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HEALTHY DESIGNED ENVIRONMENTS FOR PRE-SCHOOL CHILDREN:
INVESTIGATING WAYS TO OPTIMIZE THE RESTORATION EXPERIENCE IN
NATURE-BASED OUTDOOR PLAY ENVIRONMENTS

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Planning, Design, and the Built Environment

by
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May 2020

Accepted by:
Dr. Mary, G. Padua, Committee Chair
Dr. Matthew Powers
Dr. Barry A. Garst
Dr. Sandra Linder

ABSTRACT

Current research points out that a safe, healthy, and supportive built environment is one factor that supports lifelong health (Center on the Developing Child at Harvard University, 2017). Additionally, an individual's early childhood experiences deeply affect his/her brain development, learning capabilities, and health throughout his/her lifespan (National Scientific Council on the Developing Child, 2010). However, 21st century designs of children's playgrounds are facing challenges in terms of their positive impact on children's physical fitness, health, as well their cognitive development and well-being (Frost & Wortham). Attention Restoration Theory (ART) (1989) and related studies suggest that the nature or natural elements in a built environment can provide a restorative experience that helps people recover from mental fatigue and stress and improve their overall health (Berto, Baroni, Zainaghi, & Bettella, 2010; Kaplan & Kaplan, 1989; Kaplan, 1993; Kaplan, 2001; Kuo, 2011; Mårtensson et al., 2009; van den Berg, Hartig, & Staats, 2007). Although a child's restoration experience in childcare centers is critical for healthy development, few studies have linked children's health and their restorative experience in a designed nature-based outdoor play environment.

This cross-disciplinary research intends to fill this research gap, focusing especially on preschool children (four to five-year-old age group), and investigate the inter-relationships of children's health, nature-based outdoor play environments at childcare centers, and the children's restorative experience. A larger goal is to contribute to children's healthy development and overall well-being in South Carolina's outdoor play environments at licensed childcare centers and beyond.

This study proposes a comparative case study approach. Primary data and empirical evidence of the physical environment, children - nature interaction, children's use of outdoor play environment and restorative experience were collected through assessment of the physical environment's spatial forms, field observations, interviews, and perceived restorative experience survey. The data analysis and synthesis reveal that nature-based outdoor play environment may provide higher level of children-nature interaction and indicate the significant role of outdoor play environment and natural elements on children's restorative experience. This research helps expand on Attention Restoration Theory (1989) and contributes to our understanding of the significance of nature-based outdoor designed environments on children's overall health and well-being.

Keywords

Restorative experience, outdoor play environment, biophilic design, nature play, built environment and health

DEDICATION

I would dedicate this dissertation to my mother who opened my eyes to the world; my father who taught me to be a kind and positive individual; and my dear husband and best friend, Chen Wang, who always understands me and stood by me during difficult times.

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CHAPTER

1. INTRODUCTION

1.1 Background

According to the World Health Organization (WHO), “Children should all be able to achieve their optimal physical growth and psycho-emotional development” (Irwin, Siddiqi, & Hertzman, 2007, p.7). Current research shows that early childhood development provides the foundation for people’s lifelong health (Center on the Developing Child at Harvard University, 2010). In specific, children’s brain architecture development, which supports their intellectual, social, emotional, physical, and behavioral development throughout their lifespan, is affected by children’s early experience (National Scientific Council on the Developing Child, 2010). A safe and supportive physical built environment for children’s positive early experience have been identified by extensive scientific studies as one of the three basic foundations of lifelong health (Center on the Developing Child at Harvard University, 2017). However, current research for early childhood health, both mental and physical, indicates a rise in obesity, attention deficit/hyperactivity disorder (ADHD), anxiety, and sensory disorders (Hales, Carroll, Fryar, & Ogden, 2015; Louv, 2008; Visser et al., 2014). From the perspective of a supportive environment, scholars have indicated that children’s disconnection with nature or the natural environment is a major causal factor among various factors studied under the rapid urbanization process (Kaplan, 1992; Louv, 2008). An environmental intervention is necessary to support nature’s (natural environments, nature-related elements, and nature-based design) positive role in human health. (Bell, Phoenix, Lovell,

& Wheeler, 2014; Bratman, Hamilton, & Daily, 2012; Frumkin, 2001; Hartig, Mitchell, de Vries, & Frumkin, 2014; Kaplan, 1993; Kuo & Taylor, 2004; Maller et al., 2009; Maller, 2009; McCurdy, Winterbottom, Mehta, & Roberts, 2010; Sempik, Aldridge, & Becker, 2002; Sullivan & Kaplan, 2016; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991).

The current U.S. Census Bureau's population reports suggested that, among the 20.44 million children under five years of age, 12.5 million (61 percent) of them were in some type of childcare arrangement for 35 hours a week on average (Laughlin, 2013). In addition, four childcare facilities per hundred children have been built on average across the country, as both parents are increasingly entering the labor force (Laughlin, 2013). Children in childcare centers spend most of their time indoors and may face some types of negative mental conditions, such as cognitive mental fatigue, separation anxiety, and social interaction stress (Geoffroy, Côté, Parent, & Séguin, 2006). Since children's brain development is shaped by the interaction of genes and experiences, long time mental fatigue and stress may have a negative effect on child's learning outcomes, brain architecture, and overall health development (National Scientific Council on the Developing Child, 2010). According to the Kaplans (R Kaplan & Kaplan, 1989; S. Kaplan, 1995), a restoration experience is a critical factor necessary for a child's health development and mental well-being. However, the design strategies and elements that can enhance children's restorative experiences in outdoor play environment in childcare settings have not been well developed. It indicates that there is a deficiency in the literature and in the design application.

The benefits of the relationship between nature and human health are widely accepted. Scholars in the field of environmental psychology identified the contribution of nature or natural environment to help people recover from mental fatigue and stress (Kaplan, 1993; S. Kaplan, 1995; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991). Wilson's (1984) Biophilic hypothesis proposes that human innately affiliate with the natural environment. Additionally, from an evolutionary perspective, people respond positively to settings and elements (water, light air, food, shelter) especially allowing their ancestors survive (Kellert & Wilson, 1995; Kellert, 2015; Ulrich, 1993). Ulrich's (1993) psycho-evolutionary framework suggests that people's aesthetic preference for natural configurations and content contribute to physiological arousal responses, including recovery or restoration (Simons, et al, 1991). Attention Restoration Theory (ART) (Rachel Kaplan, Kaplan, & Brown, 1989) and related studies suggests the natural environment can provide a restoration experience that helps children recover from mental fatigue and stress and improve their overall health (Kaplan 1992, 1993, 1995).

This research focuses on the effect of designed outdoor play environments on the health of preschool children (four to five-year-old age group). The two objectives of this research are: 1) investigate the inter-relationship of children's health, nature-based outdoor play environments at childcare centers and its impact on the children's restorative experience; and 2) examine ways the design of a nature-based outdoor play environment can contribute to children's restorative experience.

Scholarly literature in three realms of knowledge: biophilia, outdoor designed environments, and children's development in terms of their overall health and well-being

were reviewed to develop a theoretical framework that assesses the impact of designed outdoor play environment on children-nature relationship and children’s restorative experience. In this context, this research seeks to understand children’s play behaviors and their interaction with natural elements in the outdoor play environment. It also investigates elements in the outdoor play environment that contributes to children’s restorative experience. One objective is to develop design strategies for a nature-based outdoor play environment that promote children’s restorative experience

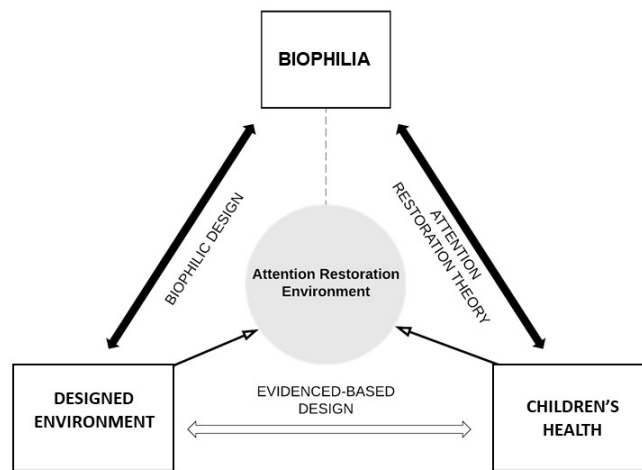


Figure 1.1 Three Realms of Knowledge

1.2 Significance of Research

Although various age groups were included in previous studies, few studies have focused on the relationship between the natural environment and children’s restorative experience, especially in early childhoods. Moreover, limited studies have linked children’s restorative experience with the designed environment, specifically, the relationship between the quality of the outdoor designed environment, children’s interaction with this environment, and their overall healthy development. It is critical to

understand children's play behaviors and interaction with natural elements in outdoor play environments, and its impact on children's restorative experience and overall health firstly. And then develop design strategies for a healthy oriented outdoor play environment accordingly. This research will contribute to the discipline of landscape architecture (practice and research) and educational professionals by highlighting the relationship between designed nature-based outdoor play environments and children's health. Furthermore, this research contributes to a deeper understanding of the restorative experience and its relationship between the quality and degree of nature-based elements and the built environment of childcare settings and the positive impact on children's overall healthy development and well-being.

1.3 Research Questions, Propositions

- General research question: How can the designed outdoor play environment in a childcare center be optimized for preschool children's restorative experience?
- Research Questions 1: How does the design of a nature-based outdoor play environment in childcare centers impact pre-school children's interactions with natural elements in childcare centers?
- Proposition 1: Nature or nature-based elements in the designed outdoor play environment affords higher levels of frequency and variety of children-nature interaction.
- Research Question 2: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's restorative experience in childcare centers?

- Proposition 2: Designed nature-based outdoor play environments in childcare centers stimulate higher level of restorative experience.

1.4 Operational Definitions

Definition of nature

Hartig et al. (2014) examined the relationship between nature represented by the physical environment, planning, design, and policy measures in urbanized societies. They introduced the following definition of nature:

In the objective sense, 'nature' as used here refers to physical features and processes of nonhuman origin that people ordinarily can perceive”

In practice, however, much research does not accept exclusion of the artificial as a basis for defining nature or natural environment. The nature of interest is often situated in built environment, ... they are typically designed, constructed, regulated and maintained. (Hartig et al. 2014 p.208)

They claimed that nature is usually experienced subjectively. Since opportunities for and ways of interaction with nature vary across individuals and populations, nature is represented by different physical and spatial variables in the existing studies.

Maller, Townsend, Pryor, Brown, and Leger (2006) investigated the benefits of being in contact with nature on children's health. In this study, she defined nature as:

an organic environment where the majority of ecosystem processes are present (e.g. birth, death, reproduction, relationships between species)....Nature also refers to any single element of the natural environment (such as plants, animals, soil, water or air), and includes domestic and companion animals as

well as cultivate pot plants. (Maller, Townsend, Pryor, Brown, & Leger, 2006. p.46)

Browning et al. (2014) developed 14 patterns of biophilic design to articulate the relationship between people and the built environment with an aim to enhance the design of the built environment and promote people's mental health and well-being through contact with nature. They defined nature as follow:

Alternatively, it could be argued that everything, including all that humans design and make, is natural and a part of nature because they are each extensions of our phenotype. ... For added clarity, we are making the distinction that, in the context of health and well-being in the built environment, most nature in modern society is designed. (Browning, Ryan, & Clancy, 2014. p.8)

Definition of nature-based outdoor play environment

According to Moore (2014), nature play as learning place is defined as:

A designated, managed area in an existing or modified outdoor environment where children of all ages and abilities play and learn by engaging with and manipulating diverse natural elements, materials, organisms, and habitats through sensory, fine motor and gross motor experience. (Moore, 2014. p.5)



Figure 1.2 An Example of Nature-based Outdoor Play. From Outdoor Spaces to Become More Friendly for Kids and Environment by M. Theophil, 2018. <http://dailytidings.com/news/government/outdoor-spaces-to-become-more-friendly-for-kids-and-environment>. Copyright by M. Thephil, 2018

Definition of natural elements

Even though the phrase “natural elements” has different meaning in different fields, there are common understandings when referring to the outdoor environment. In this study, “natural elements” refer to materials, vegetations, and landforms in the outdoor play environment derived from nature rather than being artificial or man-made. A list of natural elements in children’s play environments derived from the existing studies is provided in Table 1.1.

Natural Elements	Support in the literature
Vegetation: trees, shrubs, flowers, grasses	Woolley & Lowe (2013), Moore (2014), White (1998), Fjørtoft (2004), Kellert (2018)
Landform: hill, mound, slope	Woolley & Lowe (2013), Moore (2014), Fjørtoft (2004), Kellert (2018)

Natural ground surface: wood chips, multipurpose lawns, sand surface	Moore (2014), Fjørtoft (2004),
Natural materials, natural play structures: wood, stick, water, sand, stones, dirt piles, logs, ice, shelter	Woolley & Lowe (2013), Moore (2014), White (1998),
Natural loose parts: leaves, seeds (pinecones), wood block	Woolley & Lowe (2013), Moore (2014), White (1998),
Weather: rain, snow, sky view, light, air	Kellert (2018)
Animals and other living things	White (1998), Kellert (2018)
Source: (Fjørtoft, 2004; Heerwagen, 2009; Kellert, 2018; Moore, 2014; White & Stoecklin, 1998; Woolley & Lowe, 2013)	

Table 1.1 A Summary of Natural Elements in Play Environments

Definition of childcare center

A childcare center is an educational establishment or learning space offering care and early childhood education before children (pre-school) begin compulsory education at primary school.

Definition of attention restoration

An alternative mode of attending to temporarily make direct attention unnecessary which is in directed attention (involuntary attention). People need this alternative mode (restorative experience) to recover from directed attention fatigue (Kaplan, 1995).

Definition of restoration experience

Kaplan and Kaplan have defined the restorative experience as: “*An experience, which leads to a recovery from mental fatigue as well as a variety of associated benefits, we have come to call a restorative experience.*” (Kaplan, 1992. p.137).

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Biophilia and Biophilic Design

2.1.1 *The concept of biophilia*

It is widely accepted that being connected with nature is beneficial (Ulrich, 1993). People have long believed in the healing power of nature. For example, healing temples in ancient Greece and Italy were often located in remote areas where people could connect with nature. Additionally, throughout the human history, humans have been expressing their physical, psychological, and spiritual needs for nature in gardens, literatures, poems, paintings, and philosophies around the world (Squire, 1998). Over time, from ancient civilizations and cultures, like Egypt, and Mesopotamia, to contemporary times, people in cities around the world have been constructing gardens to maintain their connection with nature. In ancient China, Confucius (511-478 BC) believed that, “The wise and benevolent enjoy the waters and mountains, they are joyful and long-lived (智者乐山, 仁者乐水; 智者动, 仁者静; 智者乐, 仁者寿)”. These accounts show that people are powerfully responsive to nature’s process and patterns. Their thoughts, behaviors, and physiological functions are deeply influenced by their experiences with nature (Ulrich, 1993).

The logic of providing access to natural environments in the past two centuries was partly formed by the idea that nature benefits an individual’s physical and psychological well-being. This idea can be considered as an early form of the biophilic hypothesis (Ulrich, 1993). The word “biophilia” was derived by social psychologist Erich Fromm in 1973 from Latin bio (life) and philia (attraction) (Marcus & Sachs,

2013). E.O. Wilson, in his book *Biophilia* (1984), introduced the Biophilia Hypothesis and made it popularized. He described human's tendency of direct experience of nature:

The living world is the natural domain of the more restless and paradoxical part of the human spirit. Our sense of wonder grows exponentially; the greater the knowledge, the deeper the mystery and the more we seek knowledge to create new mystery. (Wilson, 1984. p.10)

Wilson's (1984) biophilia hypothesis demonstrates that human innately affiliate with nature and they pay attention to and respond positively to it (there is a partly genetic basis). Connection with nature is a basic human need because it is critical to people's physical and mental health and their overall well-being (Kellert, 2015; Ulrich, 1993; Wilson, 1984). The biophilic hypothesis emphasizes humans' dependence on nature. It extends the dependence relationship far beyond basic material and physical issues to include also people's aesthetic, intellectual, mental, and spiritual needs. Given these points, the biophilic hypothesis has the potential to provide a framework for studies on the human-nature relationship in various disciplines (Kahn, 1999). The sections that follow review the literatures that have examined biophilia hypothesis regarding the nature and human health relationship in the context of theory and empirical evidence.

2.1.2 Human values of nature

The concept of the biophilia was derived from the understanding of human evolution (Kellert & Wilson, 1995). In short, human developed biologically through the adaptive response to natural rather than human-made force (Kellert, 2008). From an evolutionary perspective of the biophilic hypothesis, affiliation with nature is a part of

human's evolutionary heritage (Kellert & Wilson, 1995). As Ulrich interpreted, "if biophilia is represented in the gene pool, it is because a predisposition in early humans for biophilic responses to certain natural elements and settings contributed to fitness or changes for survival" (Ulrich, 1993. p.74-75). This means that certain natural features, in particular, water, trees, grasslands, flowers, and shelters, have improved people's chances of survival in the East Africa savannas where human beings lived for around 2 million years (Ulrich, 1993). Consequently, the preferences and innately emotional affiliation with these natural features and elements have been written into the human gene pool during this period of deep history throughout the evolutionary process. The biophilic hypothesis concludes that human identity and fulfillment, particularly emotional, cognitive, aesthetic, and spiritual development depend on our relationship with nature (Kellert & Wilson, 1995).

Kellert (1993) classified human's biophilic tendency (value of nature) into nine categories: "utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, and negativistic" (Kellert & Wilson, 1995, p.44). Although this typology may still be too simple to describe various values of nature, it still might be able to reflect the functional expression of people's dependence on nature.

Utilitarian. The utilitarian dependence on nature refers to people's dependence on the material value of nature. To illustrate, in the past, people acquired food, medicines, clothing, tools, and other materials from the natural environment. Nowadays, beyond materials mentioned above, people also explore new potentials of material values from

natural environments, such as genetic, biochemical, and physical properties of various organisms. (Kellert & Wilson, 1995).

Naturalistic. The naturalistic dependence on nature suggests people's satisfaction with and fulfillment from direct experience with nature. Direct experience refers to actual physical connection with nature-oriented elements, like trees, water, sand, and vegetation, in a nature setting. Indeed, the naturalistic tendency can provide the basis for studies on physical and mental benefits of being in contact with natural environments. In particular, the mental benefits of direct experience with nature, including tension release, relaxation, and peace of mind, have been reported (Kaplan, Kaplan, & Brown, 1989; Kaplan, 1995; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991). For example, through a naturalistic experience, Kaplan and Kaplan (1989) found that people value and prefer all kinds of natural landscapes (Kaplan & Kaplan, 1989).

Ecologistic-Scientific. People's ecologistic-scientific tendency on nature considers people's inquiry of natural environments and their belief of understanding nature through empirical study.

Aesthetic. The aesthetic dependence on nature describes human's preference for the physical beauty of natural environment. This preference has been found in various studies (Appleton, 1996; Kaplan & Kaplan, 1989). In the 1970s, both Iltis and Appleton argued that human's aesthetic response to natural elements, patterns, and processes is a result of the evolutionary process, and it is a genetic need (Appleton, 1996; Hugh H. Iltis, 1973). Kaplan and Kaplan (1989) examined people's preferences for different types of landscape and found that people's preference decreases from natural environments to built

environments with natural elements and to built environments without natural elements. (Kaplan & Kaplan, 1989).

Symbolic. The symbolic dependency on nature refers to that human utilize nature symbols of the extremely rich and textured natural system as a way to facilitate human self-identity, language, thought, and abstraction (Shepard, 1998).

Humanistic. The humanistic experience describes humans’ emotional bonding to individual elements of natural environment. Specifically, the humanistic experience of nature fosters interactive opportunities between humans and nature, including bonding, sharing, and cooperation. (Kellert & Wilson, 1995).

Moralistic. The moralistic experience are presented in human’s protection and conservation for natural resources. (Kellert & Wilson, 1995).

Dominionistic. The dominionistic experience of nature refers to the design to have a well understanding of natural environment. Specifically, knowledge regarding natural elements, patterns, and natural systems. (Kellert & Wilson, 1995).

Negativistic. The negativistic experience nature refers to the feeling of fear and aversion towards natural environment. This negativistic experience might lead to massive destruction of elements in the natural environment (Kellert & Wilson, 1995).

Term	Definition	Function
Utilitarian	Practical and material exploitation of nature	Physical sustenance/security
Naturalistic	Satisfaction from direct experience/contact with nature	Curiosity, outdoor skills, mental/physical development
Ecologicistic-Scientific	Systematic study of structure, function, and relationship in nature	Knowledge, understanding, observation skills

Aesthetic	Physical appeal and beauty of nature	Inspiration, harmony, peace, security
Symbolic	Use of nature for metaphorical expression, language, expressive thought	Communication, mental development
Humanistic	Strong affection, emotional attachment, “love” for nature	Group bonding, sharing, cooperation, companionship
Moralistic	Strong affinity, spiritual reverence, ethical concern for nature	Group bonding, sharing, cooperation, companionship
Dominionistic	Mastery, physical control, dominance of nature	Mechanical skills, physical powers, ability to subdue
Negativistic	Fear, aversion, alienation from nature	Security, protection, safety

Table 2.1 Typology of Biophilia Values by Stephen R. Kellert (Kellert & Wilson, 1995) pg.59

Note. Reprinted from *The Biophilia Hypothesis*, by S. R. Kellert & E.O. Wilson. Copyright 1993 by Island Press

2.2 Biophilic Response

Ulrich (1993) further summarized three general adapted positive (biophilic) responses to nature: 1) “*linking/approach responses*”; 2) “*restoration or stress recovery responses*”; 3) “*enhanced high order cognitive functioning when a person is engaged in a nonurgent task*” (Ulrich, 1993, p.88).

Linking/approach responses. People show positive responses to natural elements that foster survival. According to the existing studies, people tend to respond positively to natural landscapes, like savanna environments with spatial openness, small group of trees, or relatively uniform grass surface (Appleton, 1996). Moreover, they tend to prefer natural landscapes that provide immediate drinking water, green vegetation, and sanctuary and attract animals that could be hunted for food. Empirical evidences

supporting people's (from diverse groups and cultural contexts) preference for natural landscape were collected from both people's visual preference and real experience of environments (Benfield, Rainbolt, Bell, & Donovan, 2015; Honold, Lakes, Beyer, & Van der Meer, 2016; Kaplan, 1993; Sempik, 2010). The results of these studies suggested that: 1) people respond positively to natural landscapes with open spaces and water features (Völker & Kistemann, 2011; Wendel-vos et al., 2004). 2) people show higher preference for natural than urban landscapes (Kaplan & Kaplan, 1989; Tang, Sullivan, & Chang, 2015; van den Berg et al., 2007); and 3) people show higher preference for urban landscape with natural features than urban landscapes without natural features (Kaplan & Kaplan, 1989; Schutte, Torquati, & Beattie, 2017; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991).

Restoration and stress recovery responses. Ancient people acquired restoration response from natural settings. It helped them recover from mental fatigue and other deleterious effects, recharge energy, and further enhance their survival opportunities. Considering nature's positive effects on ancient people, current researches have proposed that modern people might be biologically prepared to acquire more restorative responses from natural settings than from urban settings. Empirical evidence from the existing studies have shown that the natural elements like water features (rivers, lakes, waterfront edges), open space (grassy meadows and valleys), and trees or vegetation (dense forest, open stands of trees, masses of shrubs or ground cover), are important for helping people recover from stress and mental fatigue and acquire restorative experience (Bagot, Allen, & Toukhsati, 2015; Kaplan, 2001; Mårtensson et al., 2009; Sullivan & Kaplan, 2016;

Tang et al., 2015). Hartig et al. (1991) compared the restorative effect of walking in an urban fringe nature area, walking in an urban area, and reading magazines (Hartig, Mang, & Evans, 1991). They found that the nature walk provides more positively toned emotional states. Ulrich et al. (1991) compared the stress recovery effects of natural settings and urban environments through verbal and physiological measures. An analysis of the findings from these studies suggested that exposure to nature has a positive effect on people's stress recovery (Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991).

High order cognitive functioning. Ulrich (1993) suggested that unthreatened nature exposure facilitates more positive emotional experiences, which leads to higher levels of cognitive functioning, like better long-term memory and creativity. Moreover, Kaplan and Kaplan's (1989) attention restoration theory proposed that exposure to nature helps people recover from mental fatigue and improves direct attention span for learning and working.

2.2.1 *Biophilic design*

Many researchers have examined health benefits of being connected with nature, identifying benefits in cognitive functioning, psychological responses and physiological responses (Browning, Ryan, & Clancy, 2014). However, nowadays, society depends more on technology, disconnecting people from nature (Browning et al., 2014; Louv, 2008). Therefore, it is important to apply the idea of biophilia as well as empirical evidences from related studies to design applications so that people may experience the health benefits of nature through the designed built environment. Researchers and practitioners have developed design applications from research on biophilia. Hence,

biophilic design is a way to efficiently contribute to people's health and well-being (Browning et al., 2014). The helps to close the gap between the current research and design practice.

Browning et al. (2014) defined biophilic design as, “*a biological organism, respecting the mind-body system as indicators of health and well-being in the context of what is locally appropriate and responsive*” (Browning et al., 2014, p.13). The goal of biophilic design is to create a good living environment for people to improve their health and well-being (Kellert, 2015). How to address the contemporary built environment and establish a new framework for the supportive connection with nature in the built environment is a challenge for biophilic design (Kellert, 2015). Additionally, biophilic design was explored in many scales of built environment including urban scale, regional scale, and site scale. For example, Littke (2016) studies biophilic design from the urban scale. According to the author, biophilic urbanisms is an emerging approach for the holistic understanding of urban natural environments and people's behavior, experiences, and health outcomes. The challenges and opportunities associated with the biophilic urbanism implementation were studied through a case study in Birmingham, UK (Littke, 2016). Salingaros (2015) explored the sense of Biophilia in buildings and identified eight major factors that contribute to the effect of the biophilia experience on health. In specific, eight major factors are light, color, gravity, fractals, curves, detail, water, and life (Salingaros, 2015).

What is good biophilic design? Kellert (2001) suggested that the best biophilic design maintains thoughtful connection with nature. It helps decrease stress and anxiety

and provide many physical, mental, and behavioral benefits (Kellert, 2015). Browning et al. (2014) suggested that a good biophilic design must consider health, concern culture and social background as well as people's expectations, experiences, and perceptions. It creates a nature-based place that provides people inspiration, restorative and health (Browning et al., 2014). Moreover, Browning (2014) conducted a robust rigorous review of empirical studies, which examined the relationship between nature and health in the built environment and developed a framework of "14 Patterns of Biophilic Design."

Browning (2014) categorized fourteen biophilic design patterns into three: 1) "*Nature in the Space*"; 2) "*Natural Analogues*"; 3) "*Nature of the space*" (Browning et al., 2014 p.12). Evidence of how does each pattern address people's cognitive functioning, psychological responses, and physiological responses from previous literature were summarized.

Moreover, Heerwagen (2009) stated that a good biophilic design also creates places with positive emotional-like fascination, interesting, happy and discovery experiences. Based on this concept, Heerwagen (2009) developed a biophilic template for future biophilic design application:

- 1) "Heraclitean motion" (Heerwagen, 2009, p.48). Heerwagen (2009) believes designers should take advantage of the soft movement patterns of natural elements like water, sun, clouds, leaves, that people feel safe and tranquil.
- 2) "Change and resilience" (Heerwagen, 2009, p.48). Heerwagen (2009) summarized that natural habitats always in the cycle of birth, death, and regeneration. Therefore, compare to the built environment with always on the

- process of deterioration, natural settings can remind people the power of resilience and their connection with the ecological community.
- 3) “Variations on theme” (Heerwagen, 2009, p.49). According to Heerwagen (2009), although natural elements have various growth patterns, some of them also present similarities. Therefore, designers could use these similarities and variations to create identities of spaces. For example, design a sensory trail with many kinds of colorful flowers.
 - 4) “Discovered complexity” (Heerwagen, 2009, p.53). Living forms and spaces often provides more sense of exploration than built objects. Increasing sense of exploration foster people’s feeling of fascination. However, environment that too complex makes people confused. In responding to this situation, Heerwagen (2009) summarized a design strategy, which is to address the comprehension firstly, and develop more detailed complexity for exploration secondly.
 - 5) “Multi-sensory” (Heerwagen, 2009, p.53) Natural elements like sun, water, trees usually provide multiple sensory stimulations including sight, sound, touch, taste, and odor. Designer could foster people’s appealing to environment by providing people multiple sensory experience.
 - 6) “Transformability (Heerwagen, 2009, p.54)” Heerwagen connected the transformability of natural settings with children. He stated that natural settings have many transformable and multi-uses elements. Children love to use anything they can find in nature as play materials, such as branches, flowers, leaves.

Designing for children's environment should take nature's character of transformability into consideration.

Furthermore, Kellert (2015) established a framework for nature-based environments that provide positive emotions. Five basic principles that supports the successful application of biophilic design were presented. In this framework, the author emphasized that nature-based environment should focus on people's health and well-being. To achieve this goal, people's emotional attachment and people's responsibility need to be cultivated through providing sustained engagement with nature (Kellert, 2015, p. 6-7).

2.3 Nature Exposure and Restorative Experience

2.3.1 Nature exposure and children's health

Modern development and technology evolvement significantly affect the human-nature relationship. Children's perceptions, interactions, and behaviors with nature become more diverse. According to Kellert, broadly speaking, people experience nature in three ways, through direct experience, indirect experience, and vicarious experience (Kellert, 2002). Directed experience refers to actual physical person-nature connection within natural settings. To illustrate, natural settings usually contains nature-oriented elements, like vegetations, water, sand, and natural materials, and is away from built environments and human control. For example, when children play in natural settings, they play in places like woods, forests, meadows, and creeks. Indirect experience with nature refers to actual physical contact with natural elements, however, in a far more managed contexts, like the zoo, botanical gardens, museums, or natural centers.

Therefore, children often acquire indirect experience with nature from those human controlled natural environments that are integrated into the built environment. Vicarious or symbolic experience refers to the experience that excludes actual direct and indirect contact with nature; instead, it represents an encounter with nature through symbolic or stylized ways, such as images on television, films, and books. Even though the vicarious experience of nature has been acknowledged since ancient times through abstract depiction of the natural world, today's children have an extraordinary proliferation of symbolic experience with the natural world through mass media. Concerns regarding children's increased vicarious experience and decreased direct and indirect experience and their health development are evolving (Louv, 2008; Pyle, 1993). In this framework, Kellert (2002) suggested that experiences make different influences on children's cognitive, emotional and moral development. Evidence shows that direct and indirect experience benefits children's health development the most (Kellert, 2002).

People have long acknowledged that being in contact with nature may benefit health. Olmsted, as early as in 1865, argued that a view of nature fosters restoration from mental fatigue (Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991). Previous studies have explored various health benefits of experiencing natural environment, including physical health, psychological health, mental and emotional health, and well-being among diverse age groups, cultures, and physical contexts. (Bratman et al., 2012; Frumkin, 2001; Maller et al., 2006; Richardson, Pearce, Mitchell, & Kingham, 2013; Schutte et al., 2017; Shanahan et al., 2015; Sullivan & Kaplan, 2016; Völker & Kistemann, 2011).

The importance of physical activity in health is well known (Maller et al., 2009). Many studies have focused on the effects of green space and public parks on physical activity. The findings have indicated that environmental characteristics of green space encourage and support various physical activities, such as walking, cycling, and sports (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Hartig et al., 2014). Wendel-Vos (2003) explored individual physical activity and neighborhood level physical environment and found that green and recreational spaces encourage individuals to spend longer time cycling (Wendel-vos et al., 2004). Moreover, a cross-sectional study in New Zealand suggested that green space availability correlates with health outcomes, such as cardiovascular disease, obesity, and poor mental health via physical activity (Richardson et al., 2013).

The U.S. Department of Health and Human Services (DHHS) states that physical activity improves children's bones and muscles and reduces the risk of obesity and chronic diseases (McCurdy, Winterbottom, Mehta, & Roberts, 2010). Current studies have indicated that parks, schools, trails, and recreational facilities promote physical activity among children. Roemmich et al. (2006) conducted a quasi-experiment with four to seven-year old children and found a positive correlation between children's physical activity and proportion of park area of their homes. School grounds with natural settings, such as trees, natural trails, and natural landscape promote higher levels of physical activity. Fjortoft (2001) conducted a quasi-experimental study. The subjects are children among five to seven-year old. The results indicated that the natural environment supports children's motor development (Fjortoft, 2001).

Apart from promoting physical health, current evidence also suggests nature's positive role in restorative experience and stress reduction. Eco-psychologists have reinforced Wilson's biophilia hypothesis and pointed out that nature exerts positive emotional effects on people's mental and emotional health. (Kaplan, 1992; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991). Attention Restoration Theory (Kaplan & Kaplan, 1989) proposes that the natural environment is restorative in that it helps people's recovery from mental fatigue (Kaplan, 1992, 1995). According to Kaplan (1993), mental fatigue reduces people's ability to concentrate, which can have dangerous consequences (Kaplan, 1993). In addition, Kaplan (1993) asserted that besides the remote natural environment, nearby nature also supports health promotion. Ulrich (1991) examined the nature's positive effects on people's psychological health based on which he developed Stress Reduction Theory. He asserted that, "*All of the theoretical perspectives discussed earlier – cultural, arousal and evolutionary – coverage in implying that everyday unthreatening natural environments, compared with most urban settings, should tend to foster greater stress recovery*" (Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991, p.209).

Based on the existing theories from environmental psychology, many studies have examined the potential of natural environment on people's health. For example, Grahn and Stigsdotter (2003) surveyed 953 randomly selected individuals in Sweden and found that people like to spend some time in the urban green space when they feel stress or fatigue. They found a significant negative relationship between the people's use of urban green space and their self-reported experience of stress (Grahn and Stigsdotter 2003).

Sempik (2010) suggested that therapeutic horticulture support the treatment and caring for people with mental health problems because it contribute to people's restorative experience, meaningful occupation, and social interaction (Sempik, 2010).

Theories and studies on children have also tried to explain the ways in which children value connection with complex natural environments. These studies have shown that natural features can provide health benefits to people who interact with it (Hart 1979; Moore 1986; Rivkin 1997). Kuo and Tylor (2004) examined the effect of natural settings on children's attention-deficit/hyperactivity disorder (ADHD) and concluded that "green" settings support ADHD symptom reduction in children with diverse characteristics (Kuo & Taylor, 2004). More recently, a study examined the restorative effects of nature on four to eight-year-old children's executive functioning. The results showed that compared with children who completed an urban streets walk after an attention fatigue activity, children who completed a natural walk performed significantly better on attention task (Schutte et al., 2017). Moreover, Maller (2009) investigated the benefits of contacting with nature on children's mental, social and emotional health from educator's perspective through face-to-face interviews. The results showed that school principals, teachers, and professionals from educational industry believed that activities that involve hands-on contact with nature provide mental, emotional, and social health benefits on self-esteem, stress relief, freedom creativity, and sensory engagement (Maller, 2009).

Other health benefits of being connected with nature involve spiritual health and social health. Maller, Townsend and Prosser (2010) summarized the contribution of green space to human spiritual and social health by reviewing the existing literature. They

concluded that the natural environment promotes spiritual health since it facilitates feelings of connection to something beyond human concerns. Furthermore, natural environments, such as green spaces and parks, enhance social interactions and social health (Maller et al., 2009).

2.3.2 *Causal pathway of nature and health*

Moreover, recent studies have started to explore the implications for designing a better natural environment for health promotion in various settings. In order to achieve this goal, studies on the relationship between nature and health have tried to understand the how nature delivers health benefits, also refers to causal pathway. Sullivan and Kaplan (2016) examined recent evidences on the effects of nature on well-being and identified two pathways between nature exposure and well-being, Stress Reduction Theory (SRT) and Attention Restoration Theory (ART). Based on these pathways, they came up with design implications for healthcare settings to solve stress and mental fatigue of healthcare workers, patients, or family members (Sullivan & Kaplan, 2016). Shanahan (2015) articulated a formwork that depicts causal pathways through which specific natural elements deliver health benefits. They proposed this framework (Figure 2.1) to uncover the causal relationship between nature and health. Six steps included:

- 1) *Identify a specific, measurable element of nature.*
- 2) *Identify a key characteristic or function of the nature elements.*
- 3) *Identify factors that could influence whether the ecosystem function has an effect on people (e.g. physical, social, cultural or behavioral factors, extent and timeframe of exposure).*
- 4) *Identify what effect, if any, the ecosystem function can have on people.*
- 5) *Identify*

factors that could influence whether the effect translates to a benefit. 6) Identify a specific health benefit. (Shanahan et al., 2015, p.472).

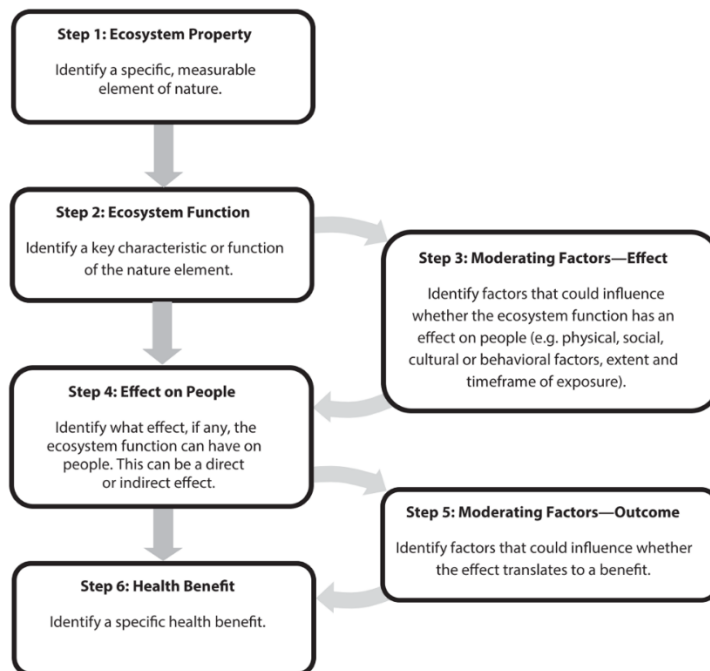


Figure 2.1 Framework for Identifying the Pathways to Health Benefits from Nature (Shanahan et al., 2015, p.472)

Note. Reprint from *Toward Improved Public Health Outcomes from Urban Nature*, by Shanahan et al., 2015. *American Journal of Public Health*, 105(3), P.472. Copyright 2015 Am J Public Health

Likewise, Hartig et al. (2014) reviewed recent studies on the health benefits of being in contact with nature. Four pathways from being connected with nature to health outcomes were identified, including 1) air quality, 2) physical activity, 3) social cohesion, and 4) stress reduction. As Hartig et al. (2014) explained, four pathways addressed three aspects of nature: physical environment, setting for (individual and social) behavior, and experience. People use three aspects and full pathways together to connect with nature (Hartig et al., 2014, p.213).

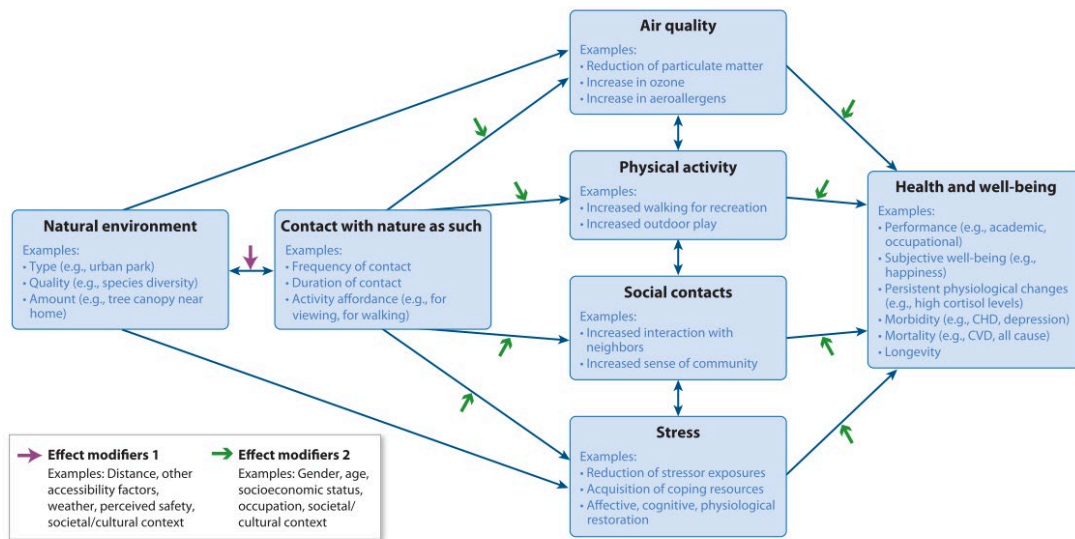


Figure 2.2 Pathways through Which Contact with Nature Relates to Health (Terry Hartig et al., 2014, p.213)

Note. Reprint from *Nature and Health*, by Terry Hartig et al., 2014, *Annual Review of Public Health*, 35 p.213

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2.3.3 Restorative experience for children

The nature of the restoration experience: theory from environmental psychology

Compared to early humans who lived closely connected with the natural environment, people today live in high-stress urban environments and constantly changing living environment. One of the major common changes today's people facing is higher levels of pressure from various sources, which gradually influence their physical and psychological health. These changes contribute to people's mental fatigue and to poor physical and psychological health and well-being. Studies in the field of environmental psychology have tried to explain the reason for these changes. Kaplan (1992) listed three pressure sources affecting individuals in modern society, specifically, "advances in technology, the knowledge explosion, and the increasing work population"

(Kaplan, 1992, p.134). Ulrich et al. (1991) stated that people's stress comes from the challenges or situations that cause fear, anger, and sadness. In addition, both of them identified the important role of natural environment in reducing mental fatigue and stress in people's health (Kaplan, 1992; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991).

Environmental psychologists have studied the relationship between the natural environment and people. They revealed the significant role of natural environments or natural features in reducing mental fatigue. The mechanisms or metrics underlying the nature's power to reduce mental fatigue vary. Kaplan and Kaplan's (1989) Attention Restoration Theory is based on the perspective of nature's attention holding ability, which suggests that nature helps people recover from things that require their direct and effortful attention and cause mental fatigue. The "involuntary attention" involves the attention that is stimulated by something fascinating or exciting by the environment, was first brought up by James (1892) (Kaplan, 1995). According to James (1892) and Kaplan (1992), one type of attention is the "directed attention" that requires effort. Since the directed attention requires effort, people who spend long time on a task that requires directed attention tend to experience mental fatigue. "Involuntary attention" is the other type of attention that requires no effort. Kaplan also concluded that in a society with mass information that requires people's directed attention, people have increased demands for environments that can evoke their "involuntary attention" (Kaplan, 1992).

Nature as a promotion for the restorative experience

Kaplan and Kaplan have defined the restorative experience as: “*An experience, which leads to recovery from mental fatigue as well as a variety of associated benefits.*” (Kaplan, 1992. p.137). Restorative experience can facilitate the recovery from mental fatigue. The mechanism of the restoration experience is that people can rest their part of mind when the models of the world effortlessly in their heads (Kaplan, 1992). A restorative experience needs the cooperation of people and environment. In their research, the Kaplan (1992) defined four components that stimulate the restorative experience (Kaplan, 1992). According to Kaplan (2001), these four components are not only four central properties of a restorative environment, but also four properties of human-environment interaction. Therefore, with these four properties, people can identify an environment that contributes to a restorative experience (Kaplan, 2001). These four properties are summarized below:

Being away. Being away refers to being in some environment that is physically or psychologically away from previous environment. Therefore, it includes two types, being away physically and being away psychologically. Kaplan clarified three reasons for being away: 1) being away from unwanted distractions in the surroundings; 2) being away from work environment as well as the environment that resembles it; and 3) suspend a pursuit of particular purposes (Hartig et al., 1991). Natural environments, like mountains, water, sky, flowers, or stream allow individuals to get away, which leads to a restorative experience, especially for people who live in the urban context. Besides natural environment far away from cities, hands-on natural settings in the urban context that

people can access easily provide restorative experience as well (Kaplan, 1993; Kaplan, 1995).

Extent. Extent refers to the scope and coherence that the environment offers to individuals to maintain engaged (Kaplan, 2001). In these environments, people feel as if they are “in a different world.” Two important properties of an environment, scope and connectedness, can be used to measure or define the extent. As Kaplan (1995) defined, scope refers to the size of the environment (physical and psychological) through which people can move freely without worrying about its limits. Connectedness refers to the understanding that sub parts of the environment are sensed as a whole part. Therefore, the physical size of an environment is not the absolute measurement of the extent of an environment. For example, the trails in a smaller environment can be designed to make people feel as if they were in a large area. Various designers of traditional Chinese and Japanese gardens have utilized this concept. Besides physical and conceptual size of an environment, many other elements can enhance people’s engagement in an environment. For example, a landscape that provides various cultural elements can connect people with different cultural-historical time periods, like a memorial garden (Kaplan, 1995). Some places stimulate people’s imagination or offer opportunities for varied activities and events, like Disneyland. Likewise, natural environment or nature-based landscapes in the urban context with rich stimulation, elements, configurations, and changes have great potential for providing a sense of scope and connectedness.

Fascination. In addition to “being away” and “extent,” a restorative environment also needs to be interesting or fascinating. In specific, fascination refers to environments

with certain patterns that hold individual's attention effortlessly (Kaplan, 2001). Two types of fascination, soft fascination (mostly experienced from nature) and hard fascination (experienced from watching TV, sports event), were identified (Kaplan & Kaplan, 1989). Soft fascination experienced from nature often requires more involuntary attention. Therefore, compared with built environment, natural environment is certainly providing people more soft fascination through various elements, stimulations, and changes. Kaplan (1995) stated that people are fascinated not only by aesthetic scene of the environment, but also by its functions, such as feelings of exploration and challenges (Kaplan, 1992). People tend to be interested in various natural phenomena. For example, changing patterns of leaves, clouds, sky, water, sounds of birds, and moves of worms seem to grab people's attention.

Compatibility. Compatibility means that an environment supports individuals do what they want to do or prefer to do (Kaplan, 2001). Environment that is compatible allows people to accomplish desired goals and actions in the environment. In this environment, the environment thoroughly supports people's mood. Thus, people can accomplish goals and actions without considering obstructions from the physical environment that require mental efforts. Consequently, the environment provides an effortless quality for people in it and leads to a restorative experience (Kaplan, 1992). According to Kaplan, natural environment is usually perceived as more compatible compared to built environment, even though people are more familiar with their immediate surroundings, which are typically built spaces. He explained that people can experience natural environment from various roles, such as:

...predator role (such as hunting and fishing), the locomotion role (hiking, boating), the domestication of the wild role (gardening, caring for pets), the observation of other animals (bird watching, visiting zoos), survival skills (fire building, constructing shelter) and so on. (S. Kaplan, 1992, p.139)

In conclusion, natural environment with its particular richness has four properties (being away, extent, fascination, and compatibility) of an restorative environment that people may recover from stress and mental fatigue (Kaplan, 1995).

The effects of the restorative environment on adults has been examined extensively, whereas research on the effects of children's restorative environment, especially very young children, is limited (Bagot et al., 2015). The research on children's restorative environment is summarized below.

Berto, Pasini, and Barbiero (2015), in their study of a sample population of 48 eight to eleven-year-old children, found that the difference between the natural environment and the built environment in restoration value could be perceived by children in this age group (Berto & Barbiero, 2015). Another study examined the predictors of the quality of perceived restoration for children's playgrounds. They found vegetation volume is a significant naturalness measure predicting perceived restoration; and identified the potential for the school's physical environment in enhancing children's restoration experience (Bagot et al., 2015). Another study examined the restoration effects of green outdoor environments on children in pre-school settings in Sweden and found that trees, shrubbery, and hilly terrains contribute to children's higher level of restoration experience (Mårtensson et al., 2009). Current research on children's mental

health emphasizes the attention restoration value of an outdoor play environment in school settings and the important relationship between natural volumes in outdoor play environment and its restoration effect. However, the concept of “nature volume” needs to be clarified, especially from the standpoint of studies on the design of the outdoor built environment. Within this context, nature volume appears ambiguous. A child’s restorative experience in the play environment is closely related to the quality of the play environments. However, research on the effects of the design of natural features on children’s restorative experience is limited.

2.4 Nature Play and Play Environments

2.4.1 Development of Children’s Play Environment

Already Plato and Aristotle had considered the importance of play in children’s development by considering that play is valuable in learning. Froebel (1826) was one of early educators who recognized the value of play in providing joy, freedom, contentment, inner and outer rest, and its contribution to children’s development. Contemporary theories of play have evolved mainly into three main theories, namely, psychoanalytical, Piagetian, and behaviorism (Frost, 1992). Freud (1950) and Erikson (1950) proposed the psychoanalytical theory and stated that play is motivated by pleasure feelings. It links children with wishes and experiences in the real world. Therefore, play is unique and meaningful to each individual (Erikson, 1950; Freud, 1955). In addition, Piaget’s cognitive-development theory regards play as a cognitive behavior. Piaget (2013) developed a comprehensive framework of intellectual development and suggested that children’s cognitive processes include assimilation and accommodation (Piaget, 2013).

Moreover, Piaget (1962) defines play as

“play constitutes the extreme pole of assimilation to the ego, while at the same time it has something of the creative imagination which will be the motor of all future thought and even of reason.”(Frost, 1992, p.11)

Dr. Joe Frost from the University of Texas at Austin studies the evolution of American playground. He suggested that early equipped playground in the United States which focused on children’s physical development, were influenced by Germany. Fredrich Froebel is the pioneer of Kindergarten in German. He noticed the impact of play on children’s development and combined play and work in his curriculum. In his kindergarten, children experienced free play with natural features. For example, children-built canals, dams, bridges; cultivated gardens and fruit trees; and observed birds and flowers. Open spaces were designed to facilitate running, ball playing, or war playing, among other activities (Frost, 1992). With the inspiration from Germany, “Sand Garden” in Boston was built in 1877. According to Frost, Fredrich Froebel was the first person to utilize existing play and learning theory in practice. Frost (1992) identified three periods of American playgrounds development based on types and ranges of their play equipment: 1) The manufactured apparatus era; 2) The novelty era; and 3) The modern era (Frost, 1992).

The first period is the manufactured apparatus era. The phrase “Model playground” first used by Jane Addam (1809) refers to playgrounds with sand piles, swings, building blocks, and a giant slide. As the “model playground” spread from city to city, the concept of playground became well known. In 1908, the designed playground

with gymnastic equipment appeared in the United States. The playgrounds contained primarily sand court, 4 rope swings, sliding board, giant strides, teeterboards or teeter ladders, ring toss or quoits, and some other play equipment for playing sports. Iron, steel, and wood were the most common materials. In this period, children's physical development was emphasized more than their mental development. While playing on the playground, children developed their muscles through physical exercise. Despite the awareness of the benefits of playgrounds, designed equipment or environments that address children's development were rarely seen until mid-1900s. In 1930s, because of the great depression, sports fields often shared space with playgrounds to meet the demands of unemployed youth and adults. After World War II, a playground construction period appeared. Adventure playgrounds emerged from the idea of "junk play" and "adventure play," and they were introduced to the United States in the 1950s. The American scheme was to use the vacant lots for play and recreation, and it created opportunities for children to mold and shape their playing environment (Frost & Wortham, 1988).

Another playground style—novelty playground—was introduced between 1950s and 1970s. This period is one of the most innovative periods in playground development. In the novelty playgrounds period, people addressed the aesthetic quality, play value, safety, and manufacturability of the playgrounds. The purpose of creating the novelty playgrounds is to use novel, imaginative, and fantasy sculptures to replace sands, slides, and swings and promote children's imagination. Theme playgrounds and sculptured play

equipment emerged. The play structures and environments became more appealing to both adults and children (Frost, 1992).

The third period is the Modern era. The standardized playground was introduced between 1970s to 1980s to reduce people's concerns about injuries and address safety issues of playgrounds. During this period, modular wood equipment was popularized. However, people focused more on expensive play structures and less on the development of the surrounding environment. From the 1990s, researchers have focused on developing integrated playscape for play, health, and learning. In the 21st century, the challenge is to design playground that would enhance play for children's fitness, health, as well as brains and bodies (Frost & Wortham, 1988).

2.4.2 Nature play

Research on children's experience of place has been conducted for decades. Hart (1979) emphasized the necessity to consider the physical environment as well as children's engagement with the landscape. He stated, "any attempts to design successful environments with children should be preceded by an understanding of children's activities in and experience of the physical environment" (Hart, 1979, p.3). Moreover, Moore (1986) studied children's use of play spaces and their preference on their local environments. He also addressed children's relationship with natural environmental elements. Furthermore, studies on biophilia revealed people's affiliation with nature. Moore and Wong (1997) examined children's affiliation with nature through investigations on existing empirical evidence (Moore & Wong, 1997). Hart (1997) pointed out that children have an innate affiliation and curiosity for natural world, which

are important for children's understanding of world and life (Hart, 1997). Heerwagen (2002) demonstrated that children generally have higher preference on small scale and moveable objects from natural environment than big structures from built environment. In addition, natural elements in play environment can stimulate more imaginary play than fixed play equipment (Heerwagen & Orians, 2002). Moreover, Heerwagen also pointed out that swings, slides or fixed play equipment dominates today's design of outdoor playgrounds in various context and it might be able to improve if designers have better understanding of children's play behaviors. Therefore, children are expected to have immediate connection with natural elements even though they live in an urban context.

Moore (2014) defined nature play as:

“A designated, managed area in an existing or modified outdoor environment where children of all ages and abilities play and learn by engaging with and manipulating diverse natural elements, materials, organisms, and habitats through sensory, fine motor and gross motor experience” (Moore, 2014, p.5).

Current research examined benefits of children's nature play. Gill (2011) did a quasi-systematic review of the existing empirical evidence. He categorized benefits of nature play into six categories, which includes:

health (physical activity, mental health healthy eating and motor development), well-being (quality of outdoor play and psychosocial health), cognitive (scientific learning, environmental knowledge, and language and communication), social (social skills), emotional/behavioral (self-control, self-

confidence, and self-awareness), Ethical/attitudinal (concern for the environment, connectedness to nature and sense of play). (Gill, 2011, p.19)

Within health aspect, physical health has been examined the most. For example, Fjortoft (2001) investigated the relationship between natural environment and children's motor fitness. The results indicated that playing in natural environments improve children's balance and coordination skills (Fjortoft, 2001). What is more, Smith et al. (2016) explored the association between outdoor learning environment and three to five-year-old children's physical activity level. They concluded that the design of outdoor learning environment, including form and content, impacts the level of children's physical activity. Moreover, previous studies also explored natural play environment and children's mental health. Specifically, Wells, Nancy and Evans (2003) found that nearby nature helps children (grades three through five) relieve from stress (Wells, Nancy; Evans, 2003). Martensson et al. (2009) concluded that preschool children show more attention after exposure in green and well-integrated outdoor environments (Mårtensson et al., 2009). Study results from Bagot et al. (2015) indicated that school playground with nature settings/elements contribute to higher perceived restorative experience (Bagot et al., 2015).

Empirical research regarding design applications also explored how do designed natural elements enhance children's play value. White and Stoecklin (1998) identified children's preferences on outdoor environments including: water, vegetation, animals, sand, natural color, shelter, and shade. In addition, places and features to sit and roll, places with privacy and views, changeable structures, equipment and materials are also

welcomed by children”(White & Stoecklin, 1998, p.6). Woolley and Lowe (2013) reviewed the existing literature and summarized the relationship between natural elements and play value as follow: landform provides physical play and various senses of spatial experience. Vegetation like trees and shrubs can provide aesthetic and educational value. Materials such as water, sand, and stones forester children’s learning and creativity. Loose parts stimulates children’s imaginary play, as well as interactions with environment (Woolley & Lowe, 2013).

2.4.3 Affordance of play environment

One typical way of describing a physical environment, both nature and built environment, is through its form, for example, two swings on the right side of the entrance, a row of trees and shrubs at the edge of the playground, and one play structure in the center. Describing a place through form emphasizes mainly the objects or things in the scene (Heft, 1988). However, this is not just one way to describe a place, and it is not always the most useful way. Gibson’s Theory of Affordance offers an alternative approach that describes a physical environment through its function instead of form (Greeno, 1994; Heft, 1988). Specifically, Gibson (1979) suggested that people are aware not only of objects or structures in the environments, but also of their functional meanings. He developed the Theory of Affordance to link features of the environment with its functions, illustrating that an environment’s composition supports specific behavior (Greeno, 1994). Therefore, the affordances of the environment focus on the functionally significant properties in relation to an individual (Greeno, 1994; Heft, 1988).

It is clear that theory of affordance focuses on the relationship between the environment and people who use it.

Heft (1988) compared two approaches to describe a physical environment: the functional approach and the form-based approach, which he summarized as follows, 1) affordances consider the functional significance, whereas form-based approach only describes the item without connecting it with the individual who uses it; 2) affordance emphasizes the experience of the place while form-based approach focuses on classification of items; and 3) unlike form-based approach, affordance approach does not have mutually exclusive character, since features in the environment often have multiple functions (Heft, 1988).

Moreover, Heft (1988) and Kytä (2002) identified the advantage of theory of affordance in describing psychologically essential qualities of children's environments (Heft, 1988; Kytä, 2002). According to Heft (1988), to identify both the affordance of a place and the psychological habitat at the same time, it is necessary to understand the characteristic of the environment, the person, and the behavior. He investigated data from Barker's and Wright, Moore, and Hart's studies of children's play environment and play behaviors and noted that functional description of the environment is more meaningful psychologically. Moreover, Heft (1988) developed a functional taxonomy to describe the functionally significant properties of children's environments. He stated that the functional taxonomy "*primarily offers a way of thinking about environments that is psychologically meaningful.*" "*...it is a much richer accounting of the psychological resources of the environment for an individual*" (Heft, 1988, p.36). This functional

taxonomy can be used as a measurement of designed children’s play environment (Heft, 1988). Ten categories were included in the original functional taxonomy of children’s outdoor play environments developed by Heft (1988). Kattä (2002) enlarged the environmental affordances, which also includes the social affordance and play.

Flat, relatively smooth surface	Affords walking, running Affords cycling, skating, skateboard
Relatively smooth slope	Affords coasting down (e.g. on bike, wagon) Affords rolling, sliding, running down Affords rolling objects down
Graspable/detached object	Affords drawing, scratching Affords throwing Affords hammering, batting Affords spearing, skewering, digging, cutting Affords tearing, crumping, squashing Affords building of structures (e.g. raw materials for forts)
Attached object	Affords sitting on Affords jumping-on/over/down-from
Non-rigid, attached object	Affords swing-on (e.g. tree branch)
Climbable feature	Affords exercise/mastery Affords looking out from Affords passage from one place to another (e.g., stairs, ladder)
Aperture	Affords locomoting from one place to another Affords looking and listening into adjacent place
Shelter	Affords microclimate Affords prospect/refuge Affords privacy
Moldable material (e.g., dirt, sand)	Affords construction of objects (e.g., pottery) Affords pouring Affords modification of its surface features (e.g., sculpting)

Water	Affords splashing Affords pouring Affords swimming, diving, boating, fishing Affords mixing with other materials to modify their consistency
Affordance for sociality	Affords role playing Affords playing rule games Affords playing home Affords playing war Affords being noisy Affords following/sharing adult's business

Table 2.2 A Functional Taxonomy of Children's Outdoor Play Environment (Heft, 1988, p.36; Kyttä, 2002, p.112)

Note. Reprint from Affordances of Children's Environments in the Context of Cities, Small Towns, Suburbs and Rural Villages in Finland and Belarus, by M. Kyttä, 2002, *Journal of Environmental Psychology*, 22(1), p.112, <http://www.idealibrary.com>. Copyright 2002 Elsevier Science Ltd.

Instead of considering affordance as a fixed phenomenon, Kyttä (2002) suggested considering its dynamic nature. As Kyttä stated, affordances in an environment can have two aspects: potential and actualized. Specifically, potential affordances involve perceived affordances related to the play object's individual characteristics while actualized affordances relate to a perceived affordance. Therefore, the affordance is decided by both environment itself and the ways in which people interact with it. (Heft, 1988).

Many studies have applied affordance theory to examine play experience of children in various environments. Based on the Theory of Affordance and Heft's functional taxonomy, Kyttä (2002) examined different types of affordance for children in

Finland and concluded that rural areas offer a physical environment of the highest affordance to children. Clark and Uzzel (2002) examined the role of the environment in adolescents' social interaction and social development by comparing different key environments. They concluded that utilize Gibson's theory of affordance as a method to study the functional characteristic of environments is applicable. Fjortoft (2001) applied affordance theory to study the effect of natural environment on learning and developments of five to seven- year-old children. They found that natural landscape has the potential to provide children with a stimulating and rich play area and indicated a strong relationship between natural environment and various play behaviors (Fjortoft, 2001).

2.5 Gap in the Literature

Figure 2.3 illustrates the three bodies of knowledge (biophilia, children's health and designed environment) that were reviewed. The bodies of knowledge define an interdisciplinary approach for this research. It also establishes the theoretical framework and research methods for data collecting and analyzing empirical data for this study.

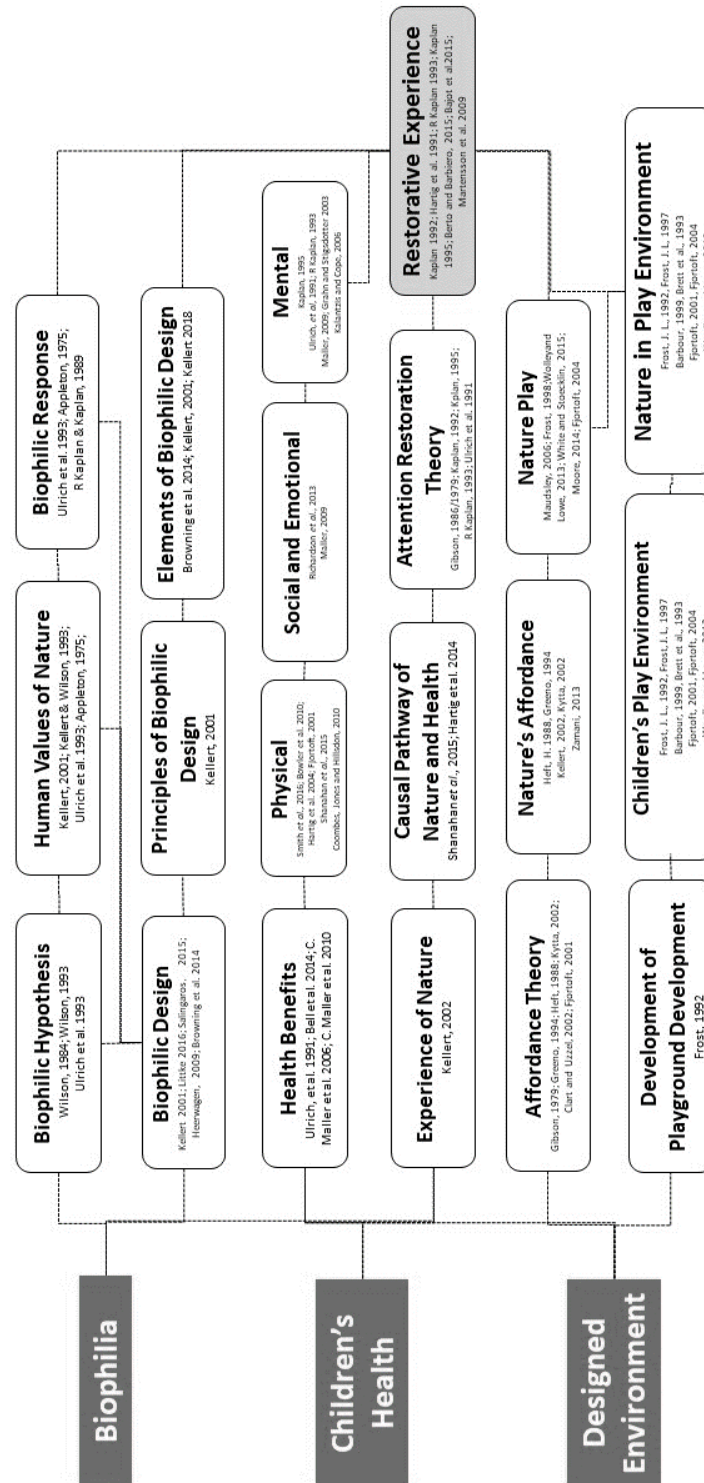


Figure 2.3 Three Bodies of Knowledge

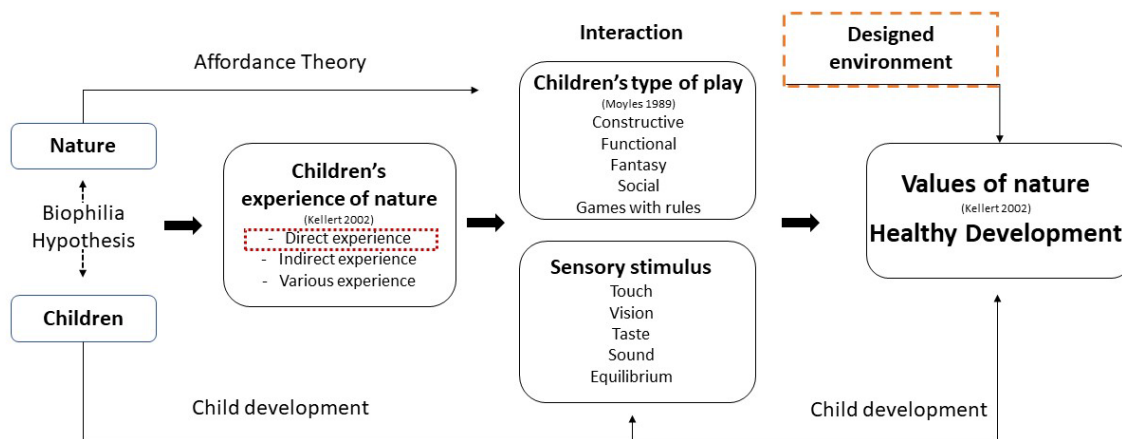


Figure 2.4 Framework of Children-nature Interaction

Figure 2.4 shows the gap in the literature. Based on the literature, the model of children's interaction with the natural environment has been developed. Specifically, according to the biophilic hypothesis, children have an innate tendency to interact with the certain natural environment (Ulrich, 1993). Children interact with nature in the built environment through direct experience, indirect experience and the experience of space and place (Kellert, 2018). The combination of these three experience will be most efficient in terms of children's healthy development (Kellert, 2018). According to the affordance theory, natural environment facilitates children's play behavior (Greeno, 1994; Heft, 1988). Based on theories in children's development (Erikson, 1950; Frost, 1992; Piaget, 1971), the children's stage of development also determines the ways in which they interact with the natural environment. Finally, an optimized children-nature interaction can contribute to children's appreciation of nature and their healthy development (Kahn & Kellert, 2002). The outdoor designed environment, which is most accessible to children, has great potential in facilitating children-nature interaction, and

positively affects their lifelong health and well-being, has however never been thoroughly examined. Few studies have focused on attention restoration in children (all ages) and few have considered designed environments (Laughlin, 2013). Preschool children’s (three to five-year-old) attention restoration has been studied even less (Laughlin, 2013). Specifically, nature volume has been used as a measure of nature in the environment to examine its relationship with children’s restorative experience, but a limited number of studies have addressed the relationship between the quality of the outdoor designed environment, children’s play behavior, and their restorative experience. Hence, this dissertation aims to address this gap in the literature.

2.6 Theoretical Framework

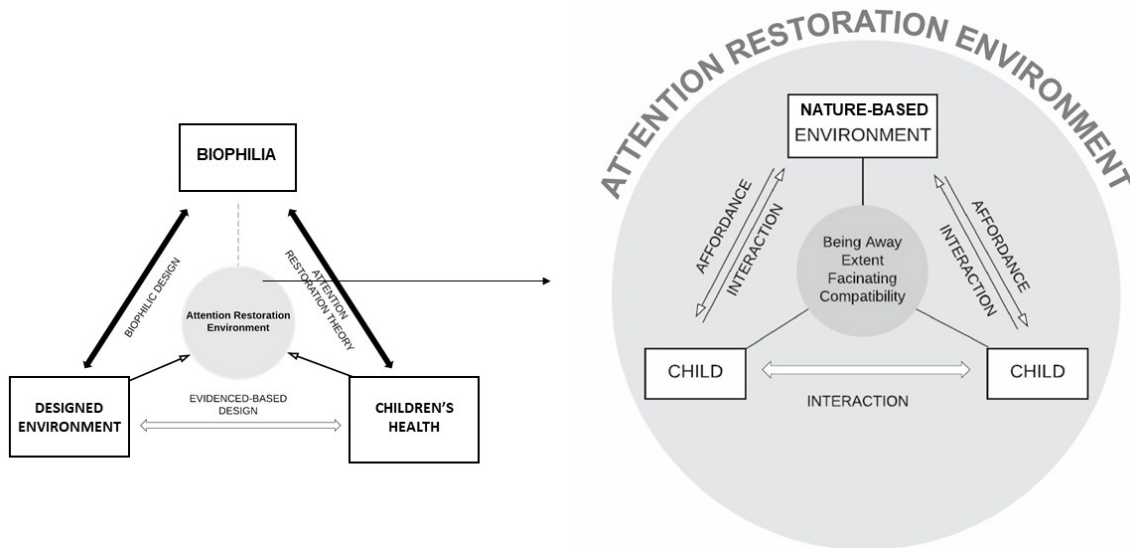


Figure 2.5 Theoretical Framework

This study examines the inter-relationship between nature, children’s health and the outdoor built environment. It specifically addresses the question: How can a nature-based designed outdoor play environment in a childcare center be optimized to support

children's restorative experience? Two theories adopted from environmental psychology were used to form the proposition and serve as the foundation of this study.

Wilson's (1984) Biophilic hypothesis asserts a close relationship between nature and people by emphasizing the innate quality of a human's love of the natural environment (Wilson 1984). The Kaplans' (1989) Attention Restoration Theory (ART) addresses the relationship between nature and a person's mental health. In this theory, a restorative experience is an alternative mode of direct attention that enables people to recover from mental fatigue; and an environment that offers a person's restorative experience is referred to as the restorative environment (Kaplan, 1995). The Kaplans (1995) further define restorative environments as having four properties: being away, extent, fascination, and compatibility. These properties, reinforce Kaplan's (1995, 2001) interpretation of nature, even in the urban context, as instrumental for restorative environment as follows: 1) natural settings with their richness can easily give people the feeling of being away both physically and psychologically; 2) nature includes many objects and dynamic processes such as the movement of leaves, worms, or clouds, growing flowers, fruits, and water flow patterns, and these natural objects and process create the feeling of fascination for people; 3) nature areas can easily provide a sense of scope and coherence through environmental design; and 4) a person's experience in a natural environment is considered highly compatible, given little effort is required to function in a natural setting.

Moreover, Gibson's Affordance theory emphasizes the functionality of the environment and explains the supportive connection of the environment on a person's

behavior (Greeno, 1994). For example, a hill in a children's outdoor play environment can enable behaviors like crawling, jumping, running, and hiding. When combined with the Biophilic hypothesis and Affordance theory, these demonstrate children's inherent attraction to nature; and natural features have the potential to facilitate various play behaviors and experiences.

Figure 2.5 illustrates the development of the theoretical framework utilized for this study. The diagram on the left illustrates the study's three knowledge realms: biophilia and biophilic design; children's health, and the designed and built environment. The diagram on the right side illustrates ways the children's restorative experience in the outdoor play environment could be improved with designed nature-based design. The designed nature-based outdoor play environment provides an outdoor play area for children. In this environment, child interacts with other children as well as the nature-based environment. The designed nature-based environment facilitates children's various play behavior, interaction with natural elements, as well as experience. Through play behavior, children-nature interaction and experience, children are likely to demonstrate feelings of the four indicators of the restorative experience indicated above.

3. RESEARCH DESIGN

This research aims to investigate the influence of a childcare center's outdoor play environment on pre-school children's health outcomes. Fundamental to this research is understanding the children's connections with nature as a major factor in the restorative experience, and as an indicator of health. It specifically investigates the inter-relationship of children's health, nature-based outdoor play environments at childcare centers and its impact on the children's restorative experience. Research questions and propositions presented in the first chapter are reiterated below:

Research Questions and Propositions:

Primary Research Question:

- How can the designed outdoor play environment in a childcare center be optimized for preschool children's restorative experience?

Secondary Research Questions and propositions:

- RQ1: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's interaction with natural elements?
- P1: Designed nature-based outdoor play environment affords higher levels of frequency and variety of children-nature interactions.
- RQ2: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's restorative experience?
- P2: Designed nature-based outdoor play environment in childcare centers stimulate higher levels of perceived restorative experience and related properties of the feeling of being away, fascination, extent and compatibility.

3.2 Overview of Research Methods

3.2.1 Research methodology

To investigate the inter-relationships of children's health and nature-based outdoor play environments at childcare centers and the effect of this built environment on children's restorative experience, an exploratory comparative case study design with embedded units of analysis was employed (Yin, 2014). This design addresses the impact of types of outdoor play environment: nature-based outdoor play environment (NBOPE) and standardized outdoor play environment (SOPE) on children's play behaviors including interaction with natural elements, and the children's restorative experience. The objective is to understand how natural elements and nature-based design influence children's play behaviors, interaction with natural elements and their restorative experiences. The unit of analysis is the licensed childcare center, and the embedded units of analysis include individual children (four to five-year-old age group), the children-nature interaction, and the childcare center's outdoor play environment.

According to (Yin, 2014), the rationale for utilizing the case study method include 1) the case study method is a rigorous research method that addressed the "how" and "why" research question the best; 2) it enables the investigation of contemporary relationships between the physical environment, children-nature interaction, and restorative experience in a real-world context, and in this research, is the outdoor play environment at a child care center; 3) it enables the researcher to collect multiple sources of data including physical artifacts, interviews, field observation, and survey, and interpret the findings and convergence in the analysis; and 4) the comparative analysis of

two case studies allows the researcher to compare two different patterns (NBOPE and SOPE) of theoretical replications and examine if their results are contrast for anticipatable reasons.

This comparative analysis involves two case studies of licensed childcare centers in South Carolina and observations of pre-school children in the four to five-year old age group: 1) nature-based outdoor play environment (NBOPE); and 2) standardized outdoor play environment (SOPE). For confidentiality and protection of the identity of the human subjects, this research discloses the name and location of the two cases and coded them as Case I and Case II. Specifically, Case I is a licensed childcare center that contains a NBOPE; and Case II is a licensed childcare center that contains a SOPE. Various data was collected at each case study location with the intended goal as evidence for understanding the physical environment, children's play behavior, interaction with natural environment as well as their restorative experience. This included: site assessment, semi-structured interviews with teachers, field observation, and structured interview with children.

An expedited review was conducted by Clemson University Institutional Review Board (IRB), and the approval (IRB2018-414) was effective from November 13th, 2018 to November 6th, 2020. Detailed documents regarding IRB approval can be found in Appendix A. Data were collected through August to October 2019. Research findings and conclusions were developed based on the analysis and synthesis of the data collected from these two cases. (Creswell & Clark, 2017).

The overview of this comparative case study is summarized in Table 3.1.

Comparative Case Study (Yin, 2014)	Research Question 1: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's interaction with natural elements?	Research Question 2: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's restorative experience?
Rationale	To examine the impact of designed outdoor play environment on children's play behavior, interaction with natural elements.	To investigate the impact of nature-based designed outdoor play environment on children's restorative experience.
Theoretical Proposition	The designed nature-based outdoor play environment affords: - higher level of frequency and variety of children-nature interaction.	Designed nature-based outdoor play environment in the childcare centers stimulate higher level of perceived restorative experience.
Data Collection Method	Field observation, Semi-structured interview with teachers.	Field observation, Semi-structured interview Interview with children.
Target population	Four to five-year-old children in childcare centers. Teachers in childcare centers.	Four to five-year-old children in childcare centers. Teachers in childcare centers.
Sample	Convenience sampling	Convenience sampling
Data Analysis	Behavior mapping, content analysis, hot spot analysis, interpretation	Behavior mapping, content analysis, hot spot analysis, statistical analysis, interpretation

Table 3.1 Overview of the Research Methodology Utilized in This Research

3.2.2 Research site selection

To investigate the impact of designed nature-based outdoor play environment on children’s play behaviors, interaction with natural elements and restorative experience, two cases were carefully selected based on the theoretical proposition. The objective was to select two licensed childcare centers: one contains nature-based outdoor play environments (NBOPE) and another one contains standardized outdoor play environment (SOPE) as a theoretical replication. Specifically, the NBOPE was expected to contain natural elements with high level of variance and perceived affordance. In contrast, the levels of these two indicators in the selected SOPE were expected to be low. At the same time, other factors of these two cases that may impact research results should be controlled. For example, the control criteria delineated that two childcare centers are located in similar community contexts (household income and physical context) in South Carolina; the outdoor play environment are similar in size; and similar numbers of pre-school children (four to five years old age group) at the childcare center. Table 3.2 shows the site selection criterial developed based on the theoretical framework.

	Cases	Case I (nature-based)	Case II (standard)
Control	Physical context	suburban	suburban
	Size of outdoor play environment	(0.1- 0.2 acre)	(0.1- 0.2 acre)
	Number of children	25-30	25-30
	Licensed	Yes	Yes
Theoretical replication	Level of variance of natural elements in the outdoor play	High	Low

	Level of perceived affordance of natural elements	High (nature based)	Low (non- nature based)
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Table 3.2 Site Selection Scenarios

The sites were selected by coordinating with South Carolina Department of Health and Environmental Control (DHEC) and ABC Quality (DHEC and ABC quality have been working on developing nature-based outdoor learning environment in South Carolina childcare centers). The site selection process began through an online search (google maps, google earth and websites for childcare facilities). The objective in the site selection process was to develop criteria for understanding outdoor play environments in South Carolina’s childcare including spatial distribution, shape, size of outdoor play environments, type of outdoor play environments (nature-based and standardized), and the community context. The web-based investigation revealed: 1) Fewer childcare centers contain NBOPE than childcare centers with SOPE in the upstate South Carolina area; 2) the SOPE in most childcare centers are similar in size and contain similar types of play settings; and 3) childcare centers are distributed in both urban and suburban areas.

Therefore, site selection strategy involved the following sequential activities:

- 1) Select potential childcare centers that contain NBOPE through online searching and coordination with DHEC and ABC Quality, and then conduct an onsite verification for each potential site based on the site selection criteria. Two onsite verification were conducted that they are all potentially suitable for this comparative case studies.

- 2) Select potential childcare centers with SOPE based on the online searching and coordination with DHEC and ABC Quality, and then conduct an onsite verification for each potential site. Five licensed childcare centers contain SOPE that potentially to be matched with previous selected sites were selected. Then three onsite verification were conducted. Finally, two childcare centers contain SOPE that potentially match with one of previous selected childcare center (contains nature-based outdoor play environment) were potentially selected.
- 3) Match the potential two childcare centers according to the site selection criteria; four previous selected childcare centers were paired into two. Then the investigator conducted a suitability analysis to find the most suitable pair for the comparative case study. The results indicated two pairs were suitable for this study.
- 4) Select the final two sites based on the convenience, accessibility, available data sources, and suitability of the scenario.

Table 3.3 shows background information of the two selected cases and the site selection criteria.

	Case I	Case II
Location	South Carolina	South Carolina
License	Yes	Yes
Number of teachers	23	20

Number of students (all ages)	178	150
Operating time	6:30 – 18:30	6:30 – 18:00
Daily routine for outdoor play	*9:15 – 10:00; 15:15 – 16:00 (changes based on curriculum)	*10:00 – 10:30; 14:30 – 15:00; 16:30 – 17:00 (changes based on curriculum)
Community Context (household income)	48,000 (rounded)	59,000 (rounded)
Data collection time period	August, September and October 2019	August and September 2019
Weather	Mostly sunny days	Mostly sunny days

Table 3.3 Matched Criteria of Two Selected Cases

*Daily routine for outdoor play schedule is not a fixed time, it changes accordingly with curriculum and weather conditions.

The target population for this research are teachers and four to five-year-old children in the selected childcare centers. The participants were recruited through coordination with childcare centers. Teachers and parents of children in the research provided their consent to participate (Consent forms were delivered to teachers and parents of children with the coordination with childcare centers). They were informed that their participation is voluntary and that they have the right to withdraw from the study at any time. No names and identities of the participants were collected.

An expedited review was conducted by Clemson University Institutional Review Board (IRB), and the approval (IRB2018-414) was effective from November 13th, 2018

to November 6th, 2020. Detailed documents regarding IRB approval can be found in Appendix A.

3.3 Comparative Case Study Design

3.3.1 Measurement

To investigate the inter-relationships between nature-based outdoor play environment, children-nature interaction and pre-school children’s restorative experience (metric for health), the quality of the physical environment, children’s interactions with nature, and the children’s perceived restorative experience were measured. Measurement, variables, data collection and data analysis methods are summarized in Table 3.4.

Measurement	Dimension	Variable	Measure	Method of Collection	Method of Analysis
Quality of natural elements in the physical environment	Form	Quality of artificial elements	The number of types of artificial elements	Field assessment	Mapping analysis calculation
		Quality of natural elements	The number of types of natural elements	Field assessment	Mapping analysis calculation
	Function	Level of perceived affordance of natural elements	Types of perceived affordance of children’s play	Field assessment	Mapping analysis
Children-nature interaction	Frequency	Level of frequency	Cluster of points	Field observation, behavior mapping	Hotspot analysis
			Description	Semi-structured interview with teacher	Content analysis
	Variety	Level of Variety	The number and distribution of	Field observation,	Hotspot analysis

			types of affordance	behavior mapping	
			The number and distribution of types of affordance	Semi-structured interview with teacher	Content analysis
Children's restorative experience	Perceived restorative experience	Level of perceived restorative experience	Perceived restorative experience scale for children	Structured interview with children	Statistical analysis Content analysis
			Restorative experience of children	Interview with teacher	Content analysis
		Variety of play behaviors in the play environment	The number and distribution of types of play behaviors	Field observation	Kernel Density analysis

Table 3.4 Summary of Measurements

Quality of the physical environment:

The quality of natural elements in the outdoor play environment were measured by both form-based assessment (diversity of natural elements) and functional-based assessment (perceived affordance of play).

Natural elements. The diversity of natural elements calculated by counting the number of types of natural elements in the following categories: vegetation, landform, natural ground surface, natural materials, natural loose parts, and animals and other living things. Natural elements in each category are listed in the Table 3.5.

Natural Elements Categories	Natural Elements
Vegetation	trees, shrubs, flowers, grasses

Landform	mound, slope
Natural ground surface	wood chips, meadow, multipurpose lawns
Natural materials, natural play structures	wood, stick, water, sand, stones, dirt piles, logs, ice, shelter, leaves, seeds (pinecones)
Experiential elements	rain, snow, sky view, light, air
Animals and other living things	birds, insects
Source: (Fjørtoft, 2004; Heerwagen, 2009; Kellert, 2018; Moore, 2014; White & Stoecklin, 1998; Woolley & Lowe, 2013)	

Table 3.5 Natural Elements and Categories

Perceived affordance of play. According to Gibson (1986), affordances refer to the actionable prosperities between individuals and their environments. It can be used as a functional way of describing the environment (Heft, 1988). Heft (1988), based on Gibson’s concept of affordance, conducted a meta-analysis of several observational studies on children’s activities and developed a functional taxonomy (Table 3.6) to describe children’s environment (Heft, 1988; Kyttä, 2002). In addition to Heft’s functional taxonomy, Kyttä (2002) added sociality aspects of affordance (Kyttä, 2002).

Perceived affordance of play measures children’s potential opportunities for interaction with natural elements in the play environment. The amount and diversity of perceived affordance of play behaviors from natural elements were calculated by utilizing Heft (1988) and Kyttä’s (2002) functional taxonomy of affordance.

Affords walking, running	Affords looking and listening into adjacent place
Affords cycling, skating, skateboard	Affords microclimate
Affords coasting down (e.g. on bike, wagon)	Affords prospect/refuge
Affords rolling, sliding, running down	Affords privacy
Affords rolling objects down	Affords construction of objects (e.g., pottery)
Affords drawing, scratching	Affords pouring
Affords throwing	Affords modification of its surface features (e.g., sculpting)
Affords hammering, batting	Affords splashing
Affords spearing, skewering, digging, cutting	Affords pouring
Affords tearing, crumpling, squashing	Affords swimming, diving, boating, fishing
Affords building of structures (e.g. raw materials for forts)	Affords mixing with other materials to modify their consistency
Affords sitting on	Affords role playing
Affords jumping-on/over/down-from	Affords playing rule games
Affords swing-on (e.g. tree branch)	Affords playing home
Affords exercise/mastery	Affords playing war
Affords looking out from	Affords being noisy
Affords passage from one place to another (e.g., stairs, ladder)	Affords following/sharing adult's business
Affords locomoting from one place to another	

Table 3.6 A Functional Taxonomy of Children's Outdoor Play Environment (Heft, 1988, p.36; Kyttä, 2002, p.112)

Note. Reprint from *Affordances of Children's Environments in the Context of Cities, Small Towns, Suburbs and Rural Villages in Finland and Belarus*, by M. Kyttä, 2002, *Journal of Environmental Psychology*, 22(1), p.112,

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Children-nature interaction:

Children-nature interaction is captured by assessing the children's frequency and variety of interactions with natural elements in the outdoor play environment during outdoor play. The frequency of interaction with natural elements are determined through 1) teachers' reports (1-5 rating scale) and description; and 2) the frequency with which

children have interaction with natural elements. Utilizing Heft and Kyttä's functional taxonomy of affordance (Table 3.6), the variety of interactions with natural elements were measured by counting the types of children's play behaviors facilitated by natural elements. Other affordances observed but have not been included in the functional taxonomy were recorded as well.

The perceived restorative experience

The perceived restorative experience is assessed using perceived restorative experience questionnaires for children (PRS - C), teachers' reports (1-5 rating scale and explanation), and observations of various play behaviors in the play environment.

The perceived attention restoration scale (PRS) is based on four properties identified by Kaplan (1995) and enables people to identify the environment that contributes to a restorative experience. As a measure of the restorative quality of environments, it has been frequently used in the literature (Pasini, Berto, Brondino, Hall, & Ortner, 2014) to assess the four restorative factors: being away, fascination, coherence, and compatibility. Bagot (2004) focused on children's perspectives of the restorative environment. The research studied 230 primary school children and their familiar restorative environments and developed a restorative component scale for children (PRC-C) based on the PRS and RCS created by Hartig et al. (1997) and Laumann et al. (2001). The scale contains 15 items measuring 5 restorative factors (being away-physically, being away-psychologically, extent, fascinating and compatibility). The items are measured on a five-point Likert scale. For the purpose of this study, the investigator modified Bagot's (2004) PRC-C and used it as a measure of perceived restorative experience for pre-school

children. By considering pre-school children’s attention span, language, and cognitive abilities, the following modifications were made:

- 1) Eliminated five items with loadings under 0.40 in the factor’s analysis;
- 2) Based on lessons learned from pilot study, eliminated two more items regarding numbers of questions that this age groups’ ability of answering questions;
- 3) Modified all items from statements to questions;
- 4) Use two-point Likert scale instead of five-Likert scale. (revised based on lessons learned from the pilot study);
- 5) Add three open questions regarding children’s preference of outdoor playing and elements on playgrounds based on lessons learned from pilot study.

The above amendments made the perceived restorative experience survey more understandable to children in the four to five-year-old age group and suitable for investigating research questions in this study. Table 3.7 contains the revised PRCS-C survey for preschool children. Moreover, interview questions with teachers regarding children’s restorative experience were developed based on the PRC-C.

Indicators	Questions
Being away	Q8: Do you feel you are away from things teacher want to you to do in the outdoor playground?
	Q9: When you are in the playground, do you feel it is different than in the classroom?
Content	Q10: Can you do many things in the outdoor playground?
Fascination	Q4: When you are in the playground, do you feel there are many interesting things?

	Q5: when you are in the playground, do you feel there are many interesting places?
	Q6: Do you feel there are many things to look at in the playground?
	Q7: Do you feel there are many things to discover in the playground?
Compatibility	Q11: Can you do what you want to do in the playground?
Preference	Q1: Do you like playing outside? Q2: Do you like this playground? Q3: what is your favorite part?

Table 3.7 Children’s Perceived Restorative Experience (KL Bagot, 2004)

3.3.2 Data collection

Four sets of evidentiary data were collected for this comparative case study analysis. Specifically, real-time evidence of the design elements within each outdoor play environments was collected through field measurement and assessment. In addition, evidence of children’s interaction with natural elements was collected through semi-structured interviews with teachers and direct field observations of children’s outdoor play during their routine play times. Furthermore, evidence of pre-school children, four to five-year-old age group, of their restorative experiences was collected through semi-structured interviews with teachers, interviews with children, and field observations of children’s play. The types of data collected are summarized in Table 3.8.

	Physical artifacts	Field observation	Semi-structured interview	Structured interview
RQ Addressed		RQ1, RQ2	RQ1, RQ2	RQ2

Rational	- real-time evidence - physical environment	- real - time evidence - children’s play behaviors children-nature interaction. objective evidence	- a period history evidence - children-nature interaction children’s restorative experience - subjective evidence	- evidence of children perceived restorative experience. - subjective evidence
Sampling		Four to five-year-old children in outdoor play environments.	Teachers selected from childcare centers through convenience sampling.	Four to five-year-old children in childcare centers through convenience sampling.
Participants		56 children	4 teachers	20 children

Table 3.8 Four types of evidence

3.2.3.1 Physical Artifacts

Understanding the spatial lay-out of each case study setting was important for this research and required a comprehensive inventory of the physical artifacts. Field measurements were conducted to gain an understanding of the outdoor environments’ overall dimensions, as well as to locate and measure various design elements within the play setting at each childcare center, as well as the boundaries and types of spatial enclosure. This data was collected in August 2019 and included field measurements of

boundaries and edges; horizontal and vertical elements, including landscape (types of vegetation) and surface materials (paved and vegetated areas, in and around play settings); and location, size, quality, and potential affordance of natural elements in the outdoor play areas. Location, size, quality, and potential affordance of other structures in the outdoor play areas were collected through field measurement and assessment. Collection (digital and manual) instruments included: Google maps, camera, measurement instruments, field notebook, and functional taxonomy of affordance. Collecting secondary data base map and locations, weather and climate, were acquired from websites.

3.2.3.2 Semi-Structured Interviews

The objective for utilizing semi-structured face-to-face interviews was to gain evidence for the children's restorative experience and investigate children's interactions with natural elements in outdoor play settings. The participants of semi-structured interview with teachers in the childcare centers and included. Two teachers from each childcare center with four total teachers who participated in the interview. The duration of a typical interview was forty to sixty minutes. Data collection instruments included interview survey, field notes and voice recorder; and the data sets were later transcribed and analyzed with MAXQDA¹ software.

The semi-structured interview contains three parts (Appendix B). In the first part, teachers filled out a demographic survey about their teaching experiences. In the second part, teachers were asked to talk about children's play behaviors and interactions with

¹ MaxQDA is a software package for qualitative data analysis. Source: maxqda.com

natural elements based on their observations with a children’s outdoor play experience survey (Figure 3.1). During the interview, teachers marked the types of play behaviors in each play area based on the functional taxonomy of affordance. In the third part, teachers evaluated children’s restorative experience by responding to a series of questions about the children’s restorative experience and were measured on a five-point Likert scale (from 1 to 5). Time during the interview was allocated for the teachers to provide further discussion and explanations about their responses. Example questions (Figure 3.2) listed below.

Play area [7]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



Figure 3.1 Example Questions – Children’s Play Experience

1. It is important to play outside.
2. What is the teacher’s role of children’s outdoor play?
3. How does the outdoor play relate to the curriculum?
4. Children like to play with natural elements (example: wood bark, plants, sand).
5. Many things in the playground fascinate the children.
6. The children feel different in the outdoor play settings versus when they are indoors.
7. There are many things children want to do in the outdoor play.
8. Children can do many different things in one or more parts of the play settings.

9. After playing outside, children appear to have had a restorative experience (are they calmer, relax, stress less, focused?).

Figure 3.2 Example Questions - Children's Restorative Experience

3.2.3.3 *Field Observation*

Field observations collected real-time evidence of children's outdoor play behaviors and experiences in each of the childcare center outdoor environments. This specifically included collecting data on the locations where children played, types of play behavior, their interactions with natural elements, and interactions with teachers. The investigator observed activities directly in the outdoor environment when children played outside during their regular recess time. Participants were four to five-year-old children who play in the outdoor play environments. (Specifically, according to the childcare center directors, case I contains 22 four to five-year old children and 7 children who were about four years old; case II contains 27 four to five-years-old children.)

The "System for Observing Play and Leisure Activity in Youth" (SOPLAY) is a widely accepted direct observational method to measure physical activities in physical environments (Mckenzie, 2006). It was developed based on the momentary time sampling techniques. By using this method, the investigator can acquire behavioral data in pre-determined target areas through systematic and periodic scans of individual and contextual factors (Mckenzie, 2006). This research applies the SOPLAY method and was modified for the type of observational data collected, as well as the conditions of the physical environments of the two case study settings. In addition to collecting data through the SOPLAY method this research included the deployment of behavior mapping

method. This direct observation method has been utilized for recording the location of subjects and their activity level (Cosco, Moore, & Islam, 2010). Cosco et al. (2010) investigated preschool children's physical activity and outdoor design with behavior mapping and concluded that behavior mapping provides an objective measure for evaluating the relationship between children's physical behavior and outdoor design.

The field observation in this research is a passive direct observation and aims to obtain data during children's routine play time in outdoor play environment in childcare centers. The research involved the capture of data on children's outdoor play over in each childcare center over a period of ten days during September and October in 2019. Observation periods were coordinated with the childcare center managers and conducted during children's regular outdoor play time. In total 686 minutes of direct field observation data was collected from the two childcare centers.

For field observations, the target area consisted of a designated play environment where the subjects (children) conducted outdoor play at the childcare center's designated play environments. The target area map in each childcare center was developed through site measurements and assessments. In order to increase the accuracy and capture the specific play behaviors of the subjects, the target area was subdivided into several scan areas according to the site conditions, natural boundaries, play structure locations, activity types and density of children. The sub scan areas and standard observation order in two outdoor play environments were determined with site assessment results and test observations.

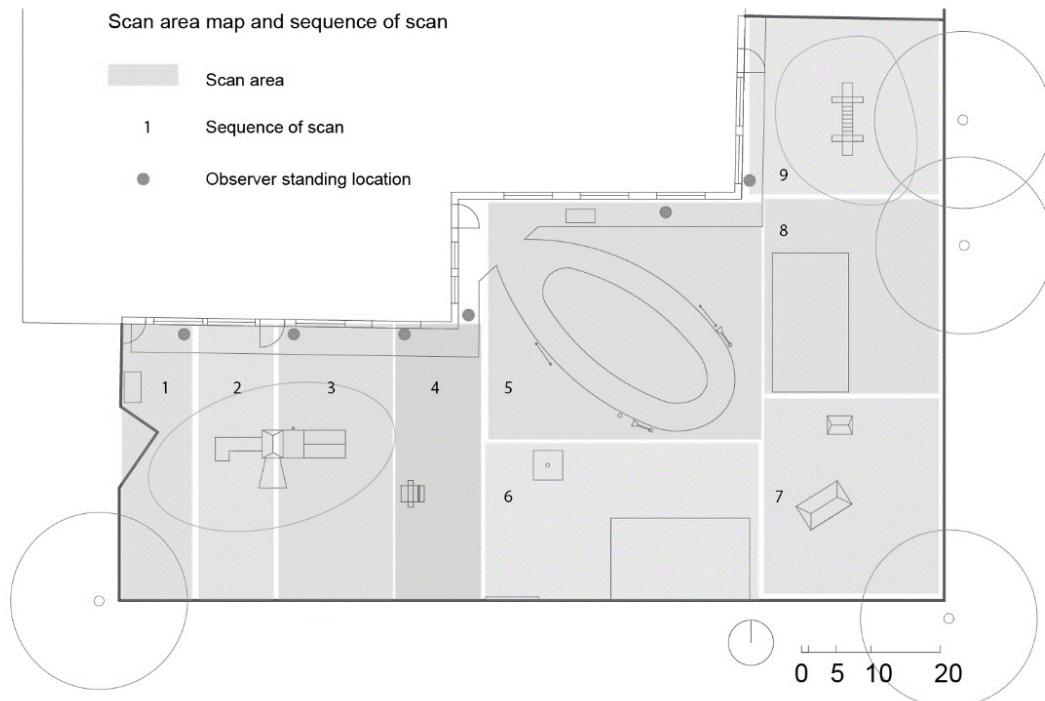


Figure 3.3 Example of Field Observation Subarea

In each observation session, the observation starts when teachers announce the play time starts and most children began engaging in playing and ends when teachers announce the playing time ends. The investigator recorded the temperature, weather, start time, end time and number of participants of each observation session. Field observation data was recorded with paper and pencil. In addition, the start time and end time of each full scan of the outdoor play environment was recorded. No names and identities of the participants were collected. The filed observation instruments included watch, clipboard, recording forms (Appendix C), pencils, and coding sheet. Children’s participation was voluntary, and they could withdraw from the observation session or the research at any

time. Data was manually input in tables created using Microsoft Excel and later analyzed with ArcMap² and Excel.

Field Observation Sheet_Test

Date: 09/04 Time: 2:25 - 2:39 Temperature: 33°C NO. 09030101/7

Area:				Area:			
No.	Affordance	I	TC	No.	Affordance	I	TC
1	Sit / twt		✓	11	W / twt		
2	Sit / twt		✓	12-14	Kip / sit	✓	✓
3	Sit / twt		✓	15	twr running / boat / dog		
4	Sit / twt		✓	16	W		✓
5	W	(mush)		17	run / el		
6	W			18	Sit on		
7	knf / twt		✓	19	Sit on		
8	knf / twt		✓	20	Sit / twt		
9	Sit						
10	push equl						

stay in the shade.
Sun went down. ?!

Figure 3.4 Example of the Field Observation Sheet

3.2.3.4 Structured Interview

The objective of the structured interview in this study was to gain an understanding of the children's perceived restorative experience gained through their outdoor play. The participants included 10 four to five-year-old children from each childcare center (20 four to five-year-old children in total). Children were recruited through coordination and communication with childcare centers. Each structured face to face interview lasted for around five minutes. The interviewer asked each subject ten

² ArcMap is a main ArcGIS suite and mainly utilized for view, edit, create, and analyze geospatial data. Source: <https://en.wikipedia.org/wiki/ArcMap>

open and “yes” or “no” questions regarding children’s preference of outdoor play environment and their perceived restorative experience (revised perceived attention restorative experience scale for children). Children’s participation was voluntary, and they could withdraw from the interview or the research at any time. No names and identities of the participants were collected. Data was collected with field notes (paper-pencil) and analyzed through Microsoft Excel.

3.3.3 Analytic strategy

The general analytic strategy is to follow the theoretical proposition (Yin, 2014). Empirical evidence was linked with theoretical propositions through pattern matching logic. To illustrate, if the empirical evidence from interviews and observations demonstrates a higher level of child-nature interactions and restorative experience in childcare center with NBOPE compared to SOPE (the expected pattern), the research proposition will be accepted (Yin, 2014).

3.2.3.1 Data analysis

To examine the spatial distribution of play locations, types of play behavior, and nature-children interaction, kernel estimation and hot spot analysis, GIS tools, were applied. The qualitative data of children’s frequent play locations, types of play behaviors, frequency and diversity of different ways of interaction with natural elements, as well as restorative experience from semi-structured interviews with teacher and structured interview with children were analyzed through content analysis. Children’s perceived restorative experience were analyzed with both statistical analysis and content analysis. Table 3.9 illustrates method of analysis utilized in this research.

Measurements		Method of Analysis
Quality of natural elements in play environments	Types of natural elements	Mapping analysis, calculation
	Types of perceived affordance	Mapping analysis
Children-nature interaction Quality of natural elements in play environments	Frequency	Kernel density analysis; Hot spot analysis
		Content analysis
	Variety	Hot spot analysis
		Content analysis
Children’s restorative experience	Perceived restorative experience scale for children	Content analysis
	Restorative experience for children	Content analysis

Table 3.9 Method of Analysis

Kernel density analysis. Geographical Information System (GIS) and Kernel density analysis were utilized to understand the spatial patterns of children’s play locations, Social scientists have examined various point pattern analysis (PPA) methods and Kernel density estimation is a widely used method due to the efficacy of its application (Silverman, 2018; Xie & Yan, 2008). It is a method to analyze observed phenomenon in environmental and behavioral research (Moore, Roux, & Evenson, 2008; Rosenblatt, 1956; Zhou, Li, & Larsen, 2016). By applying Kernel density estimation, the spatial distribution map is expected to reveal the relationship between the play environment and play behaviors. Therefore, a higher density value in spatial distribution map indicated higher frequency of play events.

Hot spot analysis. The hot spot analysis was employed to reveal the pattern of children's interaction with natural elements in outdoor play environment. Hot spot analysis is a statistical method for investigating spatial autocorrelation. Specifically, in this research it helped identify spatial areas of high occurrence and locations of children-nature interaction. On the other hand, cold spot analysis can define areas of low occurrence of children-nature interaction.

Content analysis. The contents of the teacher's responses to questions in the semi-structured interview and the children's responses from the structured interview were analyzed with MAXQDA software. Children's frequent play locations, types of play behaviors, children's ways of interacting with natural elements, as well as children's restorative experience were revealed. Content analysis enables the researcher to understand the frequency of codes as well as their meaning in the context (Marks & Yardley, 2004). Themes (coding categories) were drawn from the theoretical framework. Specifically, children's types of play behaviors and their ways of interacting with natural elements were coded using function taxonomy of affordance (Heft, 1988; Kyttä, 2002) and as mentioned earlier were based on Gibson's affordance theory. Restorative experience themes (being away, extent, fascination, and compatibility) are drawn from Kaplan and Kaplan's (1989, 1992, 1995) ART. The results revealed: 1) frequency and variety of children-nature interactions in both types of outdoor play environments; and 2) children's restorative experiences in both outdoor play environments. The comparative analysis and synthesis of the data collected from the two childcare centers revealed the

children's interactions with natural elements and their restorative experiences in the two types of outdoor play environments.

3.3.4 Threats to validity

Construct validity.

The construct validity is addressed by triangulating multiple sources of evidence from observations, structured interviews, and semi-structured interviews. For example, the children-nature interactions were interpreted through triangulating evidence from field observations and semi-structured interviews with teachers. Children's restorative experiences in outdoor play environments were analyzed through triangulating evidence collected from semi-structured interviews with teachers as well as structured interviews with four to five-year-old children.

In addition, the units of measure were developed from the theoretical framework and also addressed the construct validity. For example, the perceived attention restoration questionnaire was developed from the attention restoration theory. Children-nature interaction was measured by functional taxonomy of affordance and was developed from an interpretation of affordance theory. Moreover, the chain of evidence was maintained using Microsoft Word, Excel, MAXQDA and ArcGIS and allowed the external observer to follow the evidence of the study.

Internal validity.

The internal validity was addressed by using pattern matching logic and followed the theoretical proposition as the analytic strategy. Specific conclusions found the empirical evidence of children-nature interactions and children's restorative experiences

in outdoor play environments needed to demonstrate a degree of consistency with the theoretical proposition. In addition, the frequency and variety of children-nature interactions may also change due to the numbers and age group of participants; and this may impact the comparative analysis of the two cases. Controlling the numbers and age group of the participants in the site selection ruled out the rival explanation and ensured internal validity of this research. Moreover, the data was collected on non-event days with similar weather (sunny days) in two childcare centers to avoid the impact of inclement weather (raining) on density and the variety of children's play, and ways they interact with natural elements. The study procedure was designed based on the children's routine daily activities to minimize the chance of children being hungry or tired. A pilot study was conducted to test and refine the case study protocol and analytic strategies.

External validity.

The external validity was addressed by increasing the confidence in abstraction to theory. In this study, the results enhanced the understanding of children's play behavior, interaction with natural elements, and restorative experiences in outdoor play environments. This research contributes to and expands on Kaplans' (1989) ART. More importantly, it contributes to and validates the significance of nature-based outdoor designed environments on children's overall health and well-being.

Reliability.

The case study protocol was used to improve the reliability of the research and enable the replication of the study. The case study database was constructed as mentioned in this chapter to enable other researchers to check the chain of evidence in the database.

3.4 Pilot Study

3.4.1 Pilot study implementation

The pilot study was conducted in a licensed childcare center in South Carolina in November 2018. The criteria for site selection involved accessibility, geographic proximity to Clemson, and it's a licensed childcare center.

	Field Measurement	Field Observation	Semi-structured interview with teachers	Structured interview with children
Time	2 hours	30 min per morning 3 days	20 - 60 min	5 min
Sample size		20 four to five-year-old children	3 teachers	3 four to five-year-old children

Table 3.10 Pilot Study Data Collecting Procedure

This childcare center has a 0.15-acre nature-based outdoor play environment for three to five-year-old. The pilot study had three objectives: 1) to test research methods, instruments, and case study protocols; 2) to acquire communication and collaboration skills necessary to deal with young children; and 3) to become familiar with childcare center environment. This pilot study was conducted in a childcare setting with a smaller sample (three teachers for semi-structured interview, three children for structured interview, and 20 four to five-year-old children for field observation) from the same target population. An expedited review was approved by Clemson University Institutional Review Board (IRB) on November 2018. Table 3.10 presents the data collection procedure.

3.4.2 Lessons Learned

The findings of a pilot study and subsequent research modifications are listed in the Table 3.11.

	RQ Addressed	Pilot study findings	To be revised
Physical artifacts		Proposed method worked appropriately.	
Semi-structured interview	RQ1, RQ2	Proposed method worked appropriately. Interviewees described children’s play behavior, experience of natural elements and play settings in the outdoor play environment.	Interview time changed from 20 minutes to 60 minutes. Delete a question of children’s preference of play settings. Add a question of children’s play frequency in play areas.
Field Observation	RQ1, RQ2	Proposed method worked appropriately. Observers collected data about children’s play location, behaviors and their interactions with natural elements.	Second observer might need if 25 more children present in the playground. Make sure there are only four to five-year-old children in the outdoor play environment. Onsite practice observation is needed before formal data collection. Consider weather carefully.

Structured Interview	RQ2	Proposed method worked appropriately. Two out of three interviewees finished the perceived restorative experience questionnaire. Majority of four to five-year-old children can answer ten “yes” or “no” questions.	Make the interview more game based. Plan longer time for collecting consents from parents. A good physical environment is important for interviewing children.
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Table 3.11 Lesson Learned from Pilot Study

4. DATA ANALYSIS AND RESEARCH FINDINGS

4.1 Introduction

The objective of this research is to investigate the influence of a childcare facilities' outdoor play environment on children's restorative experience. The overall goal of this research is to understand children's health and the inter-relationship between biophilic design, built environment and the restorative experience. In this research, the restorative experience serves as a measure of children's health.

The research findings are derived from one primary research question: How can the designed outdoor play environment in a childcare center be optimized for preschool children's restorative experience? and two secondary questions: 1) How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's interactions with natural element? 2) How does the designed nature-based outdoor play environment in childcare centers impact pre-school children's restorative experience?

Comparative case studies with embedded units of analysis were designed to answer the research questions. Data was analyzed and synthesized by following the theoretical framework. Various methods deployed in this research included: form and functional based site condition assessment through field research, kernel density analysis, hot spot analysis, content analysis, as well as statistical analysis. Table 4.1 presents these measurements and corresponding methods of analysis. Each case study involved its own set of data or embedded units that were collected and analyzed. The results from the individual cases underwent a cross case comparative synthesis and in-depth

interpretation. These represented research findings with further conclusions that derived from the data analysis and drawn from the cross-case synthesis with pattern matching logic (Yin, 2014).

This chapter contains three major parts. Part one presents data analysis, results of the site assessments and comparative analysis of the two outdoor play environments. Part two describes the data analysis and research findings that answered the secondary research question that examined children’s interaction with nature-based outdoor play environments. Part three presents data analysis and research findings regarding the secondary research question that explored the influence of the outdoor play environment on children’s restorative experience.

Measurements		Method of Analysis
Quality of natural elements in play environments	Types of natural elements	Mapping analysis, calculation
	Types of perceived affordance	Mapping analysis
Children-nature interaction	Frequency	Kernel density analysis; Hot spot analysis
		Content analysis
Quality of natural elements in play environments	Variety	Hot spot analysis
		Content analysis
Children’s restorative experience	Perceived restorative experience scale for children	Content analysis
		Statistical analysis
	Restorative experience for children	Content analysis

Table 4.1 Method of Analysis

4.1.1 Case I: Nature-based Outdoor Play Environment (NBOPE)

A licensed childcare center in South Carolina was selected as Case I and located in a suburban community with \$50,000 (rounded) average annual household income. This childcare center provides curriculum including diverse courses and activities for students. Childcare operation and children's outdoor play information was collected with director as well as through semi-structured interview with teachers. Children's outdoor playing time is routinely modified throughout the year in response to factors such as weather, curriculum and others. Pre-school children in the four to five-year old age group, the target population for this research, typically play outside twice per day, specifically, one hour in the morning and one hour in the afternoon. This childcare center opens at 6:30 and closes at 18:30.

The outdoor play environment for the target population is a 0.14 acre "L" shape designed nature-based outdoor play environment. The entire outdoor play environment is surrounded by fencing, specifically, as Figure 4.1 shows high wooden fence on one side chain-link fence on the other three sides. These fences define play boundaries and address safety issues. The chain-link fencing also provides visual access to the trees and shrubs located off the fence, as well as the playgrounds of other age groups. Vegetation grew right outside of the fences, including one big mature tree and multiple groups of mature trees as showed in Figure 4.1. The outdoor play environment contains vegetation (Figure 4.1) such as grass, shrubs in planters, one big mature tree (higher than 40 feet by estimation) and two trees. During field research, site assessment showed all play settings are functioning for the children. In this context, "functioning" refers to the children's

ability to access and use them. Shaded areas are provided by the childcare building facility, trees, and a wood pavilion in the outdoor play environment, as well as vegetation inside and outside of the fences.



Figure 4.1 Vegetation and Fencing Analysis: NBOPE

Given solar exposure and climatic comfort, a shading analysis was conducted with a simulation tool in Google SketchUp Pro³. Digital model developed by the investigator was utilized for the shading analysis. Simulation includes two major factors: season and time. Specifically, shading conditions in the morning (10:00 am) and the afternoon (3:00 pm) on March 21st, June 21st, September 21st, and December 21st in the outdoor play environment were simulated. (the shading patterns was a result from digital

³ Google SketchUp Pro is a desktop software for 3D modeling.
Source : <https://www.sketchup.com/products/sketchup-pro>

simulation and may differ from the real word condition). Results indicated (Figure 4.2) most of the outdoor play environment was in shade during the children’s morning routine period for outdoor play. However, in the afternoon especially in the summer, a large part of the play environment was found to be exposed to sunlight. Moreover, the outdoor play environment at this childcare facility did not contain designated and purposefully designed landforms for children’s play. The outdoor play environment contains both fixed and moveable play settings. Fixed play settings in this research refer to play settings that cannot be moved by children during their outdoor play. Movable play settings are those can be moved by children for their play. Spatially, the fixed play settings distributed across the playground varying distances from the access point.

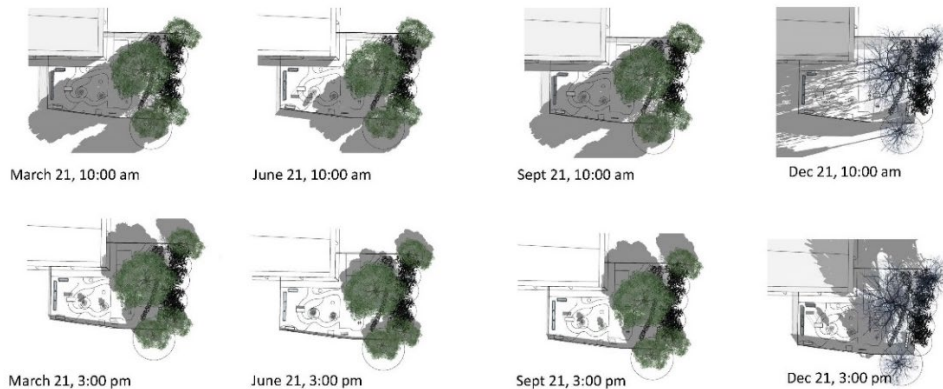


Figure 4.2 Outdoor Play Environment Shading Analysis Diagrams: NBOPE.

Site assessment was conducted from two aspects: form-based assessment and functional based assessment – spatial organization of the various elements within the outdoor play environment and the function of these elements. The purpose is to understand the quality of natural elements in the selected two outdoor play environments.

Form-based assessment evaluated the diversity of natural elements and play settings in the outdoor play environment. 32 types of natural elements and play settings and 4 types of non-nature-based play settings were identified (Table 4.2). Specifically, there are three types of natural ground surface: lawn, mulch and exposed soil or earth; three types of vegetations: trees, shrubs and groundcover; and seven types of natural elements: rocks, sand, sticks, logs, leaves, pinecones, and wood blocks; eight types of nature-based play settings: two types of live animals (insects and birds appear periodically in the outdoor play environment) and six types of experiential elements including clouds, sky view, rain, snow, light and fresh air. Four types of non-nature-based play settings: concrete path for tricycle use, a paved concrete area shaped in a square, two concrete pathways (one loop pathway, and one pathway along the perimeter of the building) and several tricycles.

During field research and site assessment, vegetation (in the form of trees, shrubs and grasses) was found growing in the outdoor play environment and outside of the fence with tree branches extending into the play environment. The majority of the nature-based play settings consisted of fixed play settings. For example, balancing logs, wood performance stage, wood bridges, dry creek, wood table, wood steps, sand table and wood planters. Many natural materials such as stones, wood blocks, sand, and wood stems were defined as moveable play settings. Some natural materials appeared periodically and seasonally in the play environment. For instance, during field research, leaves, sand, water, dirt, branches or sticks, and pinecones were observed. As part of the childcare center's curriculum, teachers provided natural materials for children to utilize

during their outdoor play time. Children were also exposed to nature and enabled regular access to experiential natural elements such as clouds, blue skies, rain, snow, sunlight, wind and fresh air in the outdoor play environment. Figure 4.3 presents the access, fixed play settings, and major vegetation types in the outdoor play environment.

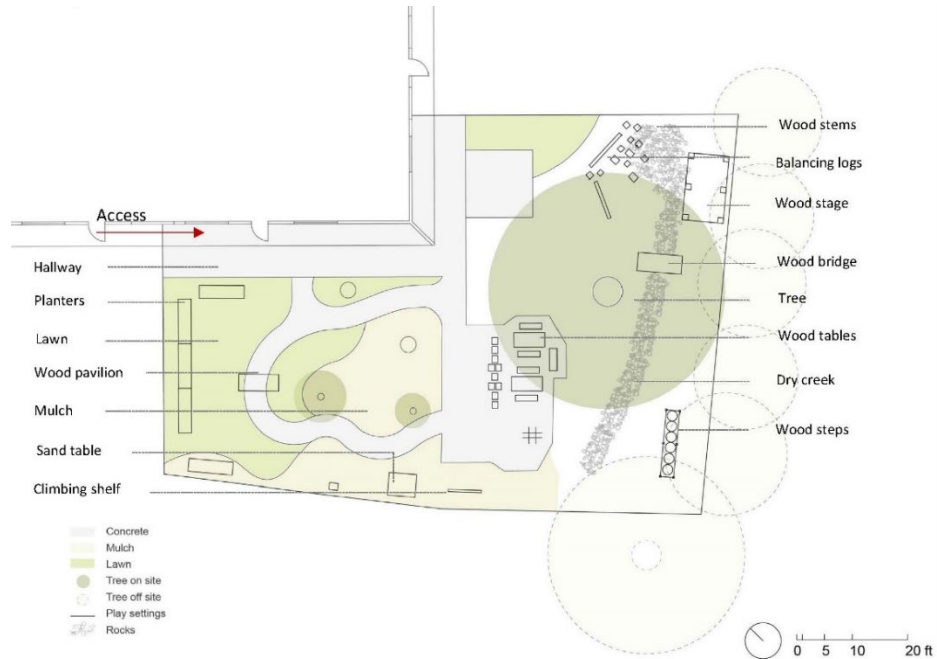


Figure 4.3 Outdoor Play Environment Site Plan: NBOPE.

Functional based analysis evaluates the variety of ways that the outdoor play environment supports children’s play. The investigator identified the potential affordance of play settings by utilizing the taxonomy of affordance (Heft, 1988; KYTTÄ, 2002). The number of types of potential affordance regarding each type of play elements are listed below. The overall types of potential affordance in the outdoor play environment involved quantitative calculations of total numbers of types of potential affordance in the outdoor play environment. The same type of potential affordance was calculated once when it was afforded by two types of play settings.

Natural elements	Category	Potential affordance	*NTA
Vegetation	trees	microclimate, observing, pulling, hiding, walking around	5
	plants	planting, picking, observing, looking for, watering	5
Natural ground surface	wood chips	walking/running on, picking, collecting, building structures, digging	6
	lawns	walking/running on, looking for, pulling	4
	dirt surface	walking/running on, digging, building structures, collecting, picking up, mixing, looking for	8
Natural materials	rocks	building structures, walking / running on, jumping on, collecting, mixing, looking for, passing from one place to another	8
	sand	mixing, passing from one place to another, building structures	3
	sticks	waving, picking up, looking for, digging	4
	logs	walking on, jumping on and down, sitting on, role playing	4
	leaves	looking, listening, picking up, pulling down, jumping, drawing on, collecting, building structures	8
	pinecones	picking up, throwing, observing, collecting	4
	wood blocks	building structures, jumping on/down, walking on, sitting on, passing from one place to another, rolling, balancing	7
Natural play structures	wood stage	jumping on/down, sitting on, walking, running,	4
	wood table set	sitting on, outdoor classroom, look out from	3
	wood planters	observing	1
	wood pavilion	microclimate, role playing, following adult business	3

	wood bridge	walking / running on, looking out from, sitting on	4
	wood steps	walking on / down, jumping down, swinging, looking out from	4
	logs	balancing, waking, jumping, sitting, role playing	5
	wood climbing	climbing, looking out from	2
Animals	bird house	observing, listening	2
	insects	looking for, observing	2
Experiential elements	clouds	observing	1
	sky view	observing	1
	rain	sensory experience	1
	snow	sensory experience	1
	light	daylighting	1
	air	sensory experience	1
Play Settings	concrete track	running / walking on, cycling, jumping on, role playing, following adult business	6
	bicycles ⁴	cycling, pushing, following adult business	3
	concrete hallway	running / walking on, cycling	3
	concrete square	sitting on, running / walking on	3

Table 4.2 Form and Functional Assessment: NBOPE.

*NTA: The number of types of potential affordance

⁴ In this context, bike was used by teachers and refers to tricycles.

4.1.2 Case II: Standardized Outdoor Play Environment (SOPE)

Case II is a licensed childcare center in South Carolina that contains standardized outdoor play environment for the target study population, four to five-year old pre-school children. It is in a suburban community with around \$48,000 average annual income per household. As a licensed childcare center, the curriculum involves diverse courses and daily activities. Childcare operation and children's outdoor play information was collected with director as well as through semi-structured interview with teachers. Weather is a major factor that influences the children's routine outdoor play schedule. The weather and related seasonality is also considered in the curriculum delivery during the regular year and the childcare's daily operations. The target study population (four to five-year-old age group) at this childcare center usually engage in outdoor play multiple times (thirty minutes per period) over the course of the day. The childcare center opens at 6:30 and closes at 18:00.

The target study population play independently with their peers in a standardized outdoor play environment. It is a "L" shape play environment covering 0.15 acres. The entire outdoor play environment is surrounded by fencing which define the boundaries, play setting areas, and provide safety. The type of fencing for the outdoor play environment is chain-link fence (Figure 4.4). Fences provide views and visual access to the adjacent streets, trees, and shrubs as well as the playgrounds of other age groups. Vegetations right outside of the fences include four big mature trees (two of them higher than 40 feet by estimation) and several groups of shrubs. The outdoor play environment contains a patch of grass (Figure 4.4). During field research, site assessment showed all

play settings are functioning for the children. In this context, “functioning” refers to the children’s ability to access and use them. The major play settings are spatially distributed across the playground with varying distances from the access point and door to the childcare building. In the field research and site assessment, no evidence of a purposely designed landform for children’s play was found.

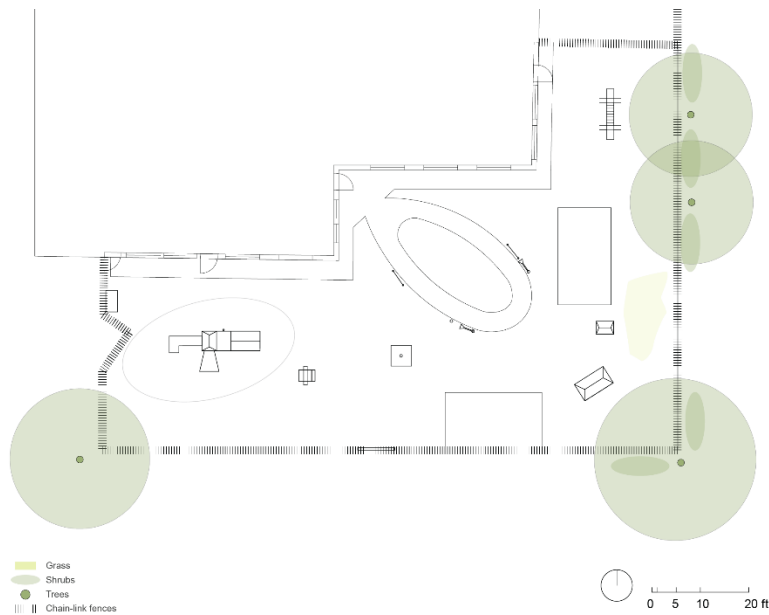


Figure 4.4 Vegetation and Fencing Analysis: SOPE

Shading is provided by the existing building, two shading structures (pergolas) along with trees outside the boundary fencing. Shading analysis was conducted by developing a digital model and simulating (the shading patterns were results from digital simulation and may differ from the real world condition) in a 3D modeling software, Google SketchUp Pro. Simulation includes two major factors: season and time. Specifically, shading conditions in the morning (10:00 am) and the afternoon (3:00 pm) on March 21st, June 21st, September 21st, and December 21st in the outdoor play

environment were simulated. The shading analysis (Figure 4.5) results showed that the central areas where the concrete path is located are exposed to sunlight during children’s primary outdoor play time periods seasonally and throughout the year.

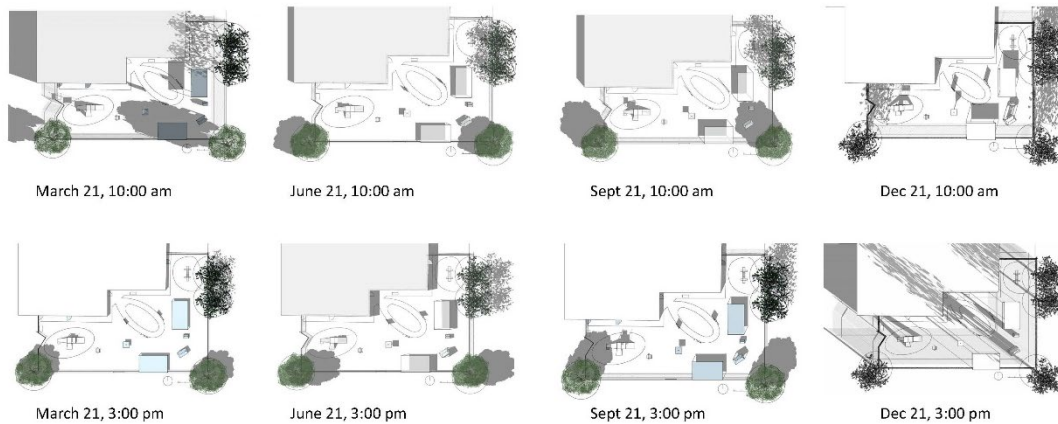


Figure 4.5 Outdoor Play Environment Shading Analysis Diagrams: SOPE.

The case II data was analyzed with the same methods utilized in case I. 13 types of natural elements and 11 types of non-nature-based play settings were identified (Table 4.3; Table 4.4). In specific, the major ground surface of the outdoor play environment is comprised of a mix of mulch and exposed soil. And two concrete pathways, one loop path and another path along the perimeter of the building were contained. Vegetation was not evident in the outdoor play environment. However various trees and shrubs outside the boundary fencing were visible with their branches and foliage extending into the play environment. Like the Case I, the children had regular access to natural elements and when they were able to experience living elements like birds, insects, cloudy skies, blue skies, rain, snow, sunlight, wind and fresh air. Most of the fixed play settings were made of non-natural or artificially man-made materials such as steel or plastic. There was evidence of diverse moveable play settings such as blocks, jumping ropes, parachute,

balls in the playground with most of these items made with non-nature-based materials. Figure 4.6, 2D site plan, illustrates the spatial arrangement with the access point, fixed play settings, key play elements, and concrete paved areas in the outdoor play environment.

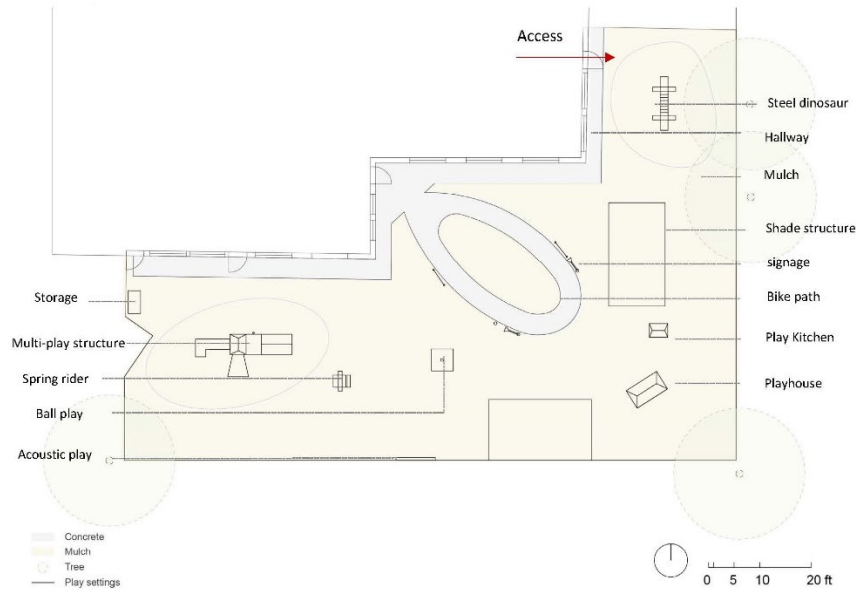


Figure 4.6 Outdoor Play Environment Site Plan: SOPE.

Figure 4.6, Table 4.3 and Table 4.4 presents the form-based and function-based assessment results. The results indicate the number of types of potential affordance of each type of play settings and natural elements. Play settings provide of the variety of affordance for children’s play such as climbing, sliding, climbing, ball throwing, privacy, looking out from, role playing, following adult’s business, and cycling.

Natural elements	Category	Potential affordance	*NTA
Vegetation	tree branches	microclimate, pulling	2

	grasses	Pulling, digging	2
Natural ground surface Animals	wood chips	picking up, collecting, digging, building structures, walking and running on, mixing, looking for	8
	dirt	walking/running on, looking for, pulling	4
	unknown	observing	1

*NTA: The number of types of potential affordance

Table 4.3 Natural Elements Form and Functional Assessment: SOPE

*NNE	Category	Potential affordance	*NTA
Play settings	multi-play structure	climbing, sliding, sitting, standing, looking out of, jumping	6
	spring rider	sitting, role play	2
	toss n' score for ball play	ball throwing	1
	acoustic play setting	playing music, knocking, listening	3
	shading structure	shading, outdoor classroom	2
	traffic signage	following adult business, role playing, looking out from	3
	traffic signage	following adult business, role playing	2
	acoustic play setting	being noisy, listen, role playing	3
	playhouse	hiding, following adult business, sitting, role playing, looking out from	5
	outdoor kitchen	hiding, following adult business, sitting, role playing, looking out from	5
	climbing dinosaur	climbing, jumping, role playing, following adult business	4
	bicycles	cycling, pushing	2

*NNE: Non-nature-based elements

*NTA: The number of types of potential affordance
 Table 4.4 Non-nature-based Form and Functional Assessment: SOPE.

4.1.3 Cross-case comparative analysis

The objective of the cross-case comparison is to analyze the condition, spatial form and quality of natural elements in the two selected outdoor play environments. The results are presented in Table 4.5. The two outdoor play environments share similar physical conditions in terms of size, shape, and topographic condition. Both have the “L” shaped form and within 0.14-0.15-acre size range. In addition, both are relatively level or flat with little change in topography with no purposely designed landform for play. Furthermore, they are in places that share similar weather conditions.

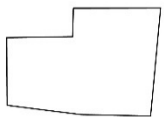
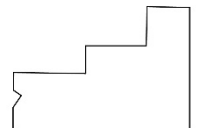
	Case I	Case II
Size	0.14 acres	0.15 acres
Shape		
Natural elements (variety)	32 (146% higher)	13
Potential affordance from natural elements (variety)	24 (118% higher)	11
Non-nature-based play settings (variety)	4	11 (175% higher)
Potential affordance from artificial play settings (variety)	8	16 (100% higher)

Table 4.5 Cross-case Comparison: Form and Functional Based Assessment.

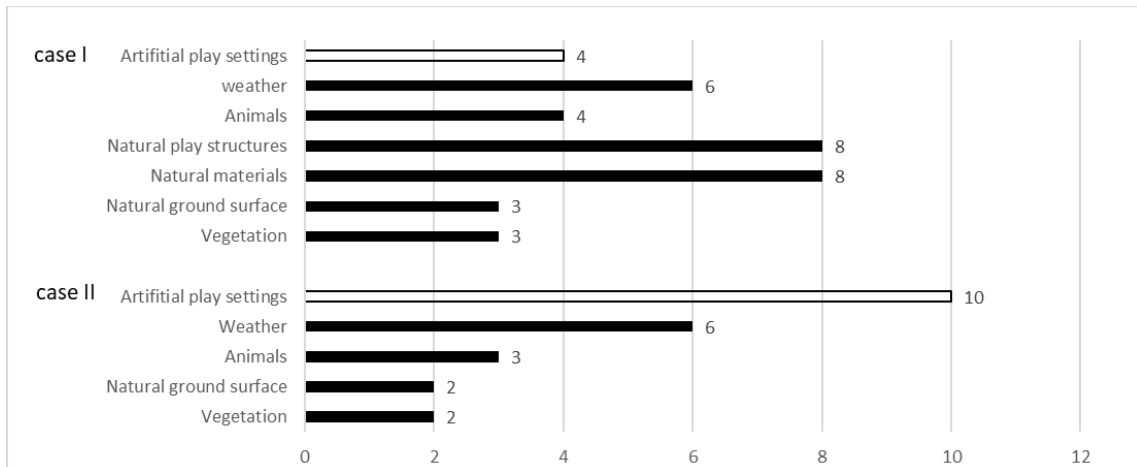


Figure 4.7 Cross-case Comparison: Types of Natural Elements and Play Settings.

Black bar: nature-based elements or play settings; write bar: non-nature-based or artificial play settings

The natural elements and the variety in the two sites were analyzed. Overall, thirty-two types of natural elements were identified in the NBOPE while in the SOPE, the number is thirteen. Results showed the NBOPE contains 146% more types of natural elements than the SOPE. The major reason for this difference is that the NBOPE contains various types of nature-based play structures and designed natural materials, but the SOPE does not. For instance, the NBOPE contains designed natural play structures such as logs, wood bridges, wood pavilion, wood stage, and designed natural materials such as rocks, sand and wood blocks. But few of these were found in the SOPE. Similarly, the variety of non-nature-based play settings were analyzed. Results showed that the SOPE contains eleven types of non-nature-based play settings and the number is 175% higher than the NBOPE, which contains four. Figure 4.7 presents the number of types of natural elements and non-natural play settings in each category.

The results (Table 4.5) of functional analysis revealed that the natural elements in NBOPE provide a higher level of variety of potential affordances than the SOPE.

Twenty-four types of potential affordance provided by natural elements were identified in NBOPE, 118% higher than the SOPE, which the number of types of potential affordance is eleven. However, sixteen types of potential affordance provided by non-natural play settings were identified in SOPE, 100% higher than the NBOPE, which is eight.

4.1.4 Summary

The following are the general findings from the cross-case comparative analysis:

- Both outdoor play environments share similar size, shape, weather and topographic conditions. These similarities provide a baseline in terms of physical condition in this comparative analysis.
- The quality of natural elements in the NBOPE is higher than the natural elements in the SOPE.
- Form-based analysis suggested that the NBOPE contains higher level of variety of natural elements than case II outdoor play environment.
- Functional based analysis revealed that natural elements in the NBOPE potentially provide higher level of variety of affordance for children's play than natural elements in the SOPE.
- Both OPEs contain non-nature-based play settings. Those in the SOPE have a higher level of variety and potentially provide higher level of variety of affordance than those in the NBOPE.
- Overall, the NBOPE contain mostly nature-based play settings and children's play behaviors are greatly afforded by the nature-based play settings (Figure 4.8). In contrast, the SOPE contain mostly non-natural

based play settings and children’s play behaviors are provided by the non-natural play settings.

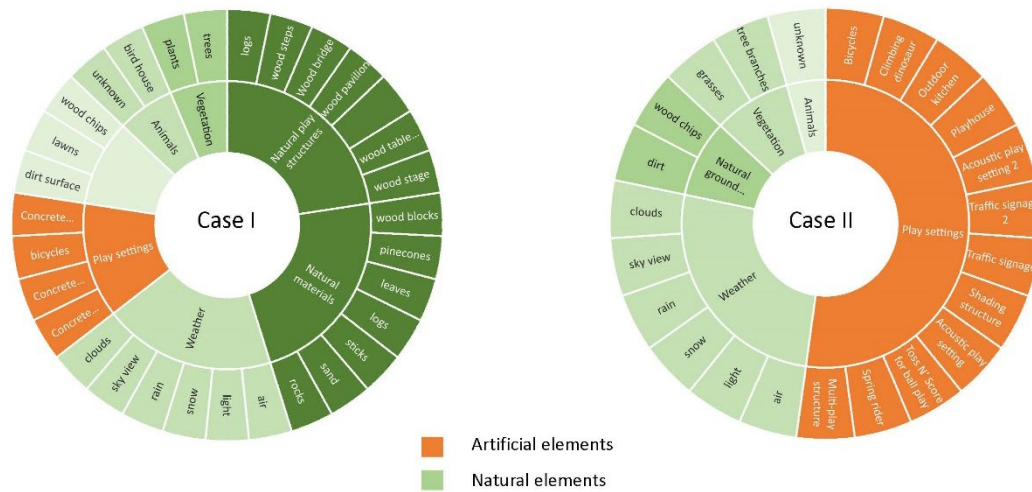


Figure 4.8 Cross Case Comparison: Types of Natural Elements and Non-natural Play Settings in Two Outdoor Play Environments.

4.2 Children’s Interactions with Natural Elements

This section focuses on the influence of the outdoor play environment on children’s interaction with natural elements. It aims to answer the secondary research question: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children’s interactions with natural elements? Field observations and semi-structured interviews with teachers provided two sources of evidentiary data that were later analyzed and synthesised.

The investigator conducted 686 total minutes of direct field observation on the two case study sites. Behavior mapping method was also employed. Evidentiary data included children’s play locations, their interaction with natural elements, types of play behavior, and interaction with their teacher; and were recorded using prepared field observation tables. Twenty-nine children (12 females and 17 males) from Case I and

twenty-six children (13 females and 13 males) from Case II participated in this research. Field studies for Case I generated 67 field observation sheets and 104 field observation sheets were generated during Case II field research. Field observation points, or stationary field locations where the investigator observed, were recorded on each observation sheet and coded in Excel. In addition, two teachers from each case participated in the semi-structured interview. Their responses were recorded and transcribed and later analyzed using MaxQDA.

Organizing this data involved two steps. The first step involved the elimination of observation sheets containing data where teachers directly guided more than twenty children to engage in group play behaviors. The focus of this research is on children's "free" or independent play behaviors and data reflecting the teachers direct guidance would skew the findings. The second step involved the elimination of observation sheets containing data with less than twenty children in the outdoor play environments during recording times. In the end, 65 field observation sheets (out of 67 originally collected sheets) were collected for Case I and 86 field observation sheets (out of 104 originally collected field observation sheets) were collected for Case II. Both case studies were analyzed individually for content and comparatively for content and pattern logic.

Figure 4.9 presents the data analysis and synthesis strategies. The data was collected through field observations and semi-structured interviews with teachers (audio recorded and later transcribed). Analysis of the data from field observations involved ArcMap. Content analysis of responses from the teachers' involved MaxQDA. Each set was analyzed for each case study, followed by triangulation of content analysis and

spatial analysis for pattern matching logic, and eventual comparative analysis (Yin, 2014). The field observation data created an understanding of each case spatially with two types of spatial analysis methods using ArcMap. Kernel density analysis and hot spot analysis. One result represents a measure of the spatial relationship between the outdoor play environment and the children’s preferred play location and the other is an indicator of the frequency and variety of the children’s interactions with natural elements. The last step in the analytical process involved the synthesis and triangulation that sought to match the patterns of children’s interaction with natural elements from the two sources of evidentiary sources. This synthesis and triangulation address the validity data gathered and analyzed for this research. The cross-case comparative analysis led to synthesis in the stages of the research.

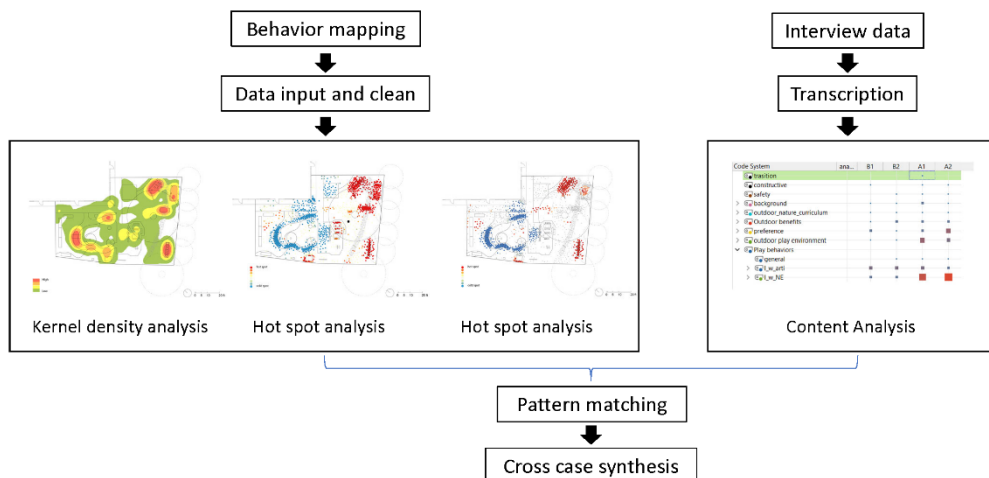


Figure 4.9 Data Analysis Methods and Strategy for RQ1.

4.2.1 Case I: Nature-based Outdoor Play Environment (NBOPE)

The behavior mapping method enabled the data collection for children’s play locations, play behaviors, interactions with natural elements, and interactions with

teachers. Every point on each observation sheet represents that one child appeared in that location at one time point. Also, that child’s interaction with natural elements, interaction with teachers and his/her types of play were recorded at the same time.

Spatial patterns of children’s outdoor play

By utilizing ArcMap, observation sheets were served as a layer of information for play behavior patterns, spatial locations of features and the outdoor play environments. In combination these layers can represent density of children’s play and play patterns.

Kernel density analysis is a measure of density of children’s play in the outdoor play environment. In other data analysis, evidence of children’s frequent play locations from the teacher’s perspective was collected through semi-structured interview with teachers.

Content analysis revealed the patterns of children’s outdoor play location. Figure 4.10 shows the results from kernel density analysis results and Figure 4.11 presents results evolved based on the content analysis.

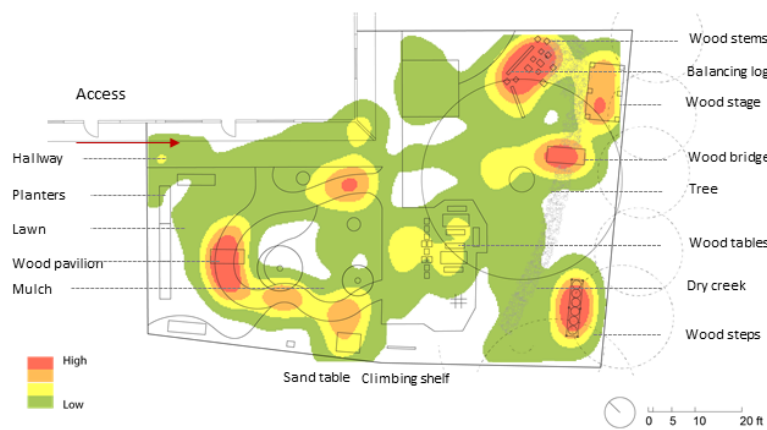


Figure 4.10 Kernel Density Analysis: NBOPE.

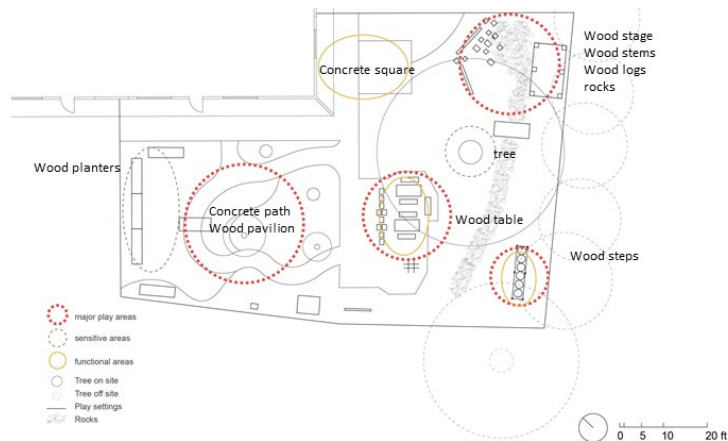


Figure 4.11 Density of Children's Playing Locations Patterns from Interview: NBOPE.

The following shared patterns were discovered through this analysis.

The kernel density analysis reveals that the density of children's play location is positively correlated with the play settings' location. The children appear to play more frequently in the areas where play settings are located. For example, analysis of the play settings and their surrounding areas such as the bike⁵ track area, balancing logs and wood stems area, wood stage area, wood bridge area as well as wood steps area indicates a high density of children's play. At the same time, findings from the content analysis reinforce the above patterns. These findings demonstrated that bike track area, wood steps area, wood stage, wood stems and log area are three major play areas (red circle areas in the Figure 4.11) in the outdoor play environment. For example, teacher said: *"they love this area over here (wood stem, balancing log and wood stage area). Aside from the track, I would say this is another big part of our playground."*; *"They do a lot of play on the*

⁵ In this context, bike was used by teachers and refers to tricycles.

stairs (wood steps)” (Interviewee C); “they definitely love being on the track and play with the sand and water table for sure.” (interviewee D)

Another major finding is that designed nature-based play structures attract children. The findings from the kernel density analysis indicate most of the high-density areas such as wood stems, balancing log, wood stage, wood bridge, wood steps areas contain one or multiple designed natural play settings. Main themes from the content analysis indicate children prefer playing with natural elements and demonstrate a preference for designed nature-based play areas, like playing in the balancing log and dry creek area, wood stage area, big tree area and the wood bridge. Content analysis also revealed children’s play location and play activities are affected by seasons and climate conditions. Some natural elements can provide shade. This is beneficial for children’s play behaviors and activities, especially in the summer. Interviewees mentioned *“I think they are more active when it is cooler” (Interviewee C); “That (big tree area) is the more shaded area, so when it gets really hot, all the kids kind of like get around the tree” (Interviewee D).*

The kernel density analysis notes another finding with indications that children played less frequently in lawn areas and areas with raised planting beds. Content analysis of the children’s responses to the questionnaires suggested the same pattern of behavior and illustrated the children’s understanding that planters and tree areas are sensitive and they have to be careful, they are engaged when observing the growth and maturing process (interviewee C). As the teacher stated, *“we do not play rough around the fruits and flowers because they like to hand them out to parents, and we like them to grow”*

(interviewee C). “From what I have seen like I said the bird feeder is on that tree, and they are very sensitive with that area simply because they know that this is for birds”

(interviewee C). Teachers mentioned that children strongly prefer to observe and participating in planting trees, fruits and vegetables since they connect emotionally with the plants, especially watching their growth. They enjoy helping the teacher with gardening activities: picking flowers and leaves for their teachers, and hand delivering fruits and flowers to parents. However, these activities do not happen daily and were not necessarily observed during the field observation periods. In addition, some spaces are functional areas such as areas for cooling down, spaces between two or several major play areas, and spaces for teachers doing “headcount”, talking and applying bug spray. These locations in the analysis may indicate lower density of children’s play.

Children-nature interactions in the nature-based outdoor play environment

Evidence of children’s interactions with natural elements was collected through the behavior mapping method. The relationship between children’s play location and children’s interaction with natural elements were assessed with both hot spot analysis and content analysis using ArcMap and MaxQDA, respectively. Findings from this data analysis highlighted the play areas and play settings that afford higher levels of frequency and variety of children’s play behaviors.

The results and findings of the hot spot analysis are presented in Figure 4.12. It indicates that children’s interaction with natural elements is positively correlated with the location of designed natural based play settings (significant on 99% confidence level). The frequency of children’s interactions with natural elements in wood stems area,

balancing logs area, wood stage area, wood bridge area, and wood steps area are high. Wood tables and sand table areas also provide high frequency of children-nature interactions. However, loop pathway area and concrete surface areas provide children the least opportunities of interaction with natural elements. And these areas showed as cold spots in the hot spot analysis results diagram.

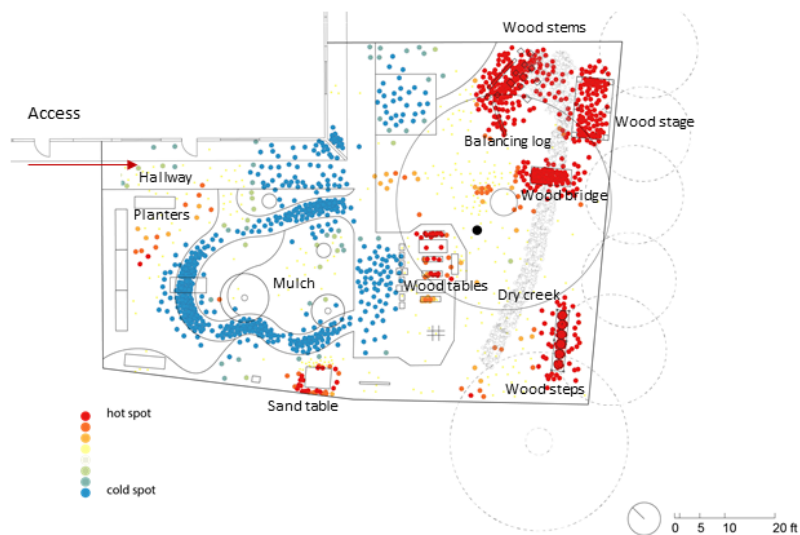


Figure 4.12 Hotspot Analysis I: NBOPE.

The hot spot analysis was also utilized to examine the relationship between children’s play locations and the variety of children’s play behaviors (Figure 4.13). The findings suggested that designed nature-based play settings afford higher level of variety of children’s play behaviors compared with non-nature-based play settings (significant in 99% confidence level). As Figure 4.13 illustrates, the wood stems area, balancing logs area and wood steps area, afford the most variety of play behaviors. The wood stage and sand table areas also afford a higher level of variety of affordance. However, the loop pathway area and concrete area support lower level of variety of play behaviors.

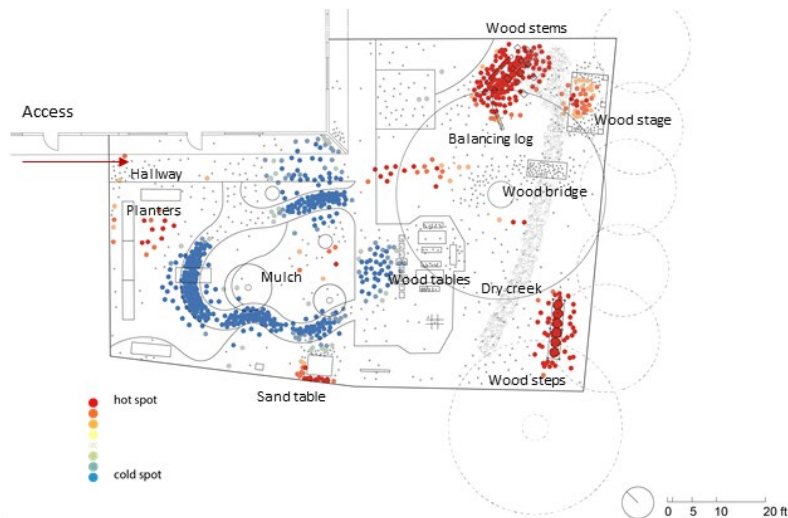


Figure 4.13 Hotspot Analysis II: NBOPE.

Through content analysis of the responses to the semi-structured interview with teachers, the following main themes were revealed. The main themes highlighted that the children’s behavior demonstrated a strong and emotionally positive preference for interacting with natural elements; and natural elements afford many types of children-nature interaction through constructive, dramatic, exploration, physical and learning play behaviors as well as sensory experiences. Major specific findings and themes included:

- 1) Children’s strong emotional preference for playing with the designed nature-based play settings through various play behaviors. Teachers found that children demonstrate preferences for interacting with natural elements. For example, the following play behaviors were mentioned by the teachers: planting vegetations in planters and picking flowers, berries, and other objects off them when they mature; playing in the lawn area; running through bridges; walking and jumping on wood steps. In addition, children and teachers’ interactions allow creative play within the nature-based play settings. Teacher

described the variety and creativity of children's play by saying that *"You ask them what they are playing, they are going to tell you something different every day."* (interviewee D). Some examples were provided: *"we have some tree stems. they are in different sizes. they will line them up according size, they are smart kids. They line them up according to size and walk across, kind of like a balancing beam and they jump off them."* (Interviewee C).

Furthermore, content analysis also suggested that role play, such as pretending adult business activities and playing house as a major type of play behavior.

Children have large imaginations where play settings like wood stage, balancing log, bike, bridges can provide children opportunities for children's role play. For example, teacher describes: *"Sometimes, they playhouse, or they pretend like their dogs or their cats. So, I think that they do a lot of role playing in that area. They pretend like the platform is their house, or you know. A lot of boys like to play like their superheroes, they have their superhero fights. so, there is a lot of that."* (interviewee C); *"So, the stage is kind of like, they will pretend it is a boat, they will pretend it is like a stage for the dancing. So, in that one part, it can be like fifty different things. It could be they are on boat in the ocean, or they are doing gymnastics."* (interviewee D)

- 2) Children usually use natural elements as tools for role playing or hands-on natural elements which including mulch, dirt and rocks. One possible reason is that they like feeling things and touch new things (Interviewee C).

- 3) Children show high preference on exploration through digging and looking for. Natural elements stimulate children's exploratory play behavior. Outdoor playground is like a whole new world for children, where they can be very creative and exploratory every day (Interviewee D).
- 4) Children have high preference on observing and talking about changes of trees, clouds, birds and other living things with their imagination. *"The kids love like looking at the clouds, they are like, oh, that is a dog; oh, that is a pancake; oh, that is my mom's car. They come up with crazy things with the clouds, and birds, and other animals". "Yeah. They have big imagination, so you just sit and talk with them forever, and they will be like look at this."* (Interviewee D).
- 5) Through interacting with natural elements, children understand to protect sensitive plants or animals.

4.2.2 Case II: Standardized Outdoor Play Environment (SOPE)

Evidentiary data of children's play locations and interaction with natural elements in the standardized outdoor play environment were collected and analyzed through the same strategies and methods as Case I.

Spatial patterns of children's outdoor play

Kernel density analysis (Figure 4.14) suggests that children's play locations are positively correlated with the designed play settings. Content analysis results (Figure 4.15) also indicated that children have a high preference for outdoor play settings. Multi-

purpose play structures, playhouse, play kitchen, bike track and dinosaur and their surrounding areas indicate children's major play areas.

In addition, the findings from spatial analysis indicate microclimate, especially shade, impacts areas children choose to play. Areas with heavy shade indicate a high density of children's play. Teachers indicated children are sensitive about the outdoor temperatures and that it impacts the children's outdoor play experience and the level of engagement in activities. Children prefer playing in shaded areas on hot days. Shade structures provide shaded areas and comfortable spaces where children can engage multiple play behaviors; and these areas create affordances with moveable play settings such as blocks, jumping ropes.

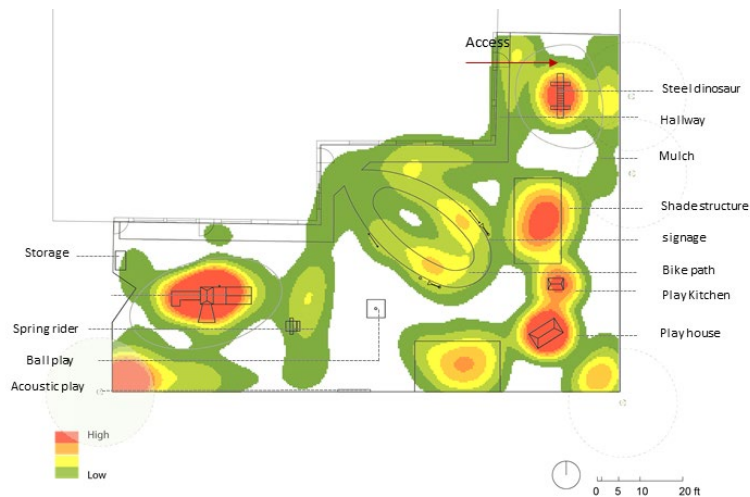


Figure 4.14 Kernel Density Analysis: SOPE

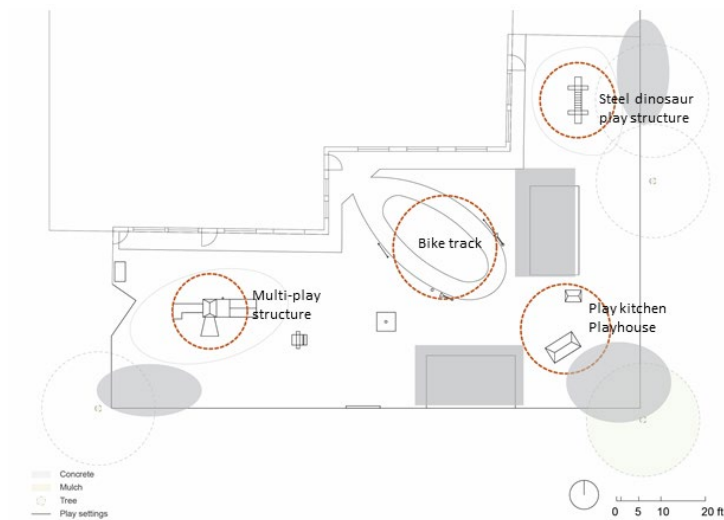


Figure 4.15 Density of Children's Playing Locations Evolved from Content Analysis: SOPE

Children-nature interactions in nature-based outdoor play environment

Hot spot analysis (Figure 4.16) revealed the relationship between children's play locations and children's interaction with natural elements. The findings from the analysis indicated tree canopy areas and the play kitchen area presents a high level of children-nature interaction (significant on 99% confidence level). However, the tree canopy area at the southeastern corner is a cold spot area regarding levels of children-nature interaction. Based on direct field observation, children engage in many rule play behaviors like racing with each other or group games in that area. Children usually demonstrate less interaction with natural elements when they engage in these types of activities. This may explain the low density or why this tree canopy sub-area in the outdoor play setting does not show up as a hot spot in the kernel density analysis for the children's interaction with natural elements. The dinosaur play structure, multi-purpose play structure and bike track area provide children with less opportunities for interactions with natural elements.

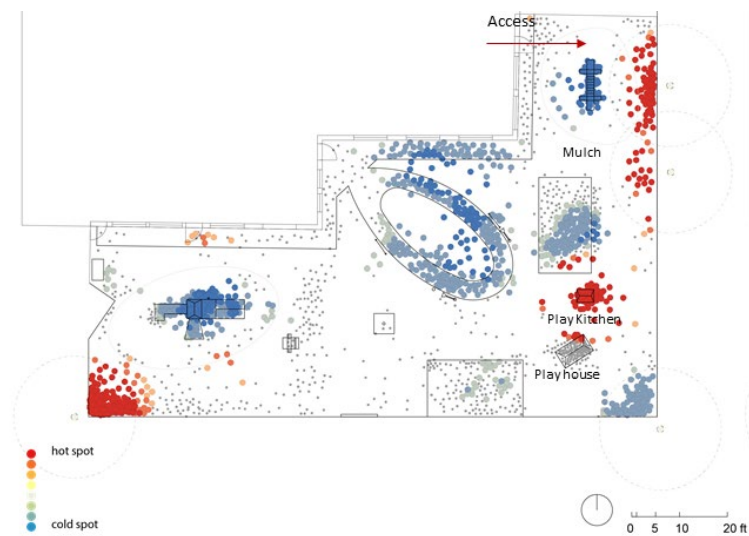


Figure 4.16 Hotspot analysis I: SOPE

Additionally, the spatial analysis (Figure 4.17) indicated designed play settings and shading areas afford a higher level of variety of children’s play behaviors (significant in 99% confidence level). Major areas that provide diversity of play behaviors are the dinosaur play structure, play kitchen, playhouse, bike track and left corner area.

Therefore, the hot spot analysis indicates that well-designed artificial play settings may enhance the variety of children’s play behaviors. Comparing the hot spot areas between two hot spot analysis results revealed no evidence for the impact of natural elements on the variety of play behaviors in the standardized outdoor play environment. Lacking designed nature-based play settings and the low quality of natural elements may be the cause.

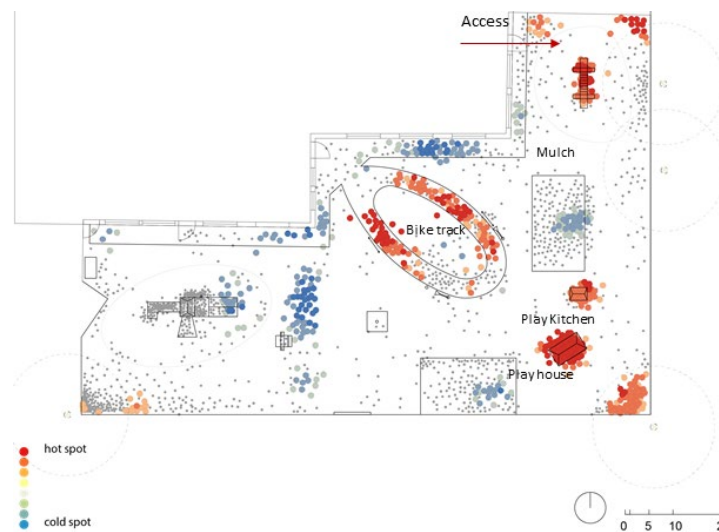


Figure 4.17 Hotspot analysis II: SOPE

However, evidence of natural elements such as soil on the ground, mulch, tree branches, and experiential natural elements such as fresh air, the wind, blue sky, clouds, rain are regularly accessible to the children at this childcare center. Findings from the content analysis reveal children’s preference, frequency and variety of children-nature interaction in the standardized outdoor play environment. The following themes were revealed in the analysis:

- 1) The Children feel strongly about the natural elements and they use them as tools during role playing or hands on natural elements like mulch or soil. Teacher mentions that *“they do like play with natural elements”* (interviewee B). Teachers noted children use wood chips, leaves, when cooking during role play (interviewee A) and they also like playing with water.
- 2) The childcare center provides other opportunities for children to interact with natural elements. For example, people from the zoo were invited to introduce animals to the children (interviewee A); teachers also organize storytelling

games to connect children with animals and their natural habitats through indirect experience.

- 3) The children demonstrate a strong interest for exploring through the activity of digging and using their imagination for living objects they hope to find. They play with leaves, mulch, grass and worms through digging (interviewee A). Children's strong observation of trees and ways these change along with other living things demonstrates their active use of imagination. Teacher described: "*Yes, they are. They are interest in the tree when it changes. They would say, "look at the tree"*" (interviewee A).
- 4) The children feel strongly about the experiential dimension of observing natural elements especially discussing when these changes. The teacher noted children's observations of the sky and objects like the clouds, moon, and airplanes flying over.

However, content analysis suggested the children's variety of play behaviors in standardized outdoor play environment, mainly rely on following.

- 1) Children can do many different things in one or more parts of the play settings. Teacher mentioned "*Children try different toys, experience new things, and changes. Children can do what they want to do, get to be free outside. (interviewee A)*"
- 2) Teachers try to arrange various play activities with existing play settings. Moveable play settings like jumping ropes, blocks, and parachute and chocks help creating various play behaviors like running, chocks, exercises,

structures, jumping ropes, and drawing. *“I try to do different things with them every day. Like I said, we play with them at least ten minutes. So, I try to run, parachute, the blocks, climbing, sliding down the slides. (interviewee A)”*

- 3) Children engage in diverse play behaviors through role play and the use of their imagination. The standardized outdoor play environment contains multiple settings for role play. For example, the playhouse and play kitchen afford behaviors like playing doctors, families, cooking, and selling staff; the multi-play structures afford playing monsters, castle, and families; the burger hut affords role play behaviors like serving food. Teacher described that *“you know with role play, they can all be something else, you know, using their imagination, they can do different things (interviewee B).”*

4.2.3 Comparative case study analysis

This section presents the findings from the comparative case study analysis that investigated the children’s frequency and variety of interaction with natural elements in nature-based and standardized outdoor play environment. The percentage of observed natural elements affordances were calculated. Themes were also revealed.

Specifically, as described in previous sections, field observation recorded the observed points (observed point represents one child was observed in the certain time period), along with types of affordances (each observed point may contain one or more observed affordances since the child may engage in multiple play behaviors in that observed time period) and whether interacts with natural elements at each observe point.

The percentage of observed natural elements affordances were calculated to represent the level of frequency of children-nature interaction.

$$\text{Observed affordance} = \sum \text{observed affordances of each observed point}$$

Observed natural element affordances

$$= \sum \text{observed natural element affordances of each observed point}$$

$$\text{Percentage of observed natural elements} = \frac{\text{Observed natural element affordances}}{\text{Observed affordance}}$$

The result in Table 4.6 suggested that natural elements in the nature-based, NBOPE afford a higher level of frequency of children-nature interactions than standardized, SOPE. Given that the percentage of observed natural elements affordance in NBOPE is 66% and the percentage of observed natural elements affordance in SOPE is 14%.

	Total observed affordances	Total observed natural elements affordances	Percentage of observed natural elements affordances
Case I	3436	2256	66%
Case II	4515	622	14%

Table 4.6 Cross-case Comparison: Frequency of Children-Nature Interaction

The level of variety of children-nature interaction in the two types of OPE was compared by comparing the total types of observed natural elements affordances. To illustrate,

Total observed types of affordances

$$= \sum \text{observed types of affordances of each observed point} *$$

Total observed type of natural elements affordance =

$$\sum \text{observed types of natural elements affordances of each observed point} *$$

* Per type of affordance was calculated once.

As Table 4.7 presents, the total number of observed types of affordance in both outdoor play environments are 48. However, in the NBOPE, natural elements afford 48 types of affordances; and in the SOPE, natural elements afford 38 types of affordances. The results indicated that natural elements in the nature-based outdoor play environment afford a higher level of variety of children-nature interactions. (26% percent higher)

	Total observed types of affordances	Total observed type of natural elements affordances
Case I	48	48
Case II	48	38

Table 4.7 Cross-case Comparison: Variety of Children-Nature Interaction.

In addition, to illustrate the varieties of children-nature interaction in the two types of OPE, the tree maps for both sites were created. Tree maps is a method that can display the proportions and hierarchy of data. The following tree maps display the proportions and hierarchy of each type of natural elements affordance observed in each OPE. As Figure 4.18 and Figure 4.19 showed, each square represents a type of natural elements affordance, and the size of each square represents the proportion of a certain

type of affordance in the total observed natural elements affordance. The hierarchy of types of natural elements affordance is presented from left top to the right bottom.

talking	sitting on	walking	Balancing	looking for							
		walking up	walking down	Building of structures	collecting						
			swinging on	climbing	holding						
	looking out from	waving	Constru... of objects	listing	playing mulch						
		Being Noisy	picking	playing war	hiding	thr...	cyc...				
	jumping	ruunning	standing	role playing	mixing with...	dr...	kic...	h...	o...		
				passage from one place to another		l...	
						fo...	d...
						a...	d...
				crawing	pulling						

Figure 4.18 Observed Types of Natural Elements Affordance: NBOPE

In comparing these two maps, the following patterns were identified: 1) Nature elements in the NOPE affords a higher level of variety of affordance than natural elements in the SOPE; 2) the SOPE tree map, indicates some dominating natural elements affordances can be observed such as playing mulch, sitting on, talking, and kicking, while in the NBOPE tree map, the proportion of natural elements affordances are more evenly distributed.

	talking		kicking			
	playing mulch	role playing	Building of structures	throwing	running	
standing			Being noisy	collecting	digging	hiding
	walking	looking out from		privacy	looking for	mixing with other...
singing			Balanc...	playing home	pla... im...	cru...
	observing	holding	followi... adult's...	walk...	cr...	
climbing			C...	...

Figure 4.19 Observed Types of Natural Elements Affordance: SOPE

4.3 Children’s Restorative Experience

This section examines the relationship between outdoor play environment and the children’s restorative experience. It attempts to answer the secondary research question: How does the designed nature-based outdoor play environment in childcare centers impact pre-school children’s restorative experience?

To answer this question, evidentiary data of children perceived restorative experience were collected through structured interviews with four to five-year-old children (N=20), and a semi-structured interview with teachers (N=4). The structured

interview questionnaire was developed based on Bagot's (2014) PRC-C. For the purpose of this research, it was revised to be applicable to the target study population, pre-school children in the four to five-year-old age group. The questionnaire contains ten "yes" or "no" and open-ended questions on the children's preference of outdoor play, and four indicators of the restorative experience – being away, content, fascination and compatibility. Paper-based field notes were utilized to record answers for each question. In keeping with confidentiality protocols, no identification of participants was collected, and they were coded through a numeric system. The field notes were input, cleaned and analyzed in Microsoft Excel. The methods of analysis included statistical analysis and content analysis with SAS⁶ and Excel, respectively.

Additionally, children's restorative experience evidence was also collected through the semi-structured interview with teachers. The children's restorative experience survey for teachers involved questions regarding the four indicators of the children's restorative experience. The purpose is to understand a period history of children's restorative experience from the teacher's perspective. Data from the semi-structured interviews was transcribed and analyzed in MaxQDA.

Figure 4.20 presents the data analysis and synthesis method and strategies. This section begins with the comparison of statistical analysis and content analysis of the children's perceived restorative experience from the nature-based, NBOPE and the standardized, SOPE, followed by the content analysis and cross-case comparison of the

⁶ SAS "Statistical Analysis System" developed by SAS institute, is purpose for data management, advanced analysis and other analysis. Source: [https://en.wikipedia.org/wiki/SAS_\(software\)](https://en.wikipedia.org/wiki/SAS_(software))

children’s restorative experience. The summary of the research findings derived and presented at the end of this section.

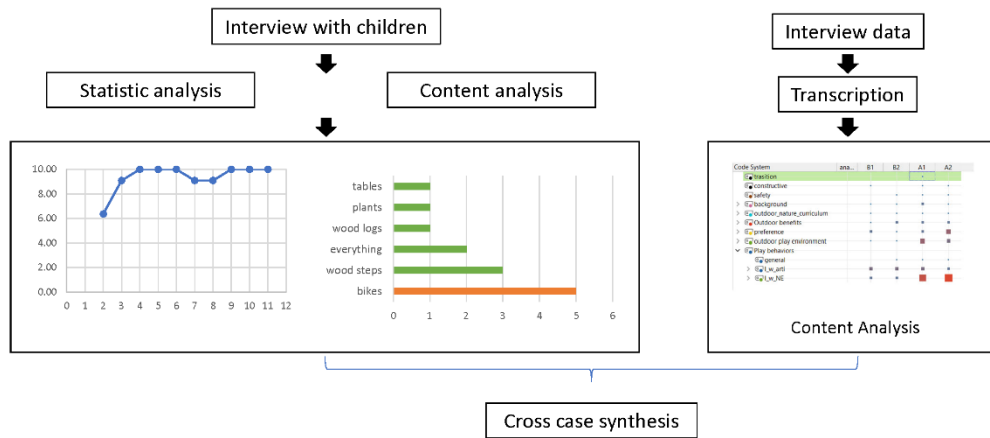


Figure 4.20 Data Analysis and Synthesis Methods and Strategies for RQ 2.

4.3.1 Perceived restorative experience

Nineteen participant’s data sets were analyzed (case I = 10, case II = 9) for the perceived restorative experience. Participants were asked to answer ten “yes” or “no” questions and followed with open questions. The score for each question was calculated as: Yes = 1; No = 0.

Table 4.8 presents the percentage of “yes” for each question from each case. All children from both childcare centers indicated that they preferred playing outside and their outdoor play environment. Specifically, two questions referred to the children’s feeling of being away from the outdoor play environment. 80% of the children who played in the NBOPE felt it was different than in the classroom while they were playing outside, whereas 63% of the children from SOPE feel “yes”. When asked if they are able to do many things in the outdoor playground, 100% of the participants from the nature-

based outdoor play environment responded “yes”, while 86% of children from SOPE responded “yes”. In addition, on average 90% of the participants who played in the NBOPE felt fascination from outdoor playing; while on average 83.5% of the participants who played in the SOPE felt fascination from outdoor playing. Finally, 100% of the participants who played in the NBOPE and 85% of the participants who played in SOPE, indicated their feeling of compatibility.

	Questions	Case I	Case II
Being away	Q8: Do you feel you are away from things teacher want to you to do in the outdoor playground?	90%	87%
	Q9: When you are in the playground, do you feel it is different than in the classroom?	80%	63%
Content	Q10: Can you do many things in the outdoor playground?	100%	86%
Fascination	Q4: When you are in the playground, do you feel there are many interesting things?	90%	67%
	Q5: when you are in the playground, do you feel there are many interesting places?	80%	78%
	Q6: Do you feel there are many things to look at in the playground?	100%	100%
	Q7: Do you feel there are many things to discover in the playground?	90%	89%
Compatibility	Q11: Can you do what you want to do in the playground?	100%	85%
Preference	Q1: Do you like playing outside? Q2: Do you like this playground? Q3: what is your favorite part?	100 %	100 %

Table 4.8 Perceived Restorative Experience Questionnaire Analysis

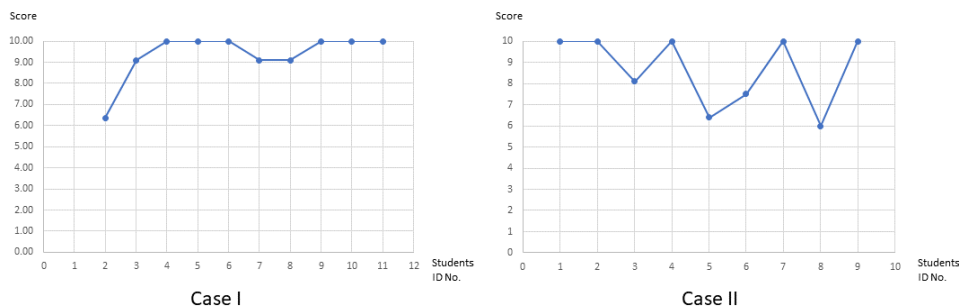


Figure 4.21 Perceived Restorative Experience Score.

The perceived restorative experience score measures the level of perceived restorative experience for each participant. Figure 4.21 presents the scores of participants

from two cases. The findings indicate children who played in both types of outdoor play environments can have a perceived restorative experience.

The T-test was conducted in SAS to examine the difference between the children perceived restorative experience from the two cases. The findings indicate no significant difference ($p=0.157$) of perceived restorative experiences between the two groups of children from each of the two cases. The T-test results are presented in the Table 4.9.

Case	N	Mean	SD	SE	t	p
Case I	10	9.363	1.139	0.3602	1.04	0.1577
Case II	9	8.667	1.689	0.5630		

Table 4.9 T-test of Perceived Restorative Experience.

The logic for the follow-up open questions (Q3, Q4, Q6, Q7) were to: 1) address the validity of the structured interviews; 2) explore the sources of the children’s perceived restorative experience from the children’s perspective. One major factor in the follow up open questions focused on the children’s feelings of fascination. One example of the open-ended question is: “Could you please give me some examples?” Content analysis included quantifying the number of times a particular play setting or element was mentioned or described by participants in each case.

Findings from the content analysis (Figure 4.22) highlight major sources of children’s feelings of fascination involve nature-based play settings and natural materials. Some non-nature-based play settings like bike (In this context, bike was used by teachers and refers to tricycles) indicate a level of contribution. To illustrate, bikes are mentioned

the most times as the children’s favorite setting in the playground. Other favorite settings or elements indicated all nature-based play settings or materials including the wood table, plants, wood logs and wood steps. Additionally, children indicated their interest in the diversity of natural elements including wood logs, wood steps, wood stems, rocks, wood stage, and wood table. Moreover, the children indicated four natural elements including trees, bridge, dry creeks and wood tables as interesting things to look at in the outdoor playground. Finally, most of elements or play settings children indicated in terms of discovery in the playgrounds were natural elements such as mulch, corn, rocks, grass, worms, trees and gardens.

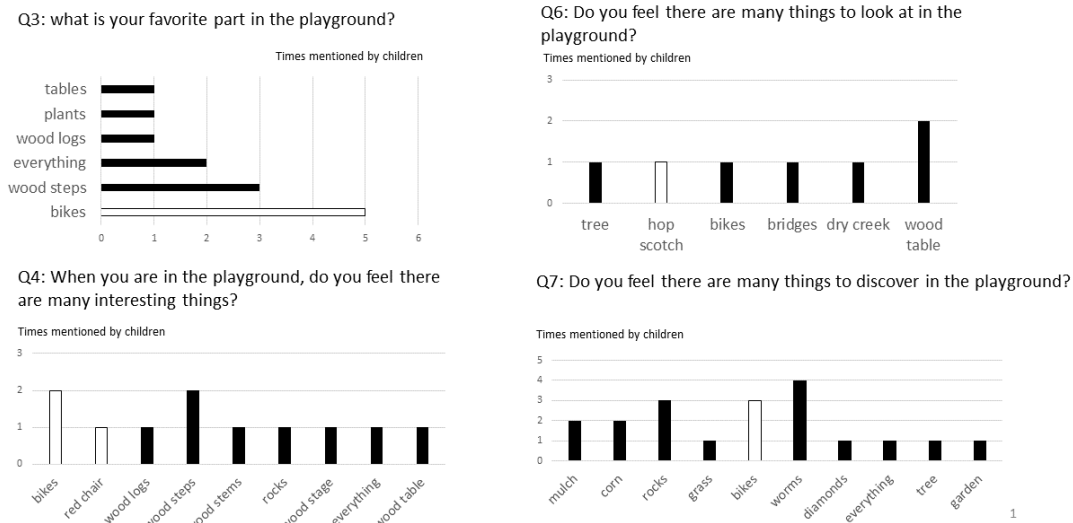


Figure 4.22 Children's Perceived Restorative Experience Open Question: NBOPE

Black bar: nature-based elements; white bar: non-natural or artificial elements

Figure 4.23 presents the findings from the Case II content analysis. Findings indicate major play settings and natural materials served as major sources for the children’s feelings of fascination. In the SOPE, children’s favorite parts were the major play settings. Things that interested the children included the various play settings, as

well as the natural materials such as mulch, dirt and shades. Other findings also revealed natural elements may support children’s feelings of fascination by providing interesting things to look at and discover. Although the SOPE is limited in terms of natural elements, many natural elements such as rocks, mulch, trees, dogs (outside and beyond the boundary fences) were mentioned as interesting things to look at; and rocks, dirt, grass, and mulch were discussed as interesting things to discover.

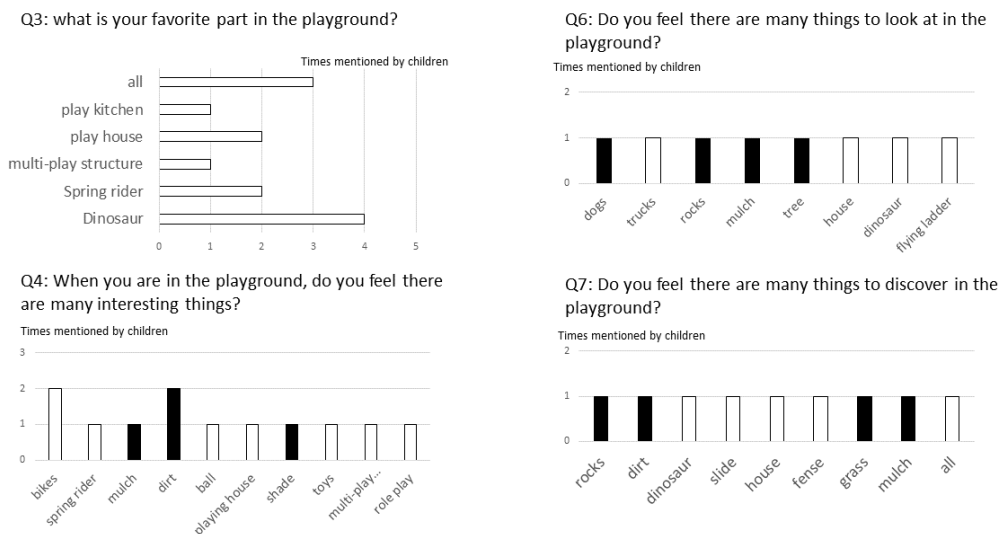


Figure 4.23 Children's Perceived Restorative Experience Open Question: SOPE

The findings from the cross-case comparative analysis from the children perceived restorative experience survey indicate: 1) both types of outdoor play environment support pre-school children’s restorative experience at childcare centers; 2) major play settings and natural elements may serve as important factors for affording children’s feelings of fascination.

4.3.2 Restorative experience

The restorative experience survey was embedded as the third part in the semi-structured interview with teachers. The purpose of this survey was to validate findings

from the children's perceived restorative experience survey. Questions were developed based on the children's perceived restorative experience survey. It aims to cover the children's feelings of being way, fascination, content and compatibility, acquired from the outdoor play environment and their sources from the teacher's perspective.

The findings from the content analysis are presented in Table 4.10. This includes the teachers' opinion, shared themes and differences. The findings demonstrate teachers from both childcare centers agree that children acquired feelings of being away, content, fascination and compatibility from their outdoor play. Specifically,

- Teachers agree that children feel different in the outdoor play environment than the indoors as noted in the following: 1) children can engage in free play, have a sense of independence, and do what they want to do in the outdoor area; 2) children can do things outside that they are not allowed to do inside; 3) they always experience new things and try different things during outdoor play. Natural elements in the NBOPE were highlighted as major contributors, while social interaction and movable play settings were highlighted in the SOPE.
- Teachers agree that children can do many different things in one or more sub-areas in the outdoor play environment. Role play and imagination were shared sources for both types of outdoor play environment. The NBOPE support children's role play and imagination by natural elements and nature-based play settings, while the SOPE mainly relies on the teacher's facilitation and multiple play settings.

- Teachers agreed that many objects in the playground fascinate the children. They noted children demonstrated fascination when they attempted to find different objects and experience new things. Sources of fascination in nature-based outdoor play environment included: 1) experiencing and playing with things they do not see inside; 2) engaging in explorative behaviors; 3) playing with natural elements which they are emotionally attached to; and 4) experiencing changes and new things in the outdoor play environment.
- Teachers also agree that there are many things children want to do in the outdoor play environment. The findings from the analysis revealed that children acquired feelings of compatibility from playing new and different things and were able to do what they want to do. NBOPE affords children's feeling by interactive experiences with natural elements, while SOPE affords by social interaction and moveable play settings.
- In general, teachers agree that after playing outside, children appear to have had a restorative experience. Teachers noted after the children's outdoor play, they expend their energy, and appear less energetic, more relaxed and calmer. Children are able to focus, pay attention, and listen during their learning activities after playing outside.

	Teachers opinion	Emerging themes (shared)	Case I	Case II
Being away	Teachers agree that the children feel different in the outdoor play settings versus when they are indoors.	Children can play freely outside. They can do things they cannot do inside. They can experience new things, try play different. Children can do what they want.	Outside is a whole new world, different breath, get out of imagination, scream and run, endless opportunities of what they can do.	Play independently, less structured, play with friends, play with teacher.
Content	Teachers agree that children can do many different things in one or more parts of the play settings.	Children use their imagination and do different things especially through role play.	Wood stage affords multiple play behaviors. A rely on natural elements	Rely on toys and teachers' facilitation of various play behavior.
Fascination	Teachers agree that many things in the playground fascinate the children.	Children fascinated when they try different things and experience new things.	Children fascinate with things they see and play outside but do not see inside. Fascination coming from exploration. Children get an attachment with natural elements. Every day is different.	
Compatibility	Teachers agree that there are many things children want to do in the outdoor play.	Play something new, play different; children can do what they want to do. Changes	Wood stage affords multiple play behaviors. A rely on natural elements.	Rely on toys and teachers' facilitation of various play behavior.
General	Teachers agree that after playing outside, children appear to have had a restorative experience.	Children get their energy out, they appear to be less energetic, more relax and calm. Children can pay attention and focus more on working and listening.	Some outside settings like bridge and sitting on logs create a comfy space for children who are not feeling good.	During outside play, children can play with other friends and teachers.

Table 4.10 Shared Themes of Children's Restorative Experience.

4.3.3 Cross-case comparative analysis

The analysis and cross-case synthesis reveal both the NBOPE and SOPE support children's restorative experience. The nature-based outdoor play environment may afford

children higher levels of feelings of being away, fascination, content and compatibility. The major sources of restorative experiences in the outdoor play environment are nature-based play settings and natural materials, and experiential elements. These sources stimulate children's imagination, facilitate explorative play behaviors, provide comforting zones and endless play opportunities. The analysis indicated children's attachment to natural elements and the fascination created by them. In the standardized outdoor play environment, children demonstrated their attachment for natural elements as well. Natural elements may be a factor for children's restorative experience, especially their feeling of fascination. Findings from the SOPE reveal other possible contributors for children's restorative experience. For instance, teachers, movable play settings, and play settings with role play activities were suggested as important factors to contribute to the children's restorative experience. Social interaction such as playing with students and teachers from other classes may also contribute to the children's restorative experience.

4.4 Conclusion

Field research and site assessments confirmed the selected designed NBOPE contains higher quality of nature elements; and potentially creates the affordance of high levels of the variety of play behaviors than the selected SOPE.

Spatial analysis and content analysis demonstrated children's play locations correlated with fixed play settings in the outdoor play environments. Hot spot analysis reveals the frequency and variety of interaction with natural elements in designed NBOPE may be correlated with the location of designed nature-based play settings. Content analysis reveals and highlights ways natural elements affords many types of

children-nature interaction through diverse play behaviors such as constructive play, dramatic play, physical play, exploration and sensory experiences. The cross-case synthesis confirms the correlation between children's play location and major fixed play settings in both outdoor play environments. It also reinforces natural elements in the NBOPE afford higher levels of frequency and variety of children-nature interactions. The teacher's role in the children's outdoor play environment and restorative experience has been revealed as well.

Statistical analysis and content analysis indicated both NBOPE and SOPE support children's restorative experience. NBOPE may afford children higher levels of feelings of being away, fascination, content and compatibility. Natural elements play an important role in providing children with new and various play opportunities and sensory experiences, stimulating their imagination and explorative behaviors, a new experience or "world" which is different from the indoor environment and related activities. Furthermore, the research findings highlighted the potential role of social interaction (children-teacher interaction, and child-child interaction) as a supporting mechanism for children's restorative experience.

5. CONCLUSIONS

5.1 Conclusions

This research investigated the inter-relationships of biophilic design, children's health, nature-based outdoor play environments at childcare centers and the children's restorative experience. It examined ways the built environment, especially the design of a nature-based outdoor play environment can contribute to children's restorative experience, a measure for health. The method of comparative case study analysis was conducted and utilized multiple sources of evidentiary data. The objective for collecting and analyzing this data was to uncover this inter-relationship. The research questions and theoretical propositions guided the data collection, analysis and synthesis. Research findings were derived from three questions: one primary, and two secondary research questions. Four conclusions were made as follows:

Conclusion 1: Designed nature-based outdoor play environment may afford high levels of frequency and variety of children-nature interactions during children's outdoor play compared with standardized outdoor play environment.

Conclusion 2: Natural elements especially designed nature-based settings in outdoor play environments may afford high levels of frequency and variety of children-nature interaction during their outdoor play than non-nature-based play settings.

Conclusion 3: Both the nature-based outdoor play environment and standardized outdoor play environment support the children's restorative experience. The

nature-based outdoor play environment may perform better for providing children's feelings of being-away, content, fascination, and compatibility.

Conclusion 4: Designed natural elements and nature-based play settings play important role in promoting the children's restorative experience.

5.2 Discussion of Findings

5.2.1 Designed nature-based outdoor play environment and children's interaction with natural elements

Wilson's (1984) biophilia hypothesis highlights a close relationship between nature and people by emphasizing that humans innately pay attention to, affiliate with, or respond positively to nature. Connecting with nature is a basic human need and it contributes to human health (Kellert, 2015; Ulrich, 1993; Wilson, 1984). Grounded in this theoretical foundation and framework, this research proposes designed nature-based outdoor play environment affords higher levels of frequency and variety of children-nature interaction than the standardized outdoor play environment.

The findings from site assessments indicate the designed nature-based outdoor play environment contains more types of natural play structures and natural materials than the standardized outdoor play environment. Using GIS tools, kernel density analysis explored the spatial patterns of the children's play locations. The results revealed children generally play in areas that contain play settings in both types of outdoor play environments (nature-based play environments and standardized outdoor play environments). This pattern was also confirmed and reinforced by findings from content analysis of the data collected during the semi-structured interviews of teachers.

Additionally, the level of frequency and variety of the children-nature interactions afforded by the outdoor play environment were explored through field observations and interviews of the children. The findings demonstrate two things: 1) the designed outdoor nature-based play environment affords higher levels than the standardized outdoor play environment; and 2) in this designed outdoor play environment, the natural elements and nature-based play settings affords higher levels than the non-nature-based or standardized outdoor play environment.

Specifically, findings from the cross-case comparative analysis indicated the nature-based outdoor play environment affords higher levels of frequency and variety of children-nature interaction than standardized outdoor play environment. However, the children's preference of interacting with natural elements is high in both types of outdoor play environments. Although the children's interactions with natural elements are highly affected by the existing conditions of the outdoor play environment, there are some shared ways between the two types of outdoor play environments. For example, the children frequently interacted with natural elements through exploration and discovery behaviors. They often handled and played with the natural elements and used them as tools during role playing or pretending to be adults conducting business; and they observed, discussed changes, and pointed out growth patterns and the kinetic movements of natural elements like trees, birds, clouds, and insects.

Major findings from the spatial analysis and content analysis from the nature-based outdoor play environment suggest the natural elements, especially the designed nature-based play settings, afford higher levels of frequency and variety of children-

nature interaction than non-nature-based play settings. Hot spot analysis confirmed the positive correlation between the designed nature-based outdoor play settings and the level of frequency and variety of children's play behaviors and interaction with the natural elements significantly and represented 99% confidence level. Findings from the content analysis from semi-structured interview with teachers revealed children strongly preferred creatively interacting with natural elements through various play behaviors. These are children-nature interactions highlighted from the analysis of this data set: utilized the natural elements as tools or as scenes for role playing; engaged in various physical activities; made structures with moveable natural elements like wood stems and twigs, and stones; hands on natural elements, exploring through digging in the natural mulch and soil, and observing and talking about the living, kinetic, and changing natural elements like clouds, birds, plants while using their imagination.

Moreover, research findings indicated the importance of the teachers' role in the children's outdoor play and children-nature interaction in both types of outdoor play environment. The major role of the teacher in children's outdoor play environment is to monitor and provide care for the children. By connecting the childcare center's teaching curriculum with the outdoor play environment, the teachers create various play and learning activities that can enhance the children's learning through the interaction with nature and the variety of play activities. In addition to encouraging children to interact with nature through direct experience, the teachers, especially from the standardized outdoor play environment, enhance the children's interaction with nature through indirect

experiences and symbolic experiences like role playing and storytelling with elements in the natural environment.

Finally, the significance of safety issues and the spatial arrangement of the outdoor play environments were revealed in this study. Safety is one of the most important issues for the children's outdoor play and should be fully considered in the design of outdoor play environments. Findings from this research recommends the following: 1) natural elements in the outdoor play environments should be safe for the target age groups. 2) the teacher's supervision sight lines and viewshed should be unhindered and able to visually access the entire play environment. The spatial arrangement of the outdoor play environment should address the relationship to the childcare center's overall function, interaction with teachers and peers, children's sensory experiences, and play experiences.

5.2.2 Designed nature-based outdoor play environment and children's restorative experience

The theoretical framework for this study anticipates the children's interaction with natural elements in the outdoor play environment would demonstrate children's higher level of the restorative experience. According to Kaplan's (1992, 1995) attention restoration theory, the four feelings: 1) being away; 2) extent; 3) fascination and 4) compatibility are indicators of the restorative experience. The second proposition is that the designed nature-based outdoor play environment in childcare centers provide higher levels of the perceived restorative experience with feelings of being away, fascination, extent and compatibility, than the standardized outdoor play environment.

One of the research analytical tasks compared the difference of the children's perceived restorative experience between the two types of outdoor play environment through content analysis of the children's survey that covered the restorative experience. While significant evidence was not found to fully support the original proposition that designed nature-based outdoor play environment in the childcare centers supports higher levels of perceived restorative experience than standardized outdoor play environment, aspects of the built environment of the play setting, play activities and childcare center operations were revealed in this research. Generally, both types of outdoor play environments support the children's restorative experience. However, this study reveals a trend for the nature-based outdoor play environment as a place where children demonstrate a stronger tendency for expressing feelings of being-away, fascination, extent and compatibility for children than the standardized play environment. Hence, this research validates ART and the study's expectation for evidence of the children's restorative experience in the nature-based outdoor play environment. This research also found that natural elements, especially designed natural elements in the nature-based outdoor play environment tended to play an important role in the children's restorative experience.

The T-test utilized in statistical analysis was deployed to test this proposition. The P value of the T-test was 0.15 and its value is considered insignificant statistically. A greater sample size could possibly reduce the P-value and increase the statistical significance. The results of the T-test also indicate case I has a greater mean value than

case II, and this indicates a trend where the designed nature-based outdoor play environment may afford a higher level of perceived restorative experience.

Findings from the content analysis indicate children have a high preference for being outdoor play environment and it promotes the children's restorative experience. After their routine period of outdoor play, the children appeared to be less energetic, relaxed and calm, and able to learn and listen to their teachers. The natural elements may promote the restorative experience by stimulating the children's imagination, facilitating exploration play behaviors, and providing endless play opportunities for children. Research findings also demonstrated the teacher's participation during the children's outdoor play stimulated the children's imagination and facilitated various play behaviors and may benefited the children's restorative experience.

5.3 Contributions

5.3.1 Attention restoration theory and outdoor play environment

The benefits of connecting natural environment and people for health were widely explored by previous research. Kaplan and Kapan's (1989) Attention Restoration Theory suggests that nature contributes to people's recovery from things that require their direct and effortful attention and cause mental fatigue. The restorative experience was defined by Kaplan (1992) as "an experience which leads to recovery from mental fatigue as well as a variety of associated benefits". According to Kaplan (1995), there are four components, people can identify an environment that contributes to a restorative experience, namely being away, extent, fascination and compatibility. In some ways, this research expands on Attention Restoration Theory (1989) and is discussed below.

Previous empirical research based on Attention Restoration Theory focused on the benefits of natural or nature-based environment on people's health for different age groups. However, the effects on children's restorative experience, especially very young children (four to five-year-old pre-school age group) were less explored. For instance, Berto, Pasini, and Barbiero (2015) focused on the restoration value of nature environment and built environment of eight to eleven-year-old age group. Bagot et al. (2015) examined perceived restorative experiences of this same target population and its relationship on a school's play environment. Martensson et al. (2009) focused on pre-school children's restorative experience in Sweden and explored the contribution from green outdoor environments on pre-school settings. Given the increasing trend of childcare facilities in the United States (Laughlin, 2013), and the development of promoting health development of children through nature-based design (Harry Heft, 1988; Smith et al., 2016), this research addresses the impact of childcare centers outdoor play environment or the built environment on preschooler's (four to five-year-old age group) restorative experience. The findings from this research indicated that both standardized and nature-based outdoor play environment may benefit pre-school children's (four to five-year-group) restorative experience, and the nature-based outdoor play environment appear to perform better than the standardized play environment.

In addition, previous research examined the relationship between people's restorative experience with various of types of environments (Berto, Baroni, Zainaghi, & Bettella, 2010; Kaplan & Kaplan, 1989; Kaplan, 1993; Kaplan, 2001; Kuo, 2011; Mårtensson et al., 2009; van den Berg, Hartig, & Staats, 2007), including both natural

environment and built environments. In these studies, metrics or ways to measure nature emerged and were developed including natural volume, sky view and other scales, and nature's impact on children's restorative experience or perceived restorative experience were explored. However, limited research examined the interaction between people and the built environment and its impact on their restorative experience.

This research addressed this particular literature gap, and explored the impact of the built environment on children's play behaviors and interaction with natural elements, as well as its impact on the restorative experience. By addressing this, some causal pathway of the relationship between preschool children's outdoor play and their restorative experience were revealed, and strengthened the connection between Attention Restoration Theory to design application. The findings indicate that nature-based outdoor play environment may stimulate higher frequency and variety of children-nature interaction. Nature-based play settings as well as designed natural elements may have an important role on children's restorative experience.

Moreover, four components (being away, fascination, extent and compatibility) that were discussed in Chapter II, were identified as four central properties of a restorative environment (Kaplan, 1995). The natural environment with its richness contains the four properties of a restorative environment (Kaplan, 1995). The four components have been widely utilized as indicators to measure the restorative experience especially perceived restorative experience for both children and adults (Pasini, Berto, Brondino, Hall, & Ortner, 2014). Bagot (2004) developed the Perceived Attention Restoration Components for Children (PRC-C) and measured the perceived restorative

experience of children from eight to eleven years old. This research adapted the PRC-C and revised for four to five-year-old children, which aims to measure their perceived restorative experience. The results revealed that these four components are important components for the restorative environment for pre-school age groups (four to five-year-old) as well. For children at this age group, natural elements and nature-based play setting especially in nature-based outdoor play environment were identified as major sources for children's feelings of fascination.

Finally, there is a challenge for designed outdoor play environment to address children's health development and well-being. The impact of designed outdoor play environment on restorative experience were examined by previous research. Natural volume, sky views, trees, hilly terrains in school settings or play environments were identified as factors that contribute to the restorative experience (Bagot, Allen, & Toukhsati, 2015; Mårtensson et al., 2009). Beyond these findings, empirical evidence from this research indicates that the variety of natural elements like trees, vegetation, sand and natural earth or soil, water, stones, animals and well-designed nature-based play settings indicate the relationship of affordance with diverse types of play behaviors; and these can enhance children's types of play, interaction with natural elements and their restorative experience.

5.3.2 Affordance theory and restorative experience

Gibson's Theory of Affordance, as discussed in Chapter II, provides an alternative approach that describes a physical environment through functional aspect (Greeno, 1994; H Heft, 1988). Heft (1988) developed a functional taxonomy to describe

the functionally significant properties of children's environments. Kytta (2002) expanded Gibbon's Affordance Theory further by including the social affordance of play and applied in studies regarding level of affordance of children's play environment in various settings.

By adapting the taxonomy of affordance, this research measured the level of affordance through field observations and semi-structured interview with teachers in two types of outdoor play environment and explored its correlation with perceived restorative experiences of pre-school children. Findings from this research revealed that the frequency and variety level of affordances in outdoor play environment may correlate with the children's perceived restorative experience. Therefore, affordance theory could be a theoretical foundation for studies on the built environment and its functional aspects, especially health. Furthermore, this research reveals some significance regarding the link between the level of affordance and children's restorative experience, especially as a measurement for healthy built environments for children's development.

5.3.3 Biophilic design and restorative experience

Biophilic design applications are based on the biophilic hypothesis and related empirical studies on humans' positive inherent relationships with nature. The broader objective is to improve health and wellbeing through designed built environments (Kellert, 2015). Current research in biophilic design focuses on establishing new frameworks for the supportive experience of nature in the built environment and nature's contribution to people's positive emotional, physical, mental health and overall well-

being in the general population (Browning, Ryan, & Clancy, 2014; Heerwagen, 2009; Stephen R. Kellert, 2015).

Beyond these frameworks, this research focused on examining the impact of biophilic design on a specific age group and a specific aspect of health. It examined the relationship between biophilic design of children's outdoor play environment and the children's restorative experience. This relationship was examined by employing the case study research method in a real-world context where multiple sources of primary data was collected. This included: physical artifacts in the built environment of the outdoor play setting in licensed childcare centers; field observations to understand the spatial organization of the outdoor play setting, and the children's play behaviors and interactions with design elements in these outdoor settings; semi-structured interviews with teachers; and interviews with children. The content analyses of the responses from these two sets of interviews helped frame an understanding of the children's restorative experience. The empirical evidence from this study of children's outdoor play environments (nature-based and standardized) indicates the potential positive impact of biophilic design on children's interactions with natural elements and their subsequent restorative experience, the study's primary metric for children's health

5.4 Implications

Discussion of the research findings above indicate the potential of the designed nature-based outdoor play environments on the children's connection with nature and their restorative experience. Designers and educators can better address the health of preschool children in childcare centers by understanding the way outdoor play

environment impacts the children's play behaviors, children-nature interactions, and contributes to the children's restorative experience, Research implications may assist the professions of landscape architecture, public health and early childhood educators to improve the preschool children's outdoor play environment in South Carolina's childcare centers and beyond.

5.4.1 Design implications in Outdoor Play Environments

Natural elements in outdoor play environments

- 1) Safety issues need to be fully addressed when introducing natural elements into the outdoor play environments. The children's understanding of natural elements like stones, plants, insects, leaves, water, insects, and birds and ways of they interact with them, change and are different among the age groups and individuals. This information for the specific age groups needs to be fully analyzed and considered before introducing natural elements in outdoor play environments.
- 2) It is preferred to contain high variety of natural elements with many different textures, colors, shapes and functions in the outdoor play environment. This diversity and richness can stimulate the children's exploration behaviors and enable children to play creatively.
- 3) It is important that children have access to the experiential natural elements like natural fresh air, sky views, the wind, clouds, rain, and snow. Fresh air and panoramic views of the sky, the kinetic aspects of moving clouds, changing lights and weather, attract the children's attention, stimulate their

imagination and contribute to the children's diverse sensory experience.

Taken together, these experiential natural elements promote their restorative experience.

- 4) Trees and vegetation and their dynamic growth process are preferred, especially given they create products like fruits or vegetables; and these change throughout seasons and years. The plants' dynamic living processes presents the cycle of birth, death, and regeneration (Heerwagen, 2009) and contribute to the variety of sensory and play opportunities seasonally and throughout the year. In addition, it also enhances the children's understanding of plants and vegetation and their growing patterns.
- 5) Children's participation in gardening activities connects them with natural elements and provides children with the perception of protecting nature or the natural environment.
- 6) Play areas containing and composed of rich natural elements are preferred. These promote discovery and creative play behaviors. Children in these play areas can creatively find something new to play with every day.

Nature-based play settings in the outdoor play environments

- 1) Play settings and their surrounding areas appear to be the major play areas in the outdoor play environment. Nature-based play settings are recommended to be carefully designed to incorporate natural materials and afford diverse play behaviors. For example, play settings with multiple constructive pieces can afford children's constructive play behaviors; play settings with real life

scenes (playhouse, play stage) can stimulate role play and social play behaviors; play settings with jumping, climbing and walking structure can provide various physical activities.

- 2) Shaded areas should be provided to improve microclimate of the outdoor play environment and comfort for the children. Mature trees and shrubs are preferred as shading sources. In addition to affording microclimate, this mature vegetation potentially support the children's restorative experience by: 1) affording various play activities, visual stimulations, nature connections; 2) providing soft kinetic movements and dynamic physical change to the play environment with changing motions from sunlight, shade, and growing changes of the vegetation.
- 3) Nature-based play settings are recommended to relate to the childcare center's teaching curriculum. The outdoor play environments can provide supportive physical learning activities like an outdoor classroom setting, as well as learning materials to enhance the children's play, and learning and understanding of nature.
- 4) Role play and social play is a significant aspect of play behaviors for preschool children age groups. Play settings should incorporate role play elements and provide spaces for role play; spaces, scenes and materials may support high levels of the variety of children's play behaviors; and the children's interactions with natural elements and benefits the children's restorative experience.

Spatial design of nature-based outdoor play environments

The nature-based outdoor play environment at childcare facilities should contain diverse types of spaces. This variety should be spatially organized to maintain the constructive operations of the childcare centers, improve the children's variety of play activities, enhance the children's play experience and support children's restorative experience. Recommendations include:

- Functional areas which support childcare center's daily uses;
- large open areas for children's group play; this enables teachers to create a variety of group play activities;
- sitting down or cool down areas for children who want to sit down or needs individual care from teachers;
- transition areas and circulation systems that connect major play settings and play areas;
- one or multiple focal points that promote children's interaction with peers and teachers.

Additionally, to acquire higher health benefits and restorative experience, play areas with diverse characteristics regarding openness, richness, children densities, visual access, and sensory experience are preferred. For instant,

- open and high elevation areas where children can look at interesting things and observe the sky, slow movement of clouds, as well as leaves from the trees;
- partially enclosed areas where children can play in some kind of privacy;

- transparent areas where children can hide and look out from; path areas where children can run and ride bikes and tricycles.
- the spatial design should address the teacher's supervision sight line. Teachers line of sight should be unimpeded and allow visual access to the entire outdoor play environment.

5.4.2 Implications for childcare centers, caregivers, policy-makers and related professions.

This research explored the significance of outdoor play environments on children's restorative experience, a measure for health, and assists with providing evidence that can be utilized to develop design strategies for outdoor play environments that enhance children's restorative experience in childcare settings. The framework and empirical evidence from this research enable educators, caregivers, policy-makers and related professions to better understand children's play behaviors, especially experiences and interactions with natural elements in outdoor play environments. It also suggests the need to improve outdoor play environments and the childcare center's teaching curriculum for children's health. The findings also reveal the significance of the designed outdoor play environment and children's play experience on their restorative experience and well-being.

This comprehensive understanding of the relationship between outdoor play environment design, children's health and their restorative experience can assist caregivers and service providers. It raises their awareness of the built environment, nature-based design and the importance of observation, engagement and communication

with children in their facilities, especially the importance of the restorative experience. This could be achieved through the basic understanding of Kaplan's (1995) four indicators of restoration theory (being away, fascination, extent and compatibility). Children's restorative experience could be enhanced through an understanding of ways to develop an outdoor nature-based play environment that affords various activities related to the restorative experience. This research demonstrates that both two types of outdoor play environments (standardized and nature-based) benefits children's restorative experience. It specifically indicates that well designed natural elements and nature-based play settings may improve children's restoration experience and these settings may afford better performance.

5.4.3 Implications to other outdoor environments for children.

The benefits of the designed nature-based outdoor play environment in childcare settings on pre-school children's restorative experience and well-being were demonstrated in this research. The design implications discussed in previous sections have implications beyond the childcare center outdoor play settings, especially when considering other cultural dimensions, as well as social and economic contexts. It would be important to consider these dimensions as benefits for addressing children's health through play.

Additionally, Browning et al. (2014) suggested that good biophilic design should address health, culture and social backgrounds, as well as people's expectations, experience, and perceptions. It is recommended to address children's health, culture and social backgrounds as well as their expectations, experience and perceptions when

developing outdoor play environments for various age groups in different settings like school settings, community parks, public park playgrounds, and built environment for camps as well as healthcare facilities. The framework for assessment of outdoor play environment on children's restorative experience allows site managers and landscape designers to better address the above elements and develop built environment for children's health, specifically restorative experience through designed built environment.

5.5 Limitations

Some limitations emerged as a result of this research. Firstly, the comparative case study analysis involved two cases, and each case represented one type of outdoor play environment (nature-based and standardized or non-nature-based). Both selected cases were located in South Carolina, and the second case was based on a theoretical replication. The number of cases limit the application of the research findings and the ability to generalize to the larger population. Therefore, the research findings cannot fully predict the children's interaction with natural elements, and restorative experience in other childcare facilities. Secondly, longer direct field observation time in various time periods throughout a whole year will lead to a stronger understanding of the children-nature interaction and restorative experience, and interrelationship with the built environment in future studies. Thirdly, increasing sample size for the semi-structured interview of teachers and structured interview of children will gain a better understanding of children's preference for outdoor play, interaction with natural elements and the resultant restorative experience. Fourthly, the children's perceived restorative experience was measured by the perceived restorative experience survey, which was adapted from

the restorative components scale for children (PRC-C) (Bagot, 2006). This is the first known study that utilized this instrument for measuring the children's restorative experience for preschool children. The children's abilities for answering questions were limited. Hence, additional measurements, like physiological measures or other metrics geared to this age group, may be considered for future studies. Fifthly, the outdoor play environment in the two selected cases do not contains all types of natural elements or natural characteristics like terrain. For example, the outdoor play environments are level sites with no changes in topography and purposely designed hills or mounds for children's play. The impact of these types of natural elements on children-nature interactions and restorative experience were not examined. It limits the variety of natural elements that were examined in this research. Finally, since climate, culture, social and community context vary among childcare facilities, the patterns of children's preference for outdoor play, interaction with natural elements, their contribution on children's restorative experience cannot be generalized to other childcare facilities.

5.6 Recommendations for Future Research

This research explored the interrelationships among children's play behaviors, outdoor play environments and their impacts on children's restorative experience, or children's health. The research design primarily involved the case study method with imbedded units of analysis for comparison. Research implications suggest design strategies have the potential to contribute to preschool children's interactions with natural elements and their restorative experience in designed nature-based outdoor play environments at childcare facilities. Further explorations regarding the relationship between play environment and restorative experience in the environments for other age groups are recommended. For instance, broadening the study of age groups to examine the natural elements in playgrounds at elementary schools, middle schools, summer camps and healthcare facilities and their impact of the restorative experience on the targeted populations.

This research examined the contribution of outdoor play environment on children's restorative experience through four indicators (being away, fascination, extent and compatibility) and revealed natural elements and nature-based play settings may play important role on providing children restorative experience. Future research could go beyond findings of this research and explore the role of each of these four indicators on pre-school children's restorative experience. Exploration on if there are other major indicators of the restorative experience for a specific age groups in various of social and culture context also a good topic in the future research.

Teachers could connect their curriculum with the outdoor play environment, interact with children during outdoor play, arrange group play activities to promote children-nature interactions and play experiences. This research revealed the importance of the teachers' role. Their connection, interaction and activities with the children may positively impact the children's restorative experience. Therefore, it could be important to explore the teachers' contribution and role for promoting children's play experiences, connecting children with nature, and health development during children's outdoor play.

Social interactions and role playing of the children's age group in the case study research were discovered during the course of this research. These factors came to light during this study and could be further explored in various ways. For example, the diversity of the relationships among social interactions, designed play environments or the built environment could be further examined. Additionally, the combined impacts of both the children and teacher's restorative experience would be another avenue to explore.

This research explored children's health at South Carolina's licensed childcare centers through an investigation of children's restorative experience using four measures or indicators: being away, fascination, content, and compatibility. Another avenue of research may explore and develop measurements for each of these four indicators. The measurements could improve the accuracy and validity of the measure for the children's restorative experience and could further enhance the design of health-oriented outdoor play environments and contribute to children's restorative experience and their overall health development.

Content analysis also revealed that most children (four to five-year-old) understand the patterns of the dynamic growth of living matter and demonstrate the awareness of protecting plants and animals. Future research can also explore further theoretical aspects of built environment's impact of on children's connections and bonding with nature or natural environments, the various children's age groups, and benefits to children's future development and health.

Other future research could expand the number of case studies beyond the comparative analysis of one nature-based outdoor play setting and the companion standardized; and could consider various social, economic and cultural dimensions within the state of South Carolina, and potentially within the regional south, and as part of a broader study that might compare other regions within the United States. A longitudinal study of children and youth in nature-based outdoor designed environments over time with an analysis of their restorative experiences (pre-school age through secondary school age) would deepen the research, and contribute to understanding the significance of the built environment, especially nature-based designed environments in learning institutions, on the health of children and youth in all age groups.

In summary, future research could take on various avenues. Additional studies could assist with design application and policy-making for South Carolina and the licensed childcare centers, as well as other outdoor designed environments at educational facilities in South Carolina and beyond. It can further expand ART and Gibbon's affordance theory and their combined causal impacts on children's health and the built environment. Other studies could expand on this age group, four to five-year old target

population, where little built environment and environmental behavior scholarly research exists. The social, economic and cultural dimensions discussed earlier could be further studied in case studies of children's nature-based outdoor play settings, as would a deeper understanding of the relationship between teachers and children in the licensed childcare center. Future research can also examine the importance of landscape architecture in applied research and their contributions to nature-based designed outdoor environments for children's health.

APPENDICES

Appendix A

IRB Approval

From: Belinda Witko
Sent: Monday, November 11, 2019 9:40 AM
To: Mary G. Padua <mgpadua@clemson.edu>
Cc: xiaotol@clemson.edu
Subject: SUBJECT: IRB2018-414 Approval for "A Pilot Study for Healthy Designed Environments for Pre-School Children: Investigating Ways to Optimize the Restoration Experience in Naturalized Outdoor Play Environments"

Dear Dr. Padua,

The Clemson University Institutional Review Board (IRB) approved your extension request for the protocol titled "**A Pilot Study for Healthy Designed Environments for Pre-School Children: Investigating Ways to Optimize the Restoration Experience in Naturalized Outdoor Play Environments**" using expedited review procedures. **Your approval period is November 7, 2019 to November 6, 2020.**

Please find attached the approved informed consent documents to be used with this protocol.

No change in this approved research protocol can be initiated without the IRB's approval. This includes any proposed revisions or amendments to the protocol or consent form. Any unanticipated problems involving risk to subjects, complications, and/or adverse events must be reported to the Office of Research Compliance immediately.

All research involving human participants must maintain an ethically appropriate standard, which serves to protect the rights and welfare of the participants. This involves obtaining informed consent and maintaining confidentiality of data. Research related records should be retained for a minimum of three (3) years after completion of the study.

The Clemson University IRB is committed to facilitating ethical research and protecting the rights of human subjects. Please contact us if you have any questions and use the IRB number and title when referencing the study in future correspondence.

Sincerely,

Appendix B

Semi-Structured Interview Questionnaire

No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Demographic Questions:

1. What is your age?

- 18 – 30 31 – 45 45 – 60 Over 60

2. What is your gender?

- Male
 Female

3. How long have you worked as a preschool teacher?

- 1 – 5 years
 6 – 10 years
 11 – 20 years
 Over 20 years

4. How long have you worked in this childcare center?

- 0 – 1 year
 2 – 5 years
 6 – 10 years
 Over 10 years

5. When do the children (four to five-year-old) engage in outdoor play? And for how long? What's the typical schedule? What is a typical day of children in the childcare center?

Please specify _____

6. How often do you supervise the outdoor play for the four to five-year old children?

- Several times per day
 Once per day
 Several times per week
 One time per week
 Less than one time per week

7. What are factors that impact children's outdoor play?

- Weather, please specify _____
 Event, please specify _____
 Other, please specify _____

No.

A Study on Children’s Experiences in Outdoor Play Environments at South Carolina’s childcare centers

Children’s Play Experience Survey

In this part of the survey, images of different sub-areas within the four to five-year-old children’s outdoor play environment from this childcare center will be presented to you. Please score each image of the sub-area according to how often children play in that particular location; and explain the degree to which they never play with or almost always play in the play setting and why. The range is from “1” to “5”, “Never” to “Almost always”, respectively. In addition, please specify what children usually do in each play area represented in the photo.

Play area [1]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors (please use taxonomy of affordance as a reference) _____



Interaction with natural elements (please use list of natural elements as a reference) _____

Play area [2]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____



Interaction with natural elements _____

No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Children's Play Experience Survey (Continued)

Play area [3]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



Play area [4]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Children's Play Experience Survey (Continued)

Play area [5]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



Play area [6]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Children's Play Experience Survey (Continued)

Play area [7]

How frequently do children play in this area?

- 1. Never
- 2. Rarely
- 3. Occasionally
- 4. Frequently
- 5. Almost always

Please explain _____

Frequent play behaviors _____

Interaction with natural elements _____



Interview No.

Play area No.

A Study About Children's Experience in the Outdoor Play Environment

Appendix

Functional taxonomy of affordance

Affords walking, running
 Affords cycling, skating, skateboarding
 Affords coasting down
 Affords rolling, sliding, running down
 Affords rolling objects down
 Affords drawing, scratching
 Affords throwing
 Affords hammering, batting
 Affords spearing, skewing, digging, cutting
 Affords tearing, crumpling, squashing
 Affords building of structures
 Affords sitting-on
 Affords jumping-on/over/down-from
 Affords swinging-on
 Affords exercise/mastery
 Affords looking out from
 Affords passage from one place to another
 Affords locomoting from one place to another
 Affords looking and listening into adjacent place

Affords microclimate
 Affords prospect/refuge
 Affords privacy
 Affords construction of objects
 Affords pouring
 Affords modification of its surface features
 Affords splashing
 Affords pouring
 Affords floating objects
 Affords swimming, diving, boating, fishing
 Affords mixing with other materials to modify their consistency
 Affords role playing
 Affords playing rule games
 Affords playing home
 Affords playing war
 Affords being noisy
 Affords following/ sharing adult's business

Natural elements

Natural Elements Categories	Natural Elements
Vegetation	trees, shrubs, flowers, grasses
Landform	hill, mound, slope, lakes
Natural ground surface	wood chips, meadow, multipurpose laws
Natural materials, natural play structures	wood, stick, water, sand, stones, dirt piles, logs, ice shelter
Natural loose parts	leaves, seeds (pine corns)
Weather	rain, snow, sky view, light, air, moon, clouds
Animals and other living things	birds, worms, other animals
Others:	

No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Children's (Four to Five – Year – Old) Restorative Experience

1. It is important to play outside.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please explain _____

2. What is the teacher's role of children's outdoor play?

Please explain _____

3. How does the outdoor play relate to the curriculum?

Please explain _____

4. Children like to play with natural elements (example: wood bark, plants, sand).

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

5. Many things in the playground fascinate the children.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

No.

A Study on Children's Experiences in Outdoor Play Environments at South Carolina's childcare centers

Children's (Four to Five – Year – Old) Restorative Experience (Continued)

6. The children feel different in the outdoor play settings versus when they are indoors.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

7. There are many things children want to do in the outdoor play.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

8. Children can do many different things in one or more parts of the play settings.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

9. After playing outside, children appear to have had a restorative experience (are they more calm, relax, stress less, focused?).

Strongly Agree Agree Undecided Disagree Strongly Disagree

Please specify _____

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