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Young Children's Contributions to Sustainability: The Influence of Nature Play on Curiosity, Executive Function Skills, Creative Thinking, and Resilience

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Abstract: Environmental education for young children has great potential for fostering the skills, values, and dispositions that support sustainability. While North American guidelines emphasize the importance of using the natural world for open-ended exploration, discovery, and play, this approach has been criticized for lacking the transformative power necessary for meaningfully contributing to sustainability issues. Four pilot studies were conducted exploring the influence of nature play in the context of nature preschools on children's curiosity, executive function skills, creative thinking, and resilience. These studies used established quantitative instruments to measure growth in these constructs among nature preschool participants, comparing this growth with participants in high quality, play-based, non-nature preschools. The results suggest a positive contribution of nature play, with greater levels of curiosity, creative thinking, and resilience than what was observed in the non-nature preschool participants, and executive function skills similar to the non-nature preschool participants and exceeding national norms. Collectively, these pilot studies suggest the potential contribution of nature play in the context of education for sustainability.

Keywords: early childhood environmental education; nature play; nature preschool; curiosity; creative thinking; executive function skills; resilience

1. Introduction

While the field of environmental education has long recognized the need for environmental education (EE) to be a lifelong process, efforts have generally focused on youth in the elementary and secondary grade levels. However, within the last decade, there has been growing recognition of the importance of EE for young children. Because of the importance of early childhood education in "laying a sound intellectual, psychological, emotional, social, and physical foundation for development and lifelong learning," EE for young children is described as having "enormous potential in fostering values, attitudes, skills, and behaviors that support sustainable development" [1] (p. 12).

At the early childhood level, EE can cultivate a child's sense of wonder, as well as a sense of who they are [2]. Research suggests EE experiences in early childhood support children's interest in and knowledge of nature [3], as well as the development of scientific and aesthetic thinking children [4]. Phenice and Griffore's research [5] indicates regular and positive interactions with nature are instrumental to helping children develop a respect and ethic of care for the environment. Research by Wells and Lekies [6] and Ewert, Place, and Sibthorp [7] suggest early experiences in nature influence attitudes and behaviors relating to the environment, having the potential to shape subsequent environmental paths as adults.

While there is growing consensus internationally regarding the need for EE to begin early in life [1], there are divergent views regarding what EE at the early childhood level should entail. One perspective is illustrated through the North American Association for Environmental Education's Early Childhood Environmental Education Programs: Guidelines for Excellence [8], which contain a set of key characteristics for guiding quality EE experiences for young children. One of the key characteristics is play and exploration, which emphasizes the importance of using the natural world and natural materials for open-ended exploration, discovery, and creativity. The framework for environmental learning characteristic emphasizes the importance of opportunities that span cognitive, social-emotional, physical, and language domains, as well as opportunities to develop environmental knowledge and skills. According to the guidelines, environmental learning is oriented toward developing a respect for the rights and feelings of others and a respect for nature, as well as developing curiosity. Environmental learning should also include opportunities to explore and investigate topics of young children's own choosing, as well as opportunities to make decisions about their own activities in an age-appropriate way (for example, participating in caring for living things).

The characteristics collectively are grounded in the belief that EE at the early childhood level is more than a cognitive learning process; EE needs to incorporate affective experiences that ground young children's developing knowledge, skills, and dispositions [8]. Because young children lack the coping skills and the cognitive level to make sense of complex environmental issues, and as often the needed actions to resolve these issues lie beyond the agency of young children, EE should focus on helping children bond with nature, laying the groundwork that may encourage examination of issues and taking action as they grow [8,9]. Consequently, play and exploration are used to foster in young children affective and experiential connections with nature, helping them bond with nature and laying the groundwork that may encourage examination of issues and appropriate action when they are older [8].

While participants at the international workshop in Sweden, The Role of Early Childhood Education for a Sustainable Society, emphasized the need for early childhood experiences rooted in authentic questions and local contexts, they maintained, however, that in order for early childhood EE to contribute to sustainable development, it needs to be more than experiences in local contexts and more than nature discovery [1]. Early childhood EE must include opportunities for concrete actions in favor of the environment, as well as opportunities for learning to be respectful of differences, and developing an identity as world citizens [1]. This perspective is echoed in the authors of the chapters in Research in Early Childhood Education for Sustainability [10]. Editors Davis and Elliott urge researchers and practitioners to recognize the competences of young children as "thinkers, problem-solvers, and agents of change for sustainability" [10] (p. 1). Across this text, the contributing authors challenge traditional environmental learning notions of young children, suggesting the need for a transformative shift toward learning that encourages young children to engage in sustainability issues in authentic and meaningful ways. While acknowledging their value, Davis and Elliot [10] suggest nature-focused approaches to EE impede thinking about young children's capabilities as social agents with rights to participate in decision-making and action-taking in sustainability issues relevant to them—locally and in broader contexts. They strongly advocate for a more critical, participatory orientation to EE with young children.

Elliot [11] further expands upon this perspective, suggesting "play in nature alone is not enough to address the complexities of sustainability in the current epoch of the Anthropocene" (p. 6). While she agrees that playing outdoors in nature is essential on many levels, Elliot [11] states nature play has been uncritically adopted by practitioners because it is a more comfortable space for them. She also suggests educators have misconceived nature play as education for sustainability, accepting a simplistic view that nature play prompts children to "readily adopt sustainable worldviews and ethics and be active citizens for sustainability" (p. 6). She further calls upon early childhood education to actively explore all dimensions of sustainability, from natural and cultural, to political and social dimensions, stating a need to "shift beyond the comfortable pedagogies of role modeling and scaffolding caring for

nature and engage in more challenging and responsive dialogic pedagogies exploring worldviews, ethics and values for sustainability" [11] (p. 6). Further examples of the critical and transformative pedagogy needed include problem-posing, advocacy, and action [11].

A question that emerges from this diverging viewpoint is what contribution to global sustainability, if any, is made through the pedagogical practice of nature play? The EE research literature has long put to rest the faulty assumption of a direct and linear pathway to pro-environmental behavior [12]. Similarly, while connectedness to nature is not a sole, nor potentially even necessary, antecedent to sustainable actions, the proposed pathway from place-based nature experiences to nature connectedness and its relationship to environmental concern and behaviors is grounded in a body of empirical studies (see [13] for a discussion of these studies, including a call for greater consideration of the covariance and complexity in studying antecedents to behavior and cautioning against profession-level relapse into simplicity and reductionism). Beyond affective and experiential bonds with nature, what else might nature play contribute to the complexities of sustainability in the current epoch? Can it contribute as a developmentally-appropriate pedagogy for young children, as described and recommended in the Early Childhood Environmental Education Programs: Guidelines for Excellence [8]? Or is a reorientation of the nature play movement needed toward more critical and transformative pedagogies that "not only lift consciousness of sustainability issues, but also involve children and their families in advocacy and action" [11] (p. 6)? This divergence is the backdrop for a set of four pilot studies that collectively sought to explore the influence of nature play on four outcomes that are important in both sustainability and early childhood learning and development contexts: Curiosity, executive function skills, creative thinking, and resilience. Collectively, these exploratory studies suggest a potential value for nature play, beyond serving as a "cure for the lifestyle maladies of contemporary childhood" [14] (p. 160), toward a meaningful contribution in the quest for a sustainable future.

2. Literature Review

2.1. Nature Play and Nature Preschools

According to the Early Childhood Environmental Education Programs: Guidelines for Excellence [8], frequent opportunities to explore, observe, and play in natural environments is a cornerstone of excellence in early EE. Play and exploration in nature are well aligned with early childhood pedagogy [2]. Play is a fundamental avenue for early childhood learning and deeply rooted within early childhood education as the primary way for meeting children's development requirements [15]. Due to the high level of development during this time, it is well-established in the research literature that playful and active, physical and sensory experiences are critical particularly during the first five years [16]. The American Academy of Pediatrics published a report on the influence of play on healthy child development, which summarizes the benefits of play in this way:

> It is through play that children at a very early age engage and interact in the world around them. Play allows children to create and explore a world they can master, conquering their fears while practicing adult roles, sometimes in conjunction with other children or adult caregivers. As they master their world, play helps children develop new competencies that lead to enhanced confidence and the resiliency they will need to face future challenges. Undirected play allows children to learn how to work in groups, to share, to negotiate, to resolve conflicts, and to learn self-advocacy skills. When play is allowed to be child driven, children practice decision-making skills, move at their own pace, discover their own areas of interest, and ultimately engage fully in the passions they wish to pursue [17] (p. 183).

Quality play necessitates access to a diversity of elements and surfaces [18]. Natural settings provide a variety of spaces and ground cover, loose parts that can be manipulated by children, and the possibility of 'chance' events [19]. Thus, natural settings offer the diversity, variability, and open-endedness needed to engage and challenge young children, thereby enhancing the opportunity for learning and developing through play [20]. Since nature provides such rich and varied sensory

stimuli, it is perhaps not surprising that nature experiences have been associated with improved physical health and development [3], psychological well-being [21], and cognitive functioning in children [22].

Nature play, which is defined as freely chosen, unstructured, and open-ended playful interactions with and in nature [23] provides opportunities for children to take risks, become actively and fully engaged in their surroundings, solve problems, and be curious and creative [24]. As research connecting natural outdoor environments and children's well-being continues to grow, there is renewed interest at both the policy and practice levels in many countries to encourage access to outdoor and specifically natural spaces for nature play. For example, in England there is a strong policy agenda linked toward quality outdoor play spaces that incorporate natural features. In the Anji Province of China, there is a growing focus on using minimally-structured, open-ended environments in community and school settings to allow children to explore, discover, imagine, and create through play. Teachers are trained to maximize opportunities for play-based, joyful learning through contact with natural phenomena and elements, such as bamboo, water, sand, hills, and ditches. In the Scandinavian countries and growing internationally, there are efforts to provide these nature play experiences for young children through the educational context of forest kindergartens.

Nature preschools have become a mechanism in the U.S. for early childhood educators to provide young children with opportunities to experience nature play on a frequent and on-going basis. Nature preschools are a rapidly growing movement within the U.S., with approximately 250 nature preschools operating across the country and growth seen internationally [25]. While similar in philosophy to the forest kindergartens of Europe, forest kindergartens tend to take place entirely outdoors, whereas nature preschools often have an indoor setting that is used for a portion of the day, with the majority of the time spent outdoors [26]. Nature preschools and forest kindergartens use child-initiated play in nature to support both child development across all domains and the development of an ecological identity or environmental ethic. Nature preschools and forest kindergartens generally use an emergent curriculum, where the daily activities unfold in response to children's interests and curiosity. (See Larimore [26] for an expanded definition and characteristics of nature preschools, as well as for where they fit within a taxonomy of early childhood EE).

2.2. Curiosity

One of the four outcomes of interest in the pilot studies at hand is curiosity. Curiosity is the desire to acquire new knowledge and experiences. It has also been described as a motivation for exploratory behavior and for seeking answers to what is unknown [27]. Researchers often place curiosity within the broader category of information-seeking exploratory behavior, with curiosity being a special form that is internally motivated, whereas the broader term refers to a drive that can be intrinsic or extrinsic [28]. The circularity of the terms curiosity and exploratory behavior (gathering information about the environment), however, make defining and delineating it difficult, as curiosity is used as both a description of the behavior and the hypothetical construct to explain the same behavior. Berlyne's two-dimensional framework is often used to define and describe curiosity [29]. In this framework, there are two dimensions. The motivational dimension spans between perceptual (the instinctual exploratory behavior that can be observed in humans and in other animals) and epistemic (novel stimuli-seeking behavior oriented toward dispelling uncertainties and acquiring knowledge). The second dimension of curiosity, the behavioral dimension, spans between diversive (general desire for perceptual or cognitive stimulation) vs. specific (desire for a particular piece of information and to persist or preserve in obtaining that information). While diversive curiosity (or idle curiosity) can be pleasant, it is also described as a more shallow form of curiosity, or even a distraction, that rarely produces deep understanding or insights [30]. While diversive curiosity serves a purpose of seeking out experiences, it must be allowed to deepen and mature in order for it to become the purposeful curiosity that drives inquiry, discovery, and innovation [30].

Curiosity is particularly valued in young learners, as it is a chief component that drives both their exploration and their refinement of perceptions as they gather information and learn from their environment [24]. In learning contexts, curiosity is often paired with initiative and persistence. While curiosity is the desire to know, initiative and persistence are about the ability to develop a plan to find out and to persist in satisfying one's desire to know [24]. Collectively they are described as "primary engines that drive children out into the world," compelling them to "ask questions, initiate interactions, make choices, express interest, and direct their growing independence" [24] (p. 20). Through curiosity, initiative, and persistence, children become primary agents in their own learning, becoming skilled in observing the world in expansive ways, formulating meaningful questions, and discovering their own answers [24]. Additionally, curiosity is associated with greater kindergarten reading and math achievement, and accordingly is highlighted among academic and even pediatric guidelines as a foundation for early learning [27].

From a sustainability context, curiosity is an important driver of inquiry learning and is considered foundational in scientific literacy. As explorations, discoveries, innovations, and inventions often originate with curiosity, there is a strong underlying contribution of curiosity to sustainability-related issues. Curiosity-driven basic research is described as a prerequisite for welfare, innovation, and societal progress, and key to solving many serious environmental and social problems [31]. From the perspective of early childhood education for sustainability, engaging children's innate curiosity provides a foundation for a connection to their place and a motivation to deepen their learning that can ground future habits of caring and action [32].

2.3. Executive Function Skills

Another outcome of interest in the pilot studies at hand is executive function skills. Housed in the prefrontal cortex of the brain, executive function skills are comprised the subskills working memory, cognitive flexibility, and inhibitory control [33]. Cognitive flexibility involves being able to think about something in different ways or to switch between rules or mental sets. Working memory involves retaining, updating, and manipulating information. Inhibitory control is the skill of consciously suppressing attention and dominant or automatic response to a stimulus. Collectively these skills allow for everyday functioning, accomplishing tasks, and planning for the future. The malleability of this area of the brain is heightened in early childhood and again in early adolescence. Heightened malleability during these time periods of life means that experiences have a more influential impact on the wiring of the brain than during other periods of the lifespan [34].

It is crucial for children to develop executive function skills as they are the foundation for learning and goal achievement, not only in academic contexts but throughout life. While preschool-level executive function skills are predictive of children's readiness to enter kindergarten in both academic and social-emotional dimensions, they also are predictive of overall life success including academic achievement throughout the school years, social competence, physical health, and future socioeconomic status [34]. Further, researchers suggest executive function skills are a better predictor of both short and long-term academic achievement than IQ [34].

From a sustainability context, executive function skills contribute to the conscious, goal-directed planning, and follow-through abilities needed for environmental problem-solving and policy making. Executive function skills allow one to focus on tasks, adjust to changes, understand how, and recognize when different scenarios or issues may require different "rules" or actions. They also allow one to filter and halt thoughts or impulses. These skills are all influential in the way one interacts within one's family, community, school and work place, rippling into the broader ecosystem. Further, executive function skills, when combined with creative thinking, are very relevant to the vital role of vision, imagination, and intention in creating a desired future [35].

2.4. Creative Thinking

A third outcome of interest in the pilot studies at hand is creative thinking. Creative thinking is novel thinking that produces ideas of value [36]. It is a multi-dimensional construct that includes the dimensions of fluency, flexibility, elaboration, and originality [37]. Fluency is the ability to quickly produce many ideas that are relevant and follow specified requirements. Flexibility is the ability to discard familiar ideas in order to develop new ideas. Elaboration is building upon or improving an idea, and originality is the ability to develop unique ideas that have purpose and meaning in a particular situation. While not included in all models and assessments of creative thinking, imagination is also considered to be a dimension of creative thinking. Imagination refers to the ability to develop mental representations of things or ideas that are not immediately present to the senses, enabling one to move beyond the current moment in time and place in order to plan for the future, create a new world, or consider alternatives [38].

Creativity thinking allows one to solve problems, recognize patterns, combine information in new ways, challenge assumptions, make decisions, and seek new ideas [24]. The development of these skills is particularly valuable in the context of early childhood development, as these skills affect all areas of development and are powerful ways in which children come to know the world and themselves [24]. Creative thinking is integral to adapting knowledge to new contexts and enables children to "put things together in new ways, form new associations and connections, and come to new understandings" [24] (p. 76).

Creative thinking also has significant implications in the context of sustainability. Because there are no fixed nor direct pathways to sustainability, creative thinking is an essential component. Creativity, when combined with curiosity, stimulates the construction of knowledge and drives the refinement, communication, and execution of ideas. Creative thinking is also needed for being open to new perspectives, understanding real-world limits, and viewing failure as an opportunity [39]. Through the dimensions of fluency, elaboration, and originality, creative thinking is a driver of innovation. The dimension of cognitive flexibility can provide a buffering effect in the face of uncertainty and help move one out of unsustainable actions and lifestyles. For these reasons, creative thinking has been acknowledged as being integral to addressing complex and dynamic issues, such as climate change, biodiversity loss, and resource depletion [40].

2.5. Resilience

The final outcome of interest in the pilot studies at hand is psychological resilience. Commonly described as the ability to bounce back from difficult times, psychological resilience is the human capacity to cope with stress and adversity [41]. With advances in the ability to study the neurobiology of resilience, resilience is now recognized to be embedded in complex, adaptive, and interacting systems that shape the course of development from the molecular to the macro-levels of physical and sociocultural ecologies [41]. Consequently, resilience is defined as the capacity of a dynamic system to adapt successfully to disturbances that threaten system function, viability, or development [42]. Psychological resilience is dynamic, contextual, and malleable; it is not an attribute that children do or do not possess. There are, however, a set of protective mechanisms that seem to give rise to successful adaptation in the face of adversity [43]. These protective factors include dispositions and skills within a person (e.g., problem-solving skills, initiative, self-efficacy, a sense of purpose in life, self-regulation skills, initiative, persistence, etc.), as well as contextual factors (e.g., positive relationships with caring adults, effective parenting, positive social relationships, and effective schools and teachers [44]). These protective factors and mechanisms can be drawn upon in the face of stress and adversity.

While resilience can be developed and exhibited at any age, there are certain windows of opportunity that are more conducive to fostering the development of protective factors and harnessing the power of protective systems that can lead to successful adaptation in the face of adversity [41]. Early childhood is one of those windows of opportunity, as brain plasticity is surging [44]. Studying psychological resilience and increasing children's protective factors is relevant and timely, particularly

as so many children face daily or on-going threats to their healthy development and as societal concern regarding the decline of resilience and prevalence of childhood depression and anxiety grows [45].

In the context of sustainability and the growing and complex issues faced, psychological resilience is also highly relevant and important. The ability to demonstrate resilience in the forms of coping (functioning well under currently adverse circumstances or conditions), self-righting (recovery to normal functioning after catastrophic adversity), and transforming (positive reorganization of systems, such that adaptive functioning is better than it was prior to adverse experiences) [42] can help one respond and adapt to undesirable changes in the surrounding environment that are already underway. Further, higher levels of the protective factor of initiative are associated with higher levels of responsibility, as well as with skills and qualities such as organizing activities, solving problems, enjoying challenges, and displaying self-awareness [46]. Similarly, higher levels of the protective factor of self-regulation, or the ability to express emotions and manage behavior in healthy ways, are associated with the dispositions of being patient and cooperative, and those with higher levels of self-regulation tend to be more respectful and considerate and are better able to negotiate differences with others [46]. All of these associated skills and qualities can assist one in working effectively with others toward mitigating further negative effects of less-than-sustainable lifestyles. Collectively through these skills and dispositions, personal psychological resilience contributes to socio-ecological resilience.

2.6. Synthesis

The importance of natural, playful experiences for young children has long been recognized. Early educational theorists such as Froebel, Dewey, and Montessori emphasized the role of nature experiences for young children's health, development, and well-being. As research connecting natural outdoor environments and children's well-being continues to grow, there is renewed interest at the policy and practice levels in many countries to encourage access to natural outdoor spaces for nature play. However, much of the existing research literature is in the context of supporting children's health and well-being, rather than nature play's contributions to the serious and complex sustainability challenges of the current epoch.

While North American guidelines emphasize the importance of using the natural world for open-ended exploration, discovery, and play, this approach has been criticized internationally for lacking the transformative power necessary for meaningfully contributing to sustainability issues. With further research on the impact of nature play on developmental outcomes that are relevant to sustainability, the field of early childhood EE can better respond to these critiques and more effectively consider how to contribute to a more sustainable future in age- and developmentally-appropriate ways. Thus, the set of pilot studies undertaken focused on four constructs that are relevant not only to the development and well-being of young children, but also to the dynamic and complex sustainability challenges currently faced. The four constructs studied were curiosity, executive function skills, creative thinking, and resilience.

3. Materials and Methods

The purpose of the four pilot studies was to explore the influence of nature preschools on four outcomes that are important in both sustainability and early childhood learning and development contexts. These four pilot studies were undertaken during the 2016–2017 and 2017–2018 academic years using a pretest-posttest non-randomized comparison group design. Pretests were administered at the beginning of the academic year (September), and posttests were administered toward the end of the academic year (April–May).

Four nature preschools in northern Minnesota served as the treatment group, and two non-nature preschools in northern Minnesota served as the comparison group. Of the four nature preschools, one was affiliated with a nature center, two were operated out of homes and licensed as family childcare providers, and one operated out of a church under a specialized family childcare license. At each of these four nature preschools, there was a caring, responsive lead teacher who had been at that

particular nature preschool since its inception, serving not only as the lead teacher, but also the founder and director. All four utilized a combination of unmaintained ("wild") natural settings, natural spaces that were minimally managed for nature play, and natural playscapes designed specifically for nature play. Each had indoor areas that were used minimally throughout the day. A child-directed approach was used at all four of these nature preschools, with the majority of time spent in free play outdoors in unmaintained or minimally maintained natural settings regardless of weather conditions (approximately four to five hours daily of play in and with nature).

While the intent was to include four non-nature preschools in the control group, it was difficult to find non-nature preschools who were willing to participate, due to concerns about further testing their children and because of the perceived time intensive nature of research participation for both parents and teachers. The two non-nature preschools were selected based on their willingness to participate, and due to being located in a similar geographic location, having a similar tuition structure, and being of a similar demographic make-up. One of the non-nature preschools was administered by the local university, and the other was affiliated with a local parochial elementary school. Both non-nature preschools had experienced teachers, with a teaching style that similarly could be described as caring and responsive. The guiding philosophy at both non-nature preschools emphasized child-directed play for supporting development across the domains, with the majority of time spent indoors in free or loosely guided play (four to five hours), with about one hour daily of teacher-led playful learning. Children at both non-nature preschools had one to two hours of daily outdoor playtime (weather permitting) in a maintained outdoor space that contained playground equipment. The cost for attending this non-nature preschool was similar to the costs associated with the nature preschools, and therefore it was assumed that participants across the nature and non-nature preschools were relatively similar in terms of economic background, as well as similar in terms of age, gender, race, and ethnicity.

Thus, participants across the preschools shared similar demographic characteristics and experienced caring and responsive teachers and a child-centered, play-based, developmentally-appropriate preschool program that aimed to support holistic development across the domains. The primary difference between the nature and non-nature preschools was in the proportion of the day spent outdoors and the location of the outdoor play time (in nature vs. in maintained outdoor setting). These shared characteristics allowed for exploring the potential influence of sustained nature play (play that takes place in and with nature) on the four outcomes of interest, beyond what one might expect to see from a high quality, play-based non-nature preschool program.

Following Institutional Review Board approval of the research protocol, all children at the participating preschools were invited to participate through the parent consent process. Parent consent rates were high across all of the programs (90–100%). Details regarding the participants, research instruments, and data analysis are provided in the following sections, in the context of the results for each of the four pilot studies.

4. Results

4.1. Curiosity Pilot Study

Curiosity was assessed using the Curiosity Drawer Box task. This assessment, developed by a psychologist at the University of Minnesota's Institute of Child Development [47], is a measure of object curiosity, or the desire to know and explore how things work and function, as well as the desire to acquire new information about things. This assessment procedure is administered individually to children and involves providing the child with a small box with 12 drawers, with each drawer containing a different small toy of moderate novelty (wind-up toy, pop-up toy, small puzzle, maze, miniature Rubix cube, little car, miniature binoculars, etc.). The child is invited to play with the box until they are finished (up to a maximum of 20 min). Other than the initial verbal invitation to the child to play with the box of toys, the observer/researcher is to remain passive and not further interact with

the child, but just record the child's interactions with the curiosity drawer box. The observer/researcher records the number of toys the child takes out, the number of toys that are explored, and the number of toys that the child engages with further. The number of toys taken out reflects diversive curiosity (a desire for novel stimuli) in Berlyne's framework [29]. The number of toys that are explored (held, touched, looked at, turned over, and/or examined) reflects information-seeking exploratory behavior reflective of specific curiosity on Berlyne's framework. The number of toys the child engages with further (attempting to solve, manipulating the object, and/or playing with the object whether that be in the intended way or in a more imaginative way) reflects information-seeking exploratory and/or play behavior that integrates initiative and persistence with curiosity, toward sense-making and refinement of perception. This measure of further engagement with the novel toy suggests a deeper or stronger level of specific curiosity, with persistence or perseverance in obtaining the information sought.

There are a total of 12 possible points (one point per drawer) for each of these three dependent measures (toys out, toys explored, toys engaged with further), with higher numerical scores indicating higher levels of the respective forms of curiosity. If a child returns to a drawer or toy after having already opened that draw or interacted with that toy, he/she does not receive additional points. (See [47] for additional information on the development and testing of this instrument, as well as for psychometric properties of the instrument).

Due to the time involved in administering this instrument, two of the four nature preschools were invited to participate (the two preschools with fewer participants) during the 2017–2018 school year. There were 34 nature preschool participants in the study from the two nature preschools combined, and 43 participants from the two non-nature, play-based preschools. General linear modeling (univariate analysis of covariance) was used to investigate differences between the nature preschool and non-nature preschool participants' posttest curiosity levels, when adjusting for (statistically controlling for or holding constant) pretest level, age, gender, and prior participation (see Figure 1). Race and ethnicity were not used as covariates, due to the homogenous nature of the participants.

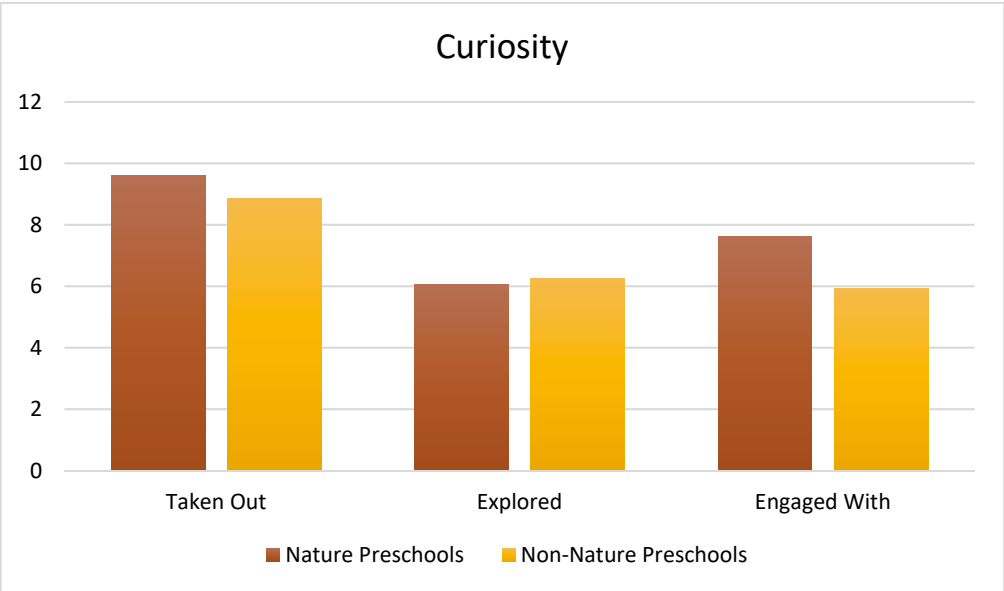


Figure 1. Comparison of nature and non-nature preschool participants' adjusted curiosity posttest means.

The results of the three analyses of covariance suggest a significant model for toys taken out and toys engaged with: $F(5) = 6.05$, $p < 0.001$ and $F(5) = 6.30$, $p < 0.001$, respectively; the model for toys examined was not significant, $F(5) = 1.26$, $p = 0.29$. The pairwise comparison of adjusted posttest means (when controlling for pretest, age, gender, and prior participation) for toys taken out indicate no significant difference between nature and non-nature preschool participants ($p = 0.21$, $\eta_p^2 = 0.02$).

Similarly, there was not a significant difference between nature and non-nature preschool participants for adjusted posttest means of toys explored ($p = 0.83$, $\eta_p^2 < 0.01$). The pairwise comparison for toys engaged with, however, indicated a significant difference, with nature preschool participants having a significantly higher posttest level than non-nature preschool participants, when controlling for pretest, age, gender, and prior participation ($F(1) = 6.99$, $p = 0.01$, $\eta_p^2 = 0.09$). (See Table 1 for unadjusted pretest and posttest means, as well as the adjusted posttest means and significance values of these comparisons).

Table 1. Pretest and posttest curiosity means and standard deviations for nature and non-nature preschools.

		Pretest M (SD)	Posttest M (SD)	Adjusted Posttest M (Stnd. Error) [1]	Statistical Significance [3] of Pairwise Comparisons of Adj. Posttest Means
Toys Taken Out	Nature [2]	8.38 (3.39)	9.76 (2.86)	9.61 (0.46)	$p = 0.21$
	Non-Nature [2]	7.81 (4.19)	8.73 (3.14)	8.85 (0.40)	
Toys Explored	Nature [2]	6.44 (3.09)	6.47 (3.56)	6.05 (0.66)	$p = 0.83$
	Non-Nature [2]	3.50 (2.71)	5.91(3.65)	6.24 (0.57)	
Toys Engaged With	Nature [2]	4.15 (2.60)	7.62 (2.58)	7.61 (0.48)	$p = 0.01$ **
	Non-Nature [2]	4.23 (2.89)	5.91(3.46)	5.92 (0.42)	

[1] Adjusted for the covariates of pretest, age, gender, and prior participation. [2] N = 77; 34 nature preschool participants and 43 non-nature preschool participants. [3] ** Denotes significance at the 0.01 level.

These results suggest nature play may not have influenced children's desire for novel stimuli (diversive curiosity) and information-seeking exploratory behavior beyond what might occur through non-nature play in preschool and/or cognitive maturation. However, the results suggest nature play may have had a significant positive effect (of a moderate effect size) on children's initiative to further act upon curiosity, persisting beyond initial information-seeking exploratory behavior toward increased sense-making through further exploration and play. While a desire for novel stimuli and initial information-seeking exploratory behavior can serve a purpose in learning, they also can detract from the deeper and more purposeful forms of curiosity that allow for refinement of perception toward sense-making. This higher level, more mature form of curiosity represents the deepening of a simple seeking of newness into a directed attempt to build understanding, and thus is valued not only from a child development perspective, but also valued in terms of contributions in a sustainability context.

Studies suggest that children seek out situations where there is uncertainty and preferentially play with toys where the mechanisms are not yet understood [48]. It seems plausible that the variety, uncertainty, and the ever-changing nature of nature provides opportunities for children to develop and deepen their curiosity, beyond what could be experienced in an indoor setting. Research further suggests children seem to structure their play in order to "de-confound" or make sense of variables when causal mechanisms at play in the world are unclear, and that they also appear to structure their play to make efficient use of information that they encounter in the world to learn correct causal structures [48]. These findings suggest children's curiosity is particularly conducive to learning about the world around them. Because these strategic information-seeking behaviors in young children are far more sophisticated and desirable than the simple attentional novelty-seeking behaviors, the potential positive influence of nature play on children's deepened information-seeking exploratory behavior shows great promise in terms of contributions to sustainability. Yet caution is needed in interpreting and generalizing from these results, given the small and homogenous sample of participants, and further research is warranted.

4.2. Executive Fucntion Skills Pilot Study

The instrument used in this study was the Minnesota Executive Function Scale (MEFS) [49], which is an assessment developed at University of Minnesota's Institute of Child Development to assess executive function skills in young children. This instrument was based upon the dimensional change

card sort, a measurement tool that has been used in hundreds of executive function studies [49]. The MEFS is unique in that it can be used with children as young as two years old and takes only an average of four minutes to administer.

The instrument is administered through an app downloaded onto an iPad or touch screen table. The app uses a game-like interface and adjusts based on the child's age and response. The child is prompted (through instructions on the screen read by the administrator of the test) to sort (by dragging) virtual cards on the screen to virtual boxes according to certain rules. Executive function is employed when the child keeps current sorting directions in mind, flexibly switch sorting behavior when instructions are changed, and inhibit the reflex of sorting in the same way as previously. A child will advance to the next level if the current level is passed, and he or she will continue advancing until failure of a full level. If a child fails his or her starting level, the program will automatically switch to an easier level until current level of functioning is reached. Due to the range of data suggesting the convergence of executive function skills in early childhood, the MEFS produces an executive function skills total score, rather than three distinct scores for the domains of cognitive flexibility, inhibitory control, and working memory [49]. Upon completion of the administration of the instrument with a child, the app automatically produces a score for that children, and the scores of all the participating children are then accessed by the researcher through a secure website administered by Reflection Sciences. Participants' scores can be used for comparing with current norms of executive function skill development based on age of participant; they can also be used to measure changes over time within children, or to compare across groups of children.

While the MEFS is a relatively new instrument, it has shown to be reliable and valid as a measurement tool for assessing executive function skills in young children [49]. Test–retest reliability of the instrument is 0.93. The iPad program directs the measurement, so the administrator does not introduce subjectivity into MEFS scores. The MEFS is significantly correlated with other commonly used research measures of executive function skills, such as the U.S. National Institute of Health Toolbox Battery of Executive Function Measures often used for clinical purposes). The MEFS does not show a strong correlation with IQ, suggesting it is measuring executive function skills rather than intelligence.

Participants in this 2017–2018 study included 78 children from the four nature preschools and 44 children from the two non-nature, play-based preschools. General linear modeling (univariate analysis of covariance) was used to investigate the difference between the nature preschool and non-nature preschool participants' posttest level of executive function skills, when statistically controlling (or accounting) for pretest level, age, gender, and prior participation. Unadjusted pretest and posttest means, as well as the adjusted posttest means when controlling for the covariates, are reported in Table 2. The results of the analysis of covariance suggests a significant model, $F(5) = 18.13$, $p < 0.001$. The pairwise comparison of adjusted posttest means indicated a mean difference of 1.14 points (standard error of 2.18) and no significant difference between the nature and non-nature participants, when controlling for age, gender, prior participation, and pretest level ($F(1) = 0.28$, $p = 0.60$, $\eta_p^2 < 0.01$; see Table 2.

Table 2. Pretest and posttest executive function means and standard deviations for nature and non-nature preschools.

	Pretest M (SD)	Posttest M (SD)	Adjusted Posttest M (Stnd. Error) [1]	Statistical Significance of Pairwise Comparison of Adj. Posttest Means
Nature [2]	41.78 (14.89)	51.46 (14.57)	50.86 (1.29)	$p = 0.60$
Non-Nature [2]	38.54 (14.40)	48.66 (14.99)	49.72 (1.73)	

[1] Adjusted for the covariates of pretest, age, gender, and prior participation. [2] N = 122; 78 nature preschool participants and 44 non-nature preschool participants.

Pretest and posttest means were also compared with the data published by Reflection Sciences (2017) of average executive function scores for typically developing children (see Figure 2). The average

increase in executive function skills over a seven-month period for U.S. children at a similar age as those in this pilot study (average of 50 months at the pretest administration) is about four points, and children in both the nature and non-nature preschools had an increase in executive function skills of about 10 points, thus exceeding what would be expected due to cognitive maturation in typically developing children. This average gain of approximately 10 points was statistically significant and corresponded with a large effect size, $\eta_p^2 = 0.38$, for both the nature and non-nature preschools (mean difference of 9.70, standard error 1.44, $p < 0.001$ and mean difference of 10.11 points, standard error = 2.04, $p < 0.001$, respectively).

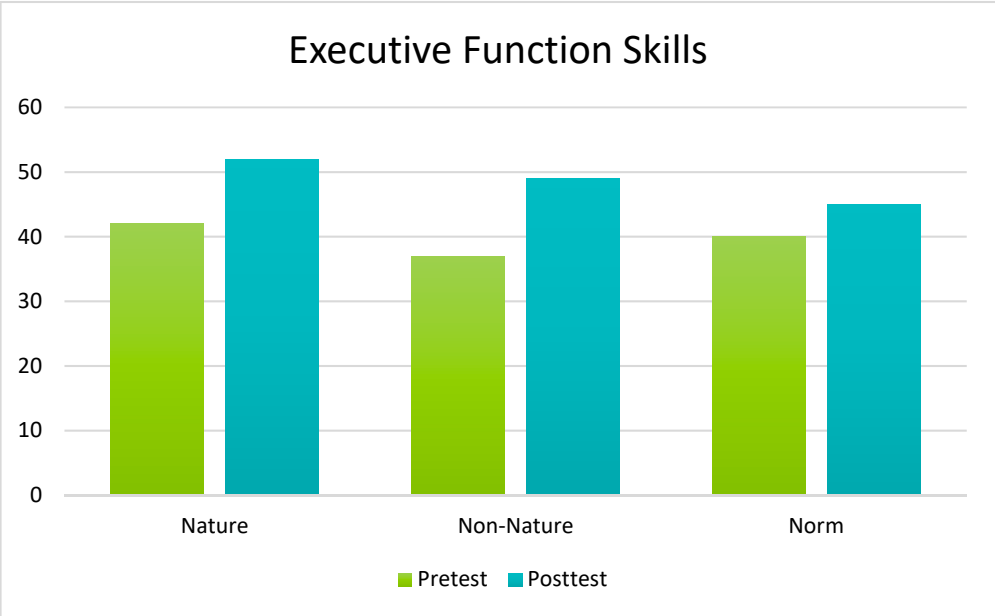


Figure 2. Comparison of growth in executive function skills of nature preschool participants, non-nature preschool participants, and national averages.

This greater than expected gain among the nature and non-nature preschoolers in this study may be due to the influence of attending a play-based preschool and/or the influence of likely higher than average socio-economic status of participating children (as socio-economic status is correlated with scores [49]). However, the study participants were only slightly higher (2 points) than what would be expected at the time of the pretest, yet were 7 points higher by the time of the posttest; this makes it less likely for socio-economic differences to be the sole or primary factor explaining the growth observed in this study. Because there was significant growth in both the nature and non-nature preschool participants, it seems plausible that what might account for this greater than expected growth is their preschool participation. Collectively these results suggest that nature play does not appear to hinder the development of executive function skills, which is of practical significance since concerns about school readiness have been one primary obstacle to expansion of the nature preschool movement. These results further suggest that participation in a play-based preschool that focuses on holistic development across domains may likely support executive function skill development, regardless of indoor or outdoor setting. (See [50] for a more critical discussion of the results and implications.)

4.3. Creative Thinking Pilot Study

This study utilized a divergent thinking test, Thinking Creatively in Action and Movement (TCAM) [51], which is an established instrument designed for use with three- to eight-year-old children who are often better at expressing themselves through movement than verbally. The TCAM accepts both kinesthetic and verbal responses to four activities that measure fluency, originality, and imagination [51]. In this assessment, fluency is the number of ideas generated, originality is the production of unique

ideas, and imagination is one's ability to take on a new role [51]. TCAM activities were administered and scored according to a provided protocol summarized in [51] and entail these prompts:

- "How Many Ways" asks participants to think of different ways to move from one side of the room to the other and is scored for fluency and originality;
- "Can You Move Like?" asks participants to take on six different roles, which are scored for imagination on a Likert scale ranging from "no movement" to "excellent, like the thing;"
- "What Other Ways?" asks participants to think of as many ways as possible to place a paper cup in a waste basket and is scored for fluency and originality; and
- "What Can You Do with a Paper Cup?" asks participants to think of as many ways as possible to play with a paper cup and is scored for fluency and originality.

The TCAM has an overall test-retest reliability coefficient of 0.84 and the individual activities have coefficients of 0.71, 0.79, 0.67, and 0.58, respectively [51]. TCAM scores do not indicate a relationship with intelligence, cooperation, race, sex, previous school attendance, and socioeconomic status; the scores are associated with learning experiences expected to produce creative growth [51].

Eighty-six children from four nature preschools and one non-nature preschool participated in this study during the 2016–2017 school year (75 from the nature preschools and 11 from the non-nature preschool). Due to the challenges of finding non-nature preschools willing to participate and consequently only one non-nature preschool in this particular study, the analysis approach focused evaluating for significant growth in the nature preschool participants, and then comparing that growth with data from the non-nature preschool participants (using the non-nature preschool as a comparison or reference group, rather than as a true control group). Paired t-tests were used to determine if there was a significant increase in the creative thinking scores of the nature preschool participants, with separate tests run for each of the three dimensions (fluency, originality, and imagination). Paired t-tests were also conducted using the data from the non-nature preschool participants to determine if there was a significant increase in their scores and to use those findings as a baseline for comparisons with the nature preschool participants. Because age was already accounted for in the standardizing of the scores, it was not used as a covariate in the analyses. Nor were the variables of gender and prior preschool attendance incorporated as covariates, as these have not been found to be related to TCAM performance [51]. Race and ethnicity also were not included as covariates, due to the homogenous nature of the participants.

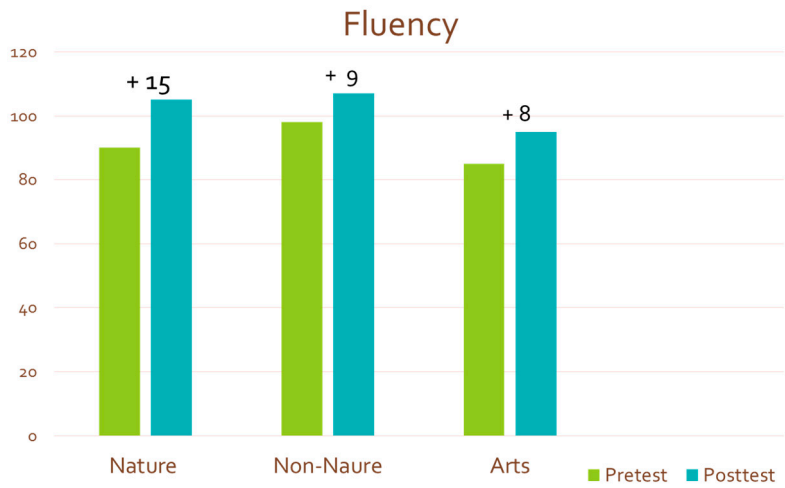
The results of the t-tests indicate significant growth ($p < 0.001$) in all three dimensions of creative thinking for the nature preschool participants. See Table 3 for the pretest and posttest means and significance levels for the paired t-tests assessing change from pretest to posttest levels. In contrast, there was not a significant growth in fluency, originality, and imagination for the non-nature preschool participants. This suggests nature play may be positively influencing young children's creative thinking, beyond what might occur through cognitive maturation and participation in a non-nature, play-based preschool, as similar growth was not seen in the comparison group. However, caution is needed in this interpretation, due to the smaller sample size of the non-nature comparison group.

Published data from a fine arts-based preschool program implemented at six preschool sites [52] was also used to further evaluate the significance of the growth in the nature preschool participants, due to the small sample size of the non-nature comparison group. Growth in fluency and originality in the nature preschools exceeded the significant growth observed in the fine arts-based preschool programs, while the growth in imagination seen in the arts-based preschools exceeded the significant growth seen in the nature preschools (see Figure 3a–c.). This comparison underscores the potential of nature play for supporting growth in creative thinking in preschoolers, particularly the fluency dimension of creative thinking as growth in nature preschoolers exceeded that seen in both non-nature and fine-arts preschoolers. See [53] for additional critical discussion and implications of the results.

Table 3. Pretest and posttest creative thinking means and standard deviations for nature and non-nature preschool.

	Pretest Mean (SD)	Posttest Mean (SD)	Statitical Significance [2] of Growth
Fluency			
Treatment (nature preschools) [1]	89.89 (17.76)	104.76 (28.35)	$p = < 0.001$ **
Baseline (non-nature preschool) [1]	97.55 (14.64)	106.55 (22.88)	$p = 0.22$
Originality			
Treatment (nature preschools) [1]	96.13 (20.16)	113.61 (36.58)	$p = < 0.001$ **
Baseline (non-nature preschool) [1]	105.20 (14.13)	126.00 (30.59)	$p = 0.07$
Imagination			
Treatment (nature preschools) [1]	89.85 (17.68)	99.99 (18.42)	$p = < 0.001$ **
Baseline (non-nature preschool) [1]	92.30 (16.52)	103.00 (12.03)	$p = 0.06$

[1] N = 122; 78 nature preschool participants and 44 non-nature preschool participants. [2] ** Denotes statistical significance at the 0.01 level.



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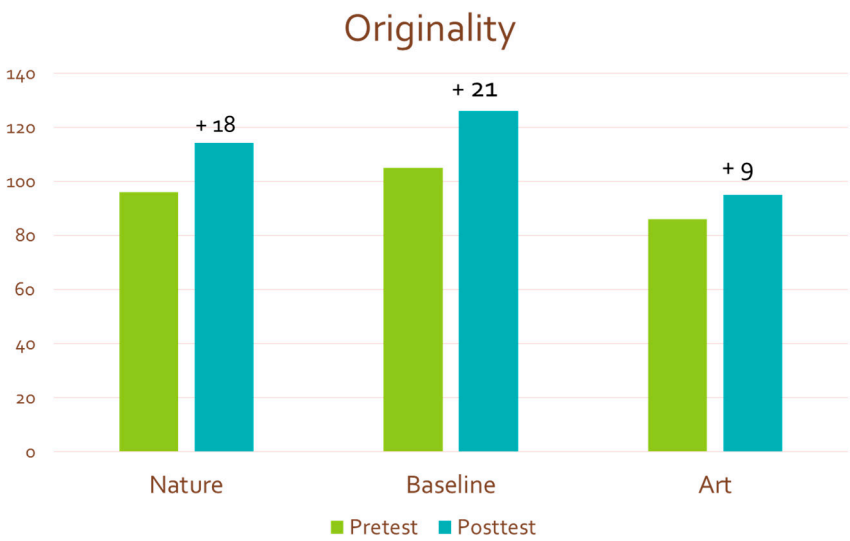

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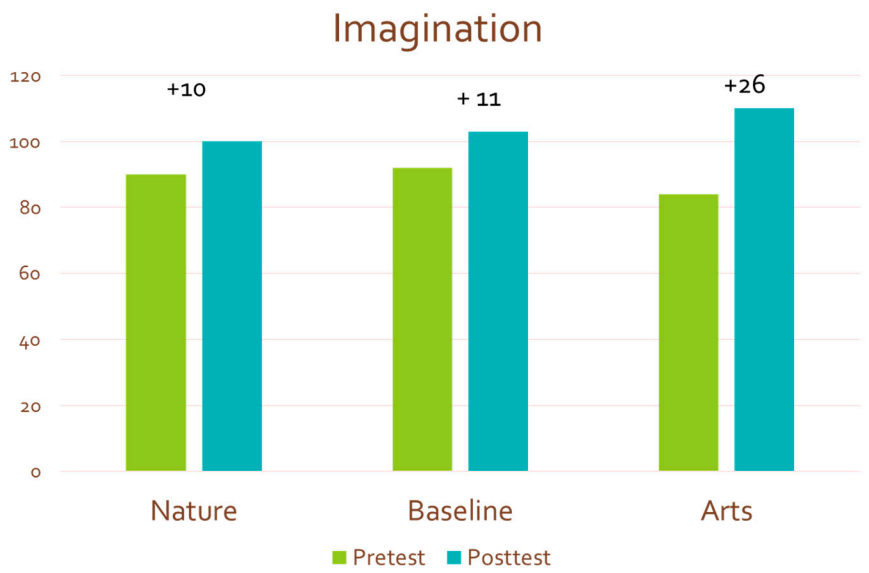

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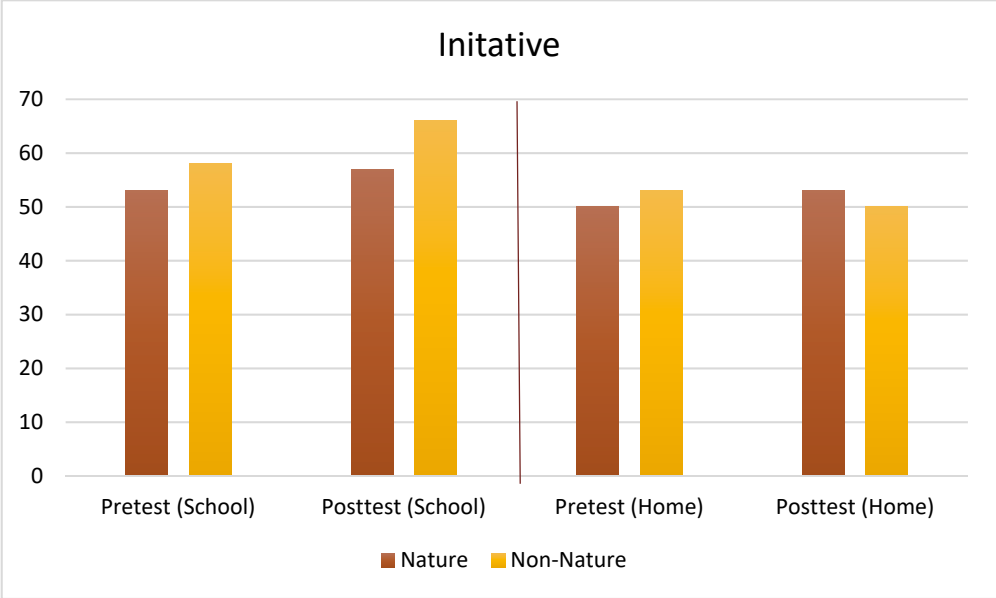
Figure 3. (**a**) Comparison of growth in the fluency dimension of creative thinking of nature, non-nature, and fine arts-based preschool participants; (**b**) Comparison of growth in the originality dimension of creative thinking of nature, non-nature, and fine arts-based preschool participants; (**c**) Comparison of growth in the imagination dimension of creative thinking of nature, non-nature, and fine arts-based preschool participants.

4.4. Resilience Pilot Study

The resilience pilot study was conducted in the 2016–2017 school year. The instrument used in this study was the Devereux Early Childhood Assessment for Preschoolers, Second Edition (DECA-P2) [46]. This instrument is a standardized, norm-referenced behavior rating scale that is used to assess within-child protective factors related to resilience. Parents and teachers/caregivers are asked to evaluate the frequency of 27 positive behaviors (strengths), which form subscales of initiative, self-regulation, and attachment. The initiative subscale contains items measuring a child's ability to use independent thought and action to meet one's needs; children who score high are often engaged learners who enjoy challenges, self-starters, and problem-solvers. The self-regulation subscale assesses the child's ability to express emotions and manage behavior in healthy ways; children are often patient, cooperative, respectful, and considerate [46]. The attachment/relationships scale assesses the child's ability to promote and maintain mutual, positive connections with other children and significant adults; children who receive high scores actively seek out adults and other children and tend to be affectionate, trusting, and optimistic, with a happy disposition. The ratings by the teachers reflect initiative, self-regulation, and attachment exhibited in the preschool setting, and the ratings by the teachers are reflective of these same three protective factors but in the home setting.

The reported internal reliability coefficient for the initiative subscale is 0.88 for parents and 0.92 for teachers, and for self-regulation, 0.90 and 0.94, respectively. The attachment/relationships subscale is slightly lower, 0.79 and 0.85, respectively. Construct validity and criterion validity was established during the test development through literature reviews, focus groups with professionals, and comparisons with performance measures (see [46] details). Per [46], there is an absence of age trends in this preschool age range, and thus norms are provided in the testing manual for these ages combined. Due to small differences in gender, particularly in the self-regulation subscale for teacher raters where girls tend to show more behaviors related to self-regulation than boys, raw-score-to-T-score norm-conversion tables are provided for boys and girls. However, only the self-regulation subscale for teacher raters shows a difference that is significant (with a moderate effect size), suggesting the need to take into consideration gender in analyses regarding self-regulation with data from teacher raters.

Seventy-eight children from the four nature preschools and 14 children from a non-nature preschool participated in the study. Similar to the approach used in the creative thinking pilot study, the analysis focused on evaluating for significant growth in the nature preschool participants, with the non-nature preschool serving as a comparison or reference group, rather than as a true control group. Age was not a covariate, per [46] indicating there is only minor variability due to age across the 3- through 5-year-old age range. Nor was ethnicity or race a covariate in the analyses, due to the lack of variance within the study participants. Also, per [46], gender was a covariate in only the analysis of data from teacher raters on the self-regulation subscale, due to the significant difference between boys and girls found in the normed data for teacher ratings of self-regulation. See Figure 4a–c for growth in the three within-child protective factors related to resilience in the nature preschool participants relative to the non-nature preschool participants.



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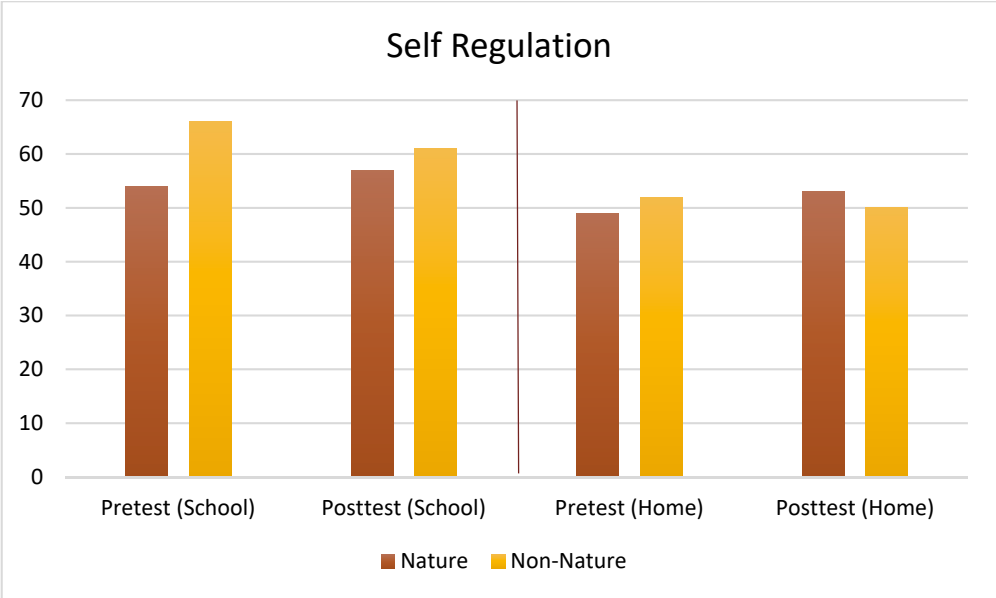

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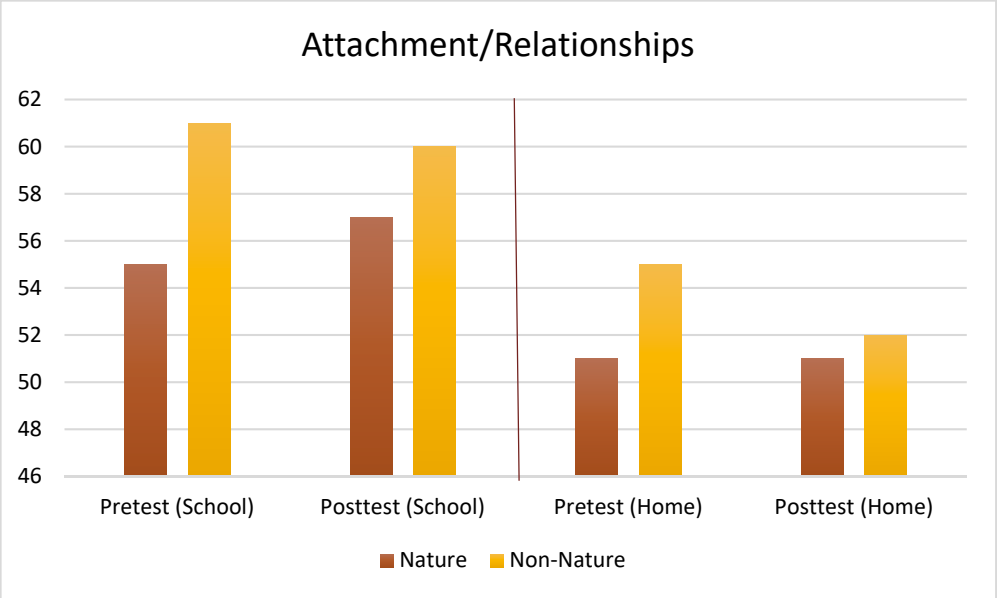

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Figure 4. (**a**) Comparison of growth in initiative in nature and non-nature preschool participants in the school and home setting; (**b**) Comparison of growth in self-regulation in nature and non-nature preschool participants in the school and home setting; (**c**) Comparison of growth in attachment/relationships in nature and non-nature preschool participants in the school and home setting.

For data from the teacher ratings, there was significant growth in nature preschoolers' initiative scores, $F(1,76) = 32.48$, $p < 0.001$, and self-regulation scores, $F(1,76) = 10.65$, $p = 0.002$. Regarding the data from parent ratings, there was again significant growth in nature preschoolers' initiative, $F(1,76) = 13.58$, $p < 0.001$, and self-regulation, $F(1,76) = 10.34$, $p = 0.002$. These results suggest that children in the nature preschools had positive development in their within-child protective factors related to resilience, specifically in the dimensions of initiative and self-regulation, displayed in both the preschool and home settings. In comparison, the only significant growth seen in the non-nature preschool participants was in the initiative scores from the teacher ratings, $F(1,10) = 30.63$, $p < 0.001$. See Table 4 for the pretest and posttest means for nature and non-nature preschool participants.

Table 4. Pretest and posttest means for total protective factors related to resilience for nature and non-nature preschool participants in the school setting (teacher rating) and home setting (parent rating).

	Nature Preschool [1] Teacher Rating		Nature Preschool Parent Rating		Non-Nature Preschool [2] Teacher Rating		Non-Nature Preschool Parent Rating	
	Pretest Mean (SD)	Posttest Mean (SD)	Pretest Mean (SD)	Posttest Mean (SD)	Pretest Mean (SD)	Posttest Mean (SD)	Pretest Mean (SD)	Posttest Mean (SD)
Initiative	52.74 (7.98)	56.93 (8.55) **	49.84 (8.45)	53.63 (8.17) **	57.93 (7.98)	66.36 (5.62) **	53.21 (6.19)	50.27 (8.60)
Self-Regulation	54.49 (6.00)	56.78 (8.05) **	49.31 (7.98)	53.34 (9.34) **	66.36 (5.63)	61.27 (5.08)	51.71 (4.50)	52.27 (9.12)
Attachment	55.26 (6.91)	57.21 (7.45)	51.64 (7.24)	51.39 (9.93)	61.27 (5.08)	60.18 (5.09)	54.57 (7.54)	54.91 (7.26)

[1] n = 78. [2] n = 14. ** Denotes significance at the 0.01 level.

While the small sample size of the comparison group indicates caution is needed in interpreting these results, the results from this pilot study tentatively suggest the potential of nature play in supporting the development of total protective factors relating to resilience. In light of only slight variability across children in the 3- to 5-year-old age range, per [46], significant changes in scores are likely attributable to preschool participation rather than developmental maturation. Thus, the results from this pilot study suggest that while preschool participation appears to have a positive influence on the within-child protective factor of initiative displayed in the preschool setting, nature preschools seem to have an additional positive influence on initiative displayed in the home setting, as well as on

self-regulation displayed in both the home and school settings. See [54] for more detailed results, as well as for a more critical analysis of the results.

5. Discussion

The results of this set of pilot studies suggest the potential of extended periods of unstructured play in outdoor natural settings to contribute important and relevant dispositions and skills to sustainability. Nature play appears to support the integration of initiative and persistence into information-seeking, exploratory behavior (curiosity), as well as supporting the development of the fluency dimension of creative thinking and the initiative and self-regulation dimensions of the total protective factors that are associated with resilience. Additionally, children are developing executive function skills necessary for goal-directed behavior at rates that exceed national norms and are comparable to other high quality, non-nature preschools.

However, it is important to consider these findings in the context of the studies' limitations. The lack of a randomized control group limits the internal validity of the studies, making it difficult to causally attribute the significant growth in these constructs to participation in nature preschools and presumably nature play. However, this limitation was somewhat, yet insufficiently, addressed through the use of nonequivalent group groups and comparisons with normed reference groups when possible. The results further lack external validity, due to the homogenous nature of the participants (primarily Caucasian and of middle to high socio-economic status). Thus, care is needed in interpreting these results and making generalizations from them, and further research is needed to more rigorously examine the influence using larger and more diverse groups of participants and to isolate the effect of nature play from other aspects of nature preschool participation. Yet while more research is needed, these results are encouraging.

The context for these pilot studies is the international call for a more critical and transformative approach to early childhood education for sustainability, including the adoption of pedagogies such as advocacy and action-taking in sustainability issues locally and more broadly. While nature play has been described as an impediment to young children's contributions to sustainability [10], these studies instead speak to its positive influence, with children growing in capabilities and dispositions that are very relevant to the goal of sustainability. Through the strength-giving landscape of nature play, these studies suggest children are developing social and emotional protective factors that can be relied upon in the face of adversity; they are developing the abilities to be creative thinkers who at the same time can employ the executive function skills of working memory, cognitive flexibility, and inhibitory control. They are fine-tuning their innate curiosity, demonstrating skills of being able to persist beyond initial information-seeking exploratory behavior toward increased sense-making. And they are doing so through the developmentally appropriate pedagogy of play.

Play is the primary vehicle of learning in early childhood and thus having a focus on play is fundamental to any curriculum that is developmentally appropriate for preschool [55]. Play is essential to healthy brain development, contributing to the cognitive, physical, social, and emotional well-being of children so integrally that it has been recognized by the United Nations High Commission for Human Rights as a right of every child [56]. The composite effect of a play-based, emergent curriculum in a natural environment appears to enhance healthy child development, beyond what might be achieved through either play or nature alone.

Natural settings and materials afford unique experiences, particularly when children are provided sustained time and freedom to interact with them as capable and autonomous decision-makers. Chawla, Keena, and Pevec [57] found elementary school students expressed value in the free movement and free choice during recess in their green schoolyard. They speculate that the "freedom of choice, a great variety of objects for discovery, and loose parts that children could use imaginatively" enabled children to select roles and activities in which they felt comfortable and competent [57] (p. 11). They further speculate that this cooperative, imaginative play afforded by the free play, nature environment supported feelings of effectance (seeing they can have a visible impact on their environment) and a

sense of efficacy (feelings of mastery and self-esteem that develop through repeated experiences of successfully meeting challenges). They also noted the supportive peer relationships facilitated through children's freedom to choose from a variety of potential activities that afforded cooperative activities and gave them control over social interactions and roles [57]. In the pilot studies at hand, similar reasoning could be applied. The child-initiated, unstructured nature play in the nature preschools affords diverse and expansive opportunities for young children to take appropriate risks, set their own goals, problem-solve, and choose roles and activities that support positive peer relationship and produce feelings of comfort and competence. While child-initiated play in an indoor setting or on a playground might allow for some of this, it seems possible that the opportunities for these experiences are even greater in nature, as the boundaries and variety and holistic challenges are likely to be more authentic and extensive.

6. Conclusions

These pilot studies offer reasons for not abandoning nature play in the pursuit of sustainability. The results suggest nature play has value beyond supporting healthy child development and serving as an antidote for the "lifestyle maladies of contemporary childhood" [14], but in the sustainability context as well. As researcher and play advocate Joan Almon notes, "As with so many aspects of healthy development, children have an innate capacity to be resilient" [58] (p. 5). Based on the findings from these pilot studies, preschools are helping bring that capacity to fruition, providing children with a strong foundation for meeting life's obstacles, including the complexity of sustainability challenges. Similar could be said for other outcomes explored in this set of pilot studies, such as creative thinking and curiosity. Innate tendencies, such as curiosity and creativity, can be reawakened and fostered rather than extinguished through nature play.

For over a decade, author and researcher David Sobel has been cautioning against laying the weight of the world's environmental problems on children already haunted with too many concerns and not enough real contact with nature [59]. With the call for a more critical and transformative form of early childhood environmental education, younger and younger children are being asked to bear the weight of pursuing a more just and sustainable present and future. At the same time, the education research literature is warning of the "academification" of early childhood education, or the trickle-down effect of high stakes testing and academic-focused elementary school curriculum that prioritizes cognitive development over development across the domains. Sobel writes, "If we want children to flourish, to become truly empowered, then let us allow them to love the Earth before we ask them to save it. Perhaps this is what Thoreau had in mind when he said, 'the more slowly trees grow at first, the sounder they are at the core, and I think the same is true of human beings.' " [59] (p. 39). As children grow in their goal-directed problem-solving skills and creative thinking abilities, as they grow in curiosity and persistence, and as they have opportunities to develop the social and emotional strengths that can be relied upon in adversity, they are being strengthened at the core. Through nature play, they are developing a solid foundation from which in due time can be drawn upon for participating in visioning and creating a healthy, just, and sustainable future. This seems to be a far cry from the uncritical, misconceived, and simplistic pedagogy that nature play has been criticized for being.

Author Contributions: Julie Ernst was the principal investigator for this set of studies and was responsible for the conceptualization and design of the studies, overseeing data collection, and the data analysis and interpretation processes. Firdevs Burcak assisted with the review of literature, methodology, and data collection.

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Conflicts of Interest: The authors declare no conflict of interest.

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