children's daily nature exposure and reshape family norms.  
**Source:** Chawla, L., & Noppeke, H. (2011). *Changes in Public Space and Urban Environment after Migration Population and Environment*.

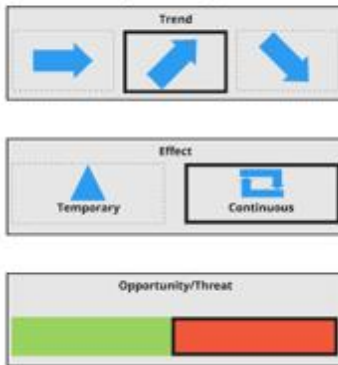
**Issue: Cultural diversity shaping relationships with nature and play**

Toronto is one of the most culturally diverse cities globally, and families differ widely in how they view nature, risk-taking, play, and "messiness." Some cultures value structured, cleanliness-oriented learning environments, while others prioritize exploration and outdoor play. These perceptions influence how parents and educators respond to biophilic interventions, natural materials, or sensory-rich environments. Understanding cultural perspectives is essential to ensure inclusive and acceptable design.

Card-ID: Soc-04

Social

Impact Analysis



Evidence/Examples

**Screen time linked to poor self-regulation and attention issues:**  
The Canadian Paediatric Society reports strong evidence that excessive screen exposure is correlated with dysregulation.  
**Source:** Canadian Paediatric Society. (2019). *Digital Media and Children*.

**Parental anxiety about overstimulation has increased post-pandemic:**  
Parents report heightened concerns about behavioural dysregulation, irritability, and focus difficulties.  
**Source:** Patrick, S. et al. (2020). *Well-being of Parents and Children During the COVID-19 Pandemic*, *Psychiatry*.

**Natural environments reduce overstimulation and restore attention:**  
Even brief interactions with plants or nature scenes improve children's attentional control.  
**Source:** Ulrich, R. (1984). *How Through a Window May Influence Recovery*, *Science*.

**Parents seek alternatives to digital entertainment and overstimulating toys:**  
Parents increasingly prefer coloring, sensory, natural materials for play.  
**Source:** Marsh, J. et al. (2017). *Dysregulation, Parents and Children: Digital Concerns in Early Childhood*, *New Media & Society*.

**Issue: Parental Concern About Children's Stress, Overstimulation & Screen Exposure**

**Description:**  
Parents increasingly express concern about children's exposure to screens, overstimulating environments, and emotional stress. The Canadian Paediatric Society warns that early and excessive screen use is associated with attention difficulties, dysregulation, and sleep problems. Families are seeking calming, sensory-supportive, and nature-based alternatives—especially in childcare settings where children spend long hours.

Card-ID: Tec-05

Technological

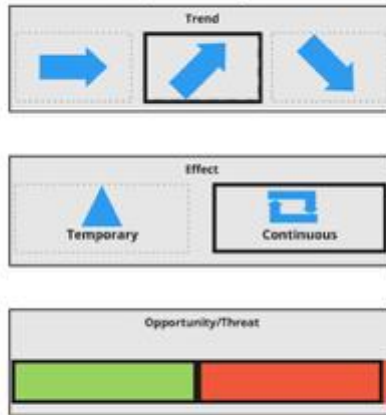
Issue

Rise of "digital-biophilic hybrids" such as smart planters or app-triggered nature activities

Description

A growing range of early childhood technologies combine digital interaction with nature-based learning. These include app-connected planters that track watering or growth, digital prompts for plant care, augmented reality nature exploration apps, and hybrid sensory stations that blend physical nature experiences with digital feedback. These tools aim to engage young children in environmental awareness and plant care while leveraging the familiarity of digital interfaces. However, they also risk substituting direct nature engagement with mediated experiences. For childcare centres, this trend raises important questions about balancing digital and embodied learning.

Impact Analysis



Evidence/Examples

Digital-nature hybrid tools are emerging as a way to engage children with environmental awareness and plant care. Source: Nansen, B., et al. (2020). *Digital Play and Nature Engagement in Early Childhood: Learning, Media and Technology*. Smart planters and IoT-based plant care devices are now marketed for educational settings, blending data tracking with hands-on plant activities. Source: Kim, M., & Park, J. (2019). *IoT-Based Smart Planters and Environmental Learning*. *International Journal of Smart Home, Augmented reality apps for nature exploration are increasingly used in early learning as a hybrid extension of outdoor play*. Source: Cheng, K. H. & Tsai, C. C. (2019). *Augmented Reality in Outdoor Environmental Education*. *Computers & Education*. Scholars caution that hybrid tools may "digitize" nature interaction, potentially reducing sensory richness or embodied play. Source: Sobel, D. (2014). *Place-Based Education: Connecting Classrooms and Communities*. Harvard Education Press.

Card-ID: Tec-06

Technological

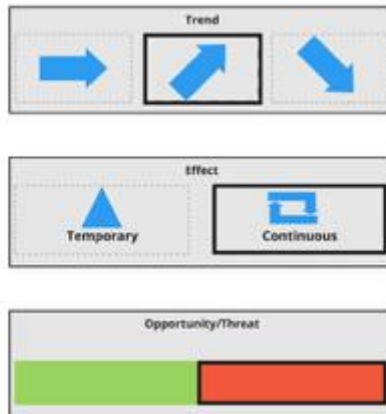
Issue

Digital Overstimulation & the Need for Sensory Balance

Description

Young children are exposed to digital media at unprecedented levels, both at home and increasingly through early learning platforms. This can lead to sensory overload, attention fragmentation, and dysregulation. Technological overstimulation has intensified demand for analogue, nature-based, and sensory-calming elements in childcare settings. This issue directly strengthens the rationale for biophilic design as a counter-stimulus that restores focus and emotional equilibrium.

Impact Analysis



Evidence/Examples

Screen exposure is linked to attention problems and dysregulation in young children. Source: Canadian Paediatric Society. (2016). *Digital Media and Children*. Digital overstimulation increases cognitive load and reduces sustained attention. Source: Christakis, D. (2019). *Digital Media and Early Childhood Development*. *Pediatrics*. Natural environments restore attention through "soft fascination," counterbalancing digital overload. Source: Kaplan, S. (1995). *Attention Restoration Theory*. *Environment and Behavior*. Parents increasingly seek sensory-calming alternatives to screens and hyper-stimulating toys. Source: Marsh, J., et al. (2021). *Digital Concerns in Early Childhood*. *New Media & Society*.

Card-ID: Tec-07

Technological

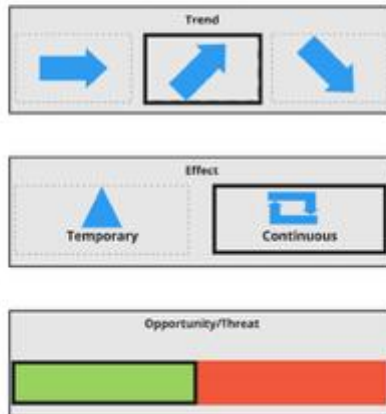
Issue

Growth of AI-supported developmental tools in early childhood

Description

AI-based tools—such as automated observation apps, developmental analytics, speech processing tools, and adaptive learning systems—are increasingly entering early childhood settings. These technologies promise efficiency, individualized learning, and early identification of developmental needs. However, they also raise concerns around data privacy, educator training, and overreliance on digital assessment. In this context, biophilic design can act as a non-digital counterbalance, offering sensory and emotional benefits without increasing screen exposure.

Impact Analysis



Evidence/Examples

AI use is projected to grow significantly in Early Childhood Education across OECD countries. Source: OECD. (2023). *AI in Early-Childhood Education and Care: Opportunities and Risks*. AI developmental screening tools are increasingly integrated into early learning apps and platforms. Source: UNICEF. (2022). *Policy Guidance on AI for Children*. Educators report time-saving benefits from AI-assisted documentation, freeing time for direct child engagement. Source: Parbo, B., et al. (2021). *AI and Early Childhood Education*. *Computers & Education*. Concerns remain about data privacy, surveillance, and loss of embodied, play-based learning. Source: Marsh, J., et al. (2021). *Digitalization of Childhood*. *New Media & Society*.

Card-ID: Eco-08

Economic

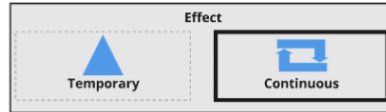
Issue

Daycare Budget Constraints Limiting Classroom Redesign

Description

Many childcare centres in Ontario operate with tight budgets, prioritizing essential staffing, licensing requirements, and daily operations. Capital improvements such as classroom redesign, new furniture, or environmental interventions are often delayed or deprioritized because they require funding outside normal operating budgets. As a result, centres may avoid implementing beneficial design changes—even low-cost biophilic interventions—without external funding or grants.

Impact Analysis



Evidence/Examples

Ontario childcare centres face chronic underfunding, limiting ability to invest in physical environments. Source: Macdonald, D. & Friendly, M. (2020). In Progress: Child Care Fees in Canada. Canadian Centre for Policy Alternatives. Capital upgrades are typically not covered by operating grants, requiring separate fundraising or government programs. Source: Friendly, M. et al. (2023). Canadian Child Care Funding Model Review. Research shows that early childhood spaces often remain outdated due to financial constraints rather than lack of pedagogical interest. Source: Elliott, S. & Davis, J. (2020). Sustainable Spaces for Children. Routledge. Non-profit childcare centres disproportionately experience budget rigidity compared to for-profit centres. Source: Cleveland, G. & Krashinsky, M. (2005). The Economic Rationale for Public Funding of Early Learning and Child Care.

Card-ID: Eco-09

Economic

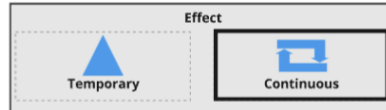
Issue

Rising Staffing Costs in Ontario's ECE Sector

Description

Staffing constitutes the largest portion of childcare operating budgets—often 70-80%. As Ontario introduces wage enhancements, retention bonuses, and new staffing requirements associated with the Canada-Wide Early Learning and Child Care (CWELCC) system, personnel costs continue to increase. This leaves less financial flexibility for environmental improvements, materials, and program innovation. The sector also reports high turnover, requiring additional funds for recruitment and onboarding.

Impact Analysis



Evidence/Examples

Ontario's Child Care Workforce Strategy highlights increasing wage pressures and the need for retention incentives. Source: Ontario Ministry of Education. (2023). Child Care Workforce Strategy. Staffing costs represent the majority of childcare operating expenses (70-80%). Source: Cleveland, G. (2018). The Costs of Quality Child Care. The national early learning expansion is hindered by major ECE workforce shortages and rising labour costs. Source: Centre for the Study of Living Standards (2024). ECE Labour Shortage Report. Turnover rates in childcare centres significantly increase recruitment and training spending. Source: Whitebook, M. et al. (2014). Worthy Work, Still Unlivable Wages.

Card-ID: Eco-10

Economic

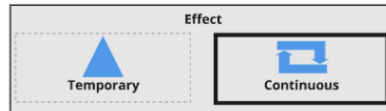
Issue

Commercial Biophilic Products Exist but Are Unaffordable for Many Centres

Description

The market for nature-integrated educational tools—such as indoor garden kits, sensory nature walls, and modular plant systems—has grown significantly. However, these products are often designed for private schools or affluent families, making them inaccessible for non-profit childcare centres operating under strict budgets. This creates a market gap where centres recognise the value of biophilic design but cannot financially justify implementation. Low-cost, durable, and regulation-compliant alternatives are urgently needed.

Impact Analysis



Evidence/Examples

Nature-based learning kits are often priced beyond the budgets of public and non-profit childcare centres. Source: Acar, I. H. (2020). Cost Barriers in Implementing Nature-Based Education Programs. Children, Youth & Environments. Commercial biophilic systems (sensory plant walls, indoor garden towers) target private markets with pricing ranging \$400-\$2,500+. Source: Industry scan (e.g., GreenStalk, AeroGarden, Edible Schoolyard tools). Research highlights inequities in access to nature-based educational tools between private and publicly funded centres. Source: Ernst, J. (2019). Early Childhood Nature Education Across Socioeconomic Contexts. Environmental Education Research. Centres with limited capital budgets often innovate with DIY or community-built solutions rather than commercial products. Source: Elliott, S. (2015). Creating Sustainable Outdoor Learning Environments in Early Childhood.

**Card-ID: Env-01** **Environmental**

**Issue**

Reduced Access to Outdoor Play Due to Urban Densification

**Description**

Rapid urban densification in cities like Toronto has resulted in limited access to green space, especially for families living in high-rise buildings. Children in dense neighbourhoods have fewer opportunities for daily outdoor play, which has well-documented developmental and health consequences. This environmental constraint increases pressure on childcare centres to provide nature-rich experiences indoors.

**Impact Analysis**

Trend: [Diagram showing a blue arrow pointing right, a blue arrow pointing up-right, and a blue arrow pointing down-right]

Effect: [Diagram showing a blue triangle labeled 'Temporary' and a blue square labeled 'Continuous']

Opportunity/Threat: [Diagram showing a green bar on the left and a red bar on the right]

**Evidence/Examples**

Toronto has significant parkland inequities, with several neighbourhoods falling below recommended park space.  
**Source:** City of Toronto. (2022). *Parkland Strategy: Growing Toronto's Parkland.*

Children living in high-rise buildings have fewer daily nature interactions.  
**Source:** Evans, G. & McCoy, J. (1998). *The Role of Architecture in Human Health. Journal of Environmental Psychology.*

Reduced access to nature contributes to lower physical activity and higher stress in children.  
**Source:** McCormick, R. (2017). *Nature and Child Mental Well-being. IJERPH.*

Urbanization is a global driver of reduced nature contact for young children.  
**Source:** Gill, T. (2022). *Urban Playground.*

**Card-ID: Env-01** **Environmental**

**Issue**

Climate Change → More Extreme Heat Days → More Indoor Confinement

**Description**

Climate projections indicate that Toronto will see a dramatic rise in extreme-heat days, heat waves, and poor air-quality events (e.g., wildfire smoke). These conditions restrict outdoor play in childcare environments, forcing educators to keep children indoors for safety. As a result, the quality of indoor environments—including access to calming, nature-based elements—becomes increasingly critical for well-being.

**Impact Analysis**

Trend: [Diagram showing a blue arrow pointing right, a blue arrow pointing up-right, and a blue arrow pointing down-right]

Effect: [Diagram showing a blue triangle labeled 'Temporary' and a blue square labeled 'Continuous']

Opportunity/Threat: [Diagram showing a green bar on the left and a red bar on the right]

**Evidence/Examples**

Toronto's Climate Resilience Report predicts 20-55 extreme heat days per year by 2050.  
**Source:** City of Toronto. (2018). *Toronto's Resilience Strategy.*

Extreme heat reduces safe outdoor play time for young children.  
**Source:** Health Canada. (2021). *Heat and Children's Health.*

Wildfire smoke events in 2023 caused widespread indoor confinement for children across Ontario.  
**Source:** Government of Canada. (2023). *Air Quality Health Index Annual Summary.*

Indoor environmental quality becomes critical when outdoor access is restricted due to climate events.  
**Source:** UNICEF. (2020). *Healthy Environments for Healthy Children.*

**Card-ID: Env-01** **Environmental**

**Issue**

Increased Focus on Indoor Air Quality in Childcare Post-COVID

**Description**

COVID-19 foregrounded the importance of clean indoor air, ventilation, HEPA filtration, and CO<sub>2</sub> levels in childcare settings. Government funding and public pressure have driven widespread adoption of IAQ strategies, making indoor air a central component of children's health and safety. This shift

**Impact Analysis**

Trend: [Diagram showing a blue arrow pointing right, a blue arrow pointing up-right, and a blue arrow pointing down-right]

Effect: [Diagram showing a blue triangle labeled 'Temporary' and a blue square labeled 'Continuous']

Opportunity/Threat: [Diagram showing a green bar on the left and a red bar on the right]

**Evidence/Examples**

Ontario installed over 70,000 HEPA units in schools and childcare settings.  
**Source:** Government of Ontario. (2021). *School Ventilation Improvement Report.*

Health Canada recommends improved IAQ as a permanent public-health measure for children.  
**Source:** Health Canada. (2022). *Indoor Air Quality in Schools.*

Poor IAQ negatively affects children's cognition, behaviour, and attention.  
**Source:** Mendell, M. et al. (2013). *Indoor Environmental Quality and Children's Health. Environmental Health Perspectives.*

Ventilation improvements remain central to childcare licensing and public expectations post-pandemic.  
**Source:** Public Health Ontario. (2022). *Ventilation in Child Care Settings.*

**Card-ID: Env-01** **Environmental**

**Issue**

Growing Preference for Non-Toxic, Low-VOC Materials

**Description**

Parents, educators, and regulators increasingly prioritise non-toxic, low-VOC, and sustainable materials due to concerns about chemical exposure, respiratory irritation, and long-term health impacts. This shift elevates demand for natural or low-emission materials in early childhood environments. Biophilic materials—such as wood, plant-based elements, or natural fibres—fit well within this preference when compliant with cleaning and safety standards.

**Impact Analysis**

Trend: [Diagram showing a blue arrow pointing right, a blue arrow pointing up-right, and a blue arrow pointing down-right]

Effect: [Diagram showing a blue triangle labeled 'Temporary' and a blue square labeled 'Continuous']

Opportunity/Threat: [Diagram showing a green bar on the left and a red bar on the right]

**Evidence/Examples**

VOC exposure is linked to respiratory issues and cognitive impacts in children.  
**Source:** Mendell, M. et al. (2013). *Indoor Environmental Quality and Children's Health.*

Health Canada identifies childcare centres as priority sites for reducing chemical exposures.  
**Source:** Health Canada. (2020). *Guidelines for Indoor Air Quality.*

Parents increasingly choose low-VOC, non-toxic materials for early childhood settings.  
**Source:** NielsenIQ. (2022). *Global Sustainability Report.*

Natural materials can support well-being and lower chemical exposure, aligning with biophilic principles.  
**Source:** Kellert, S. (2018). *Nature by Design: The Practice of Biophilic Design.*

Card-ID: Pol-01

### Political

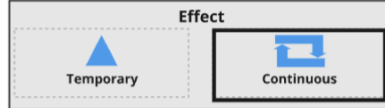
#### Issue

CCEYA  
Restrictions on  
Natural  
Materials and  
Cleaning  
Requirements

#### Description

Ontario's Child Care and Early Years Act (CCEYA), along with Toronto Public Health IPAC guidelines, requires all materials in childcare environments to be smooth, non-porous, and easily disinfected. As a result, directors often avoid natural elements such as untreated wood,

#### Impact Analysis



#### Evidence/Examples

CCEYA mandates that all materials must be "easily cleaned and disinfected."  
**Source:** Ontario Ministry of Education. (2023). *CCEYA Licensing Manual*.  
IPAC guidelines strongly discourage porous materials in childcare.  
**Source:** Toronto Public Health. (2018). *IPAC for Childcare Settings*.  
Post-pandemic inspections emphasize sanitation and material compliance.  
**Source:** Public Health Ontario. (2021). *Environmental Cleaning in Childcare*.  
Natural materials support regulation and sensory development but are often disallowed under sanitation rules.  
**Source:** Chawla, L. (2015). *Benefits of Nature Contact for Children*.

Card-ID: Pol-01

### Political

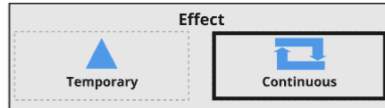
#### Issue

Lack of Clear  
Policy Guidance  
on Biophilic  
Indoor  
Interventions

#### Description

Although Ontario policy frameworks emphasise outdoor play and nature connection, none provide guidance for **indoor** biophilic design. The absence of official recommendations creates uncertainty for directors who wish to incorporate natural materials indoors while remaining compliant with health and sanitation guidelines. This policy gap leaves implementation up to interpretation, limiting system-wide adoption.

#### Impact Analysis



#### Evidence/Examples

*How Does Learning Happen?* discusses nature but NOT indoor biophilic guidance.  
**Source:** Ontario Ministry of Education. (2014). *HDLH*.  
The CCEYA Licensing Manual outlines safety but includes **no** section on indoor nature integration.  
**Source:** Ontario Ministry of Education. (2023). *CCEYA Manual*.  
Educators experience

Card-ID: Pol-01

### Political

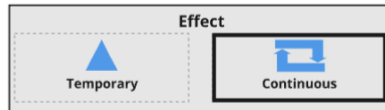
#### Issue

Rapid Childcare  
Expansion  
Prioritizes  
Capacity Over  
Quality

#### Description

The Canada-Ontario CWELCC agreement aims to rapidly expand affordable childcare spaces. While this expansion is necessary, the policy framework focuses heavily on access and affordability rather than environmental quality. Many new or retrofitted spaces are built with minimal consideration for biophilic design, natural materials, or sensory-rich environments, as operators prioritize meeting expansion targets.

#### Impact Analysis



#### Evidence/Examples

CWELCC policy is structured around affordability, access, and workforce — **not** environmental quality.  
**Source:** Government of Canada. (2021). *CWELCC Agreement*.  
Rapid expansion risks undermining quality without parallel investments.  
**Source:** Friendly, M. et al. (2022). *A Roadmap to Quality Early Learning*.  
Workforce shortages divert funds away from environmental improvements.  
**Source:** CSLS. (2024). *ECE Labour Shortage Report*.  
The physical environment is a key factor in program quality but remains underfunded.  
**Source:** Cleveland, G. (2018). *The Costs of Quality Childcare*.

**Card-ID: Pol-01** **Values**

**Issue**

Societal Shift  
Toward  
Sustainability and  
Regenerative  
Design

**Description**

There is a growing cultural movement toward sustainability, circularity, and regenerative practices across consumer behaviour, design, and education. Families increasingly value environmentally responsible materials and low-impact products. This shift creates momentum for biophilic design and nature-integrated learning environments in childcare.

**Impact Analysis**

**Trend**

**Effect**

Temporary Continuous

**Opportunity/Threat**

**Evidence/Examples**

Canadians increasingly prioritize sustainable and regenerative products.  
**Source:** NielsenIQ. (2022). *Global Sustainability Report*.  
 Regenerative design movements growing in architecture and education.  
**Source:** Mang, P. & Reed, B. (2015). *Regenerative Development and Design*.  
 Parents expect eco-friendly materials in children's environments.  
**Source:** Williams, J. (2020). *Sustainability Expectations in Education Spaces*.  
 ECE research highlights sustainability as a core pedagogical value.  
**Source:** Elliott, S. (2015). *Sustainability in Early Childhood Education*.

**Card-ID: Pol-01** **Values**

**Issue**

Parental  
Expectation for  
Emotionally  
Supportive,  
Sensory-Calming  
Environments

**Description**

Parents today prioritize environments that support emotional well-being, sensory regulation, and calm behaviour. With rising awareness of stress, anxiety, and dysregulation in children, families value childcare settings that feel warm, natural, and nurturing. Biophilic design aligns strongly with these values through its calming sensory effects.

**Impact Analysis**

**Trend**

**Effect**

Temporary Continuous

**Opportunity/Threat**

**Evidence/Examples**

Parents report increased concern about children's anxiety and emotional stress.  
**Source:** Patrick, S. et al. (2020). *Pandemic Impacts on Child Emotional Health*.  
 Biophilic design reduces stress and supports emotional regulation.  
**Source:** Kahn, P. (2012). *Human Relationship With Nature*.  
 Natural materials help reduce overstimulation in early learning.  
**Source:** Kuo, M. (2015). *Nature and Well-being*.  
 Parents increasingly seek calming alternatives to digital overload.  
**Source:** Canadian Paediatric Society. (2019). *Digital Media and Children*.

**Card-ID: Pol-01** **Values**

**Issue**

Diverse Cultural  
Relationships  
With Nature,  
Risk, and Messy  
Play

**Description**

Toronto's cultural diversity brings a wide range of attitudes toward nature, safety, risk-taking, and messy play. Some families embrace exploration, dirt, and natural materials; others value cleanliness, order, and controlled environments. Understanding these cultural expectations is essential for designing biophilic interventions that are respectful, inclusive, and communicable to all families.

**Impact Analysis**

**Trend**

**Effect**

Temporary Continuous


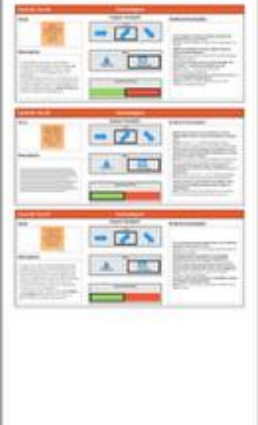




**Opportunity/Threat**

**Evidence/Examples**

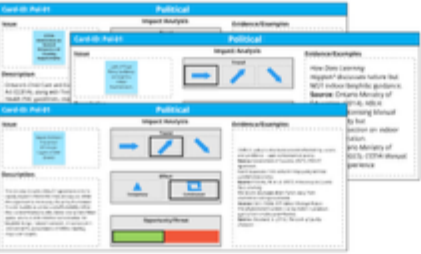



Cultural background shapes comfort with nature, risk, and messy play.  
**Source:** Little, H. & Wyver, S. (2008). *Outdoor Play and Risk-taking*.  
 Families differ widely in expectations for cleanliness and safety.  
**Source:** Rogoff, B. (2003). *The Cultural Nature of Human Development*.  
 Children's nature experiences decline after immigration to dense urban areas.  
**Source:** D'Souza, J. (2011). *Urban Migration and Nature Access*.  
 Cultural context influences how parents interpret nature-based learning.  
**Source:** Tsevereni, I. (2021). *Children, Nature and Culture*.

(AJ&Smart et al.)

- Signals categorized

S	T	E	E	P	V
Social	Technological	Economic	Environmental	Political	Values
					

(AJ&Smart et al.)

Themes	Issues	Implications
<p><b>Regulatory Tensions Between Safety &amp; Well-Being</b></p> <p>Childcare regulation in Ontario prioritizes sanitation, safety, and compliance—yet children’s well-being, sensory needs, and access to nature increasingly require more organic, textured, and biophilic environments. The tension between regulation and developmental science shapes what is possible indoors. This theme captures the systemic mismatch between what the law enforces and what children need.</p>		<p>Develop <b>compliant biophilic prototypes</b> → sealed, cleanable, modular nature elements. MRP findings can inform <b>policy adjustments</b> or new provincial guidance. Opportunity to create templates/resources for centres unsure how to balance safety + nature. Centres seeking quality improvements may welcome low-effort, compliant biophilic</p> <p>Natural materials removed by inspectors → innovation blocked. Centres default to plastic due to fear of non-compliance. Lack of IPAC-safe materials reduces feasibility of many natural interventions. Policy gaps create ambiguity and risk-aversion among directors.</p>
<p><b>Growing Demand for Well-Being, Regulation &amp; Sensory-Calm Environments</b></p> <p>There is a cultural, pedagogical, and parental shift toward prioritizing children’s emotional well-being, self-regulation, and sensory balance. Nature-based strategies—long validated in environmental psychology—align directly with these expectations, offering a non-digital, calming counterbalance to overstimulation and screen exposure.</p>		<p>Strong parental buy-in for biophilic design → easier adoption. Centres can use nature-based interventions to support mental health without relying on technology. Biophilic design aligns with ECE pedagogy (CALM → FOCUS → LEARN). Potential to demonstrate evidence of reduced dysregulation through your prototype.</p> <p>Children with high screen exposure may struggle more with attention + behaviour. Centres may focus solely on technological solutions to regulation (apps, AI tools). Lack of staff capacity to manage sensory environments properly. High expectations from parents may exceed resources.</p>
<p><b>Environmental Constraints Are Increasing Indoor Responsibility</b></p> <p>Urban densification, climate change (heat, smoke), and inequality in park access are reducing children’s opportunities for outdoor nature play. This shifts responsibility to <b>indoor environments</b> to deliver sensory richness, restorative experiences, and exposure to nature.</p>		<p>Indoor biophilic design becomes <b>essential</b>, not optional. Centres in park-deficient areas may adopt indoor nature solutions quickly. IAQ improvements + biophilia → holistic “healthy indoor environment”. Climate adaptation strategies can incorporate biophilic design.</p> <p>Outdoor play becomes unreliable due to heat, smoke, weather. Centres face increased behavioural challenges during long indoor periods. IAQ improvements may focus only on mechanical systems (HEPA, CO<sub>2</sub>) → nature overlooked. Rising inequities between centres with outdoor access vs. those without.</p>
<p><b>Cultural and Value Shifts Toward Sustainability &amp; Inclusion</b></p> <p>Families, educators, and society place growing emphasis on sustainability, regenerative design, cultural inclusion, and toxin-free materials. Diverse cultural relationships with nature and risk shape how families interpret biophilic interventions. Understanding and respecting these values is essential for designing inclusive indoor nature experiences.</p>		<p>Biophilic design directly aligns with sustainability and regenerative design values. Centres can use nature-based elements to reflect cultural identity and community connection. Low-VOC natural materials improve indoor ecological health.</p> <p>Some families may resist messy/natural materials (soil, insects, dirt). Low-VOC or regenerative materials may be more expensive → equity issues. Misalignment between cultural expectations and biophilic practices may create tension. Sustainability expectations increase pressure on centres lacking funding.</p>

## **Appendix E — Regulatory Constraints and Design Implications (CCEYA & IPAC)**

This appendix presents a synthesized summary of key regulatory considerations derived from the Child Care and Early Years Act (CCEYA) and Infection Prevention and Control (IPAC) guidelines, and how these constraints informed design decisions within this study. Rather than prescribing specific design solutions, these frameworks establish conditions related to hygiene, safety, supervision, and material use that must be considered in early childhood environments.

<b>Category</b>	<b>Regulatory Consideration</b>	<b>Source</b>	<b>Design Implication in This Study</b>
Materials & Hygiene	Use of cleanable, non-porous surfaces to reduce contamination risk	Public Health Ontario (2018)	Selection of acrylic, sealed wood, and wipeable surfaces; avoidance of raw porous materials in direct contact areas
Infection Control	Materials must withstand regular cleaning and disinfection	Public Health Ontario (2018)	Material testing included response to cleaning products and repeated handling
Living Systems	Soil and organic matter may introduce contamination risks if exposed	Public Health Ontario (2018)	Tier 1 planter contained soil within a closed acrylic system; limited direct contact; Tier 2 avoided exposed live plants
Safety	Elimination of sharp edges and hazardous components	Ontario Ministry of Education (2014)	Rounded edges, soft forms, and impact-resistant materials were prioritized
Supervision & Visibility	Environments must allow clear sightlines for caregivers	Ontario Ministry of Education (2014)	Tier 2 nook designed to suggest enclosure without full visual obstruction
Accessibility & Use	Objects must be safe for independent child interaction	Ontario Ministry of Education (2014)	Interventions designed for autonomous use without reliance on continuous adult facilitation
Maintenance	Materials and elements should be manageable within daily routines	Public Health Ontario (2018)	Avoidance of fragile or high-maintenance elements (e.g., exposed plants in Tier 2)
Spatial Constraints	Interventions must fit within existing environments without structural modification	Ontario Ministry of Education (2014)	Use of portable, small-scale interventions rather than fixed installations