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Students spend the majority of their day indoors (Kats, 2012). The school environment becomes an crucial location for children to experience contact with nature where it may otherwise be limited. The framework for this study included the Attention Restoration Theory, Stress Reduction Theory, and Biophilic Design. This study investigated the effects of biophilic attributes of water, plants, animals, natural materials, color, light, and air in elementary school classrooms with fourth and fifth-grade students. The quasi-experimental study included a pre-test, followed by the implementation of biophilic attributes in the two classrooms a week later, and a post-test five weeks after the implemented biophilic attributes remained in the classrooms. The expectation was that the presence of the biophilic attributes in the day to day environment of these classrooms would improve students' awareness of nature.

Findings showed that the implemented biophilic attributes did alter the awareness of nature in one of the classrooms, while the other classroom was not influenced after the post-test. This research begins to contribute to our understanding of the student awareness of biophilic attributes in elementary schools. There is a total of 1,845 public elementary schools consisting of grades PK-8, in the state of North Carolina. The research could be beneficial in understanding what attributes can be expanded in the classroom environment to benefit the students. It could also become beneficial in improving the designs of new and existing schools, as it could be a low-cost

implementation. The goal of this study was to assess the awareness of biophilic design attributes in elementary school classrooms.

IMPLEMENTING BIOPHILIC ATTRIBUTES IN ELEMENTARY SCHOOLS

by

Emily Miller

A Thesis Submitted to
the Faculty of The Graduate School at
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Approved by

_____
Committee Chair

DEDICATION

To my parents, Jeff and Cecile, my sister Sarah, and brother Peter; thank you for all your love and support throughout this process. Thank you for all the positive reminders that I can accomplish anything when I put my mind to it. To the love of my life, Tyler, thank you for never giving up on me, always encouraging, and being my rock. You all have helped me achieved my goals and made me a better person in the process, I love you all. This would not have been possible without you.

APPROVAL PAGE

This thesis written by Emily Miller has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

The interior quality of an educational setting encourages a connection to the built environment. There is a known affiliation between the quality of the interior built environment and student education (Uline, Tschannen-Moran, and Wolsey, 2009). The design of an educational setting nurtures the cognitive, social, and emotional development of students, creating a significant importance in a child's development (Uline et al., 2009; Maller, 2009). Direct experience with nature during middle-childhood, eight to twelve years of age, has the most powerful effect on children's psychosocial growth and development (Maller, 2009). Direct experience with nature also known as hands-on contact with nature has been shown to positively impact children's mental, emotional, and social health (Maller, 2009). Furthermore, any type of exposure to nature can improve children's cognitive abilities, resistance to negative stresses and depression, and symptoms of Attention Deficit Hyperactivity Disorder (ADHD) (Taylor & Kuo, 2009).

Children's access to nature is generally limited by the modern urban environment (Maller, 2009). On average 85% to 90% of students' days are spent in inside schools (Kats, 2012). An educational environment is considered an environment that allows people to gather to expand upon knowledge (Stavrianos, 2016). Due to the long amount of time spent in classrooms an educational setting becomes an ideal location for children

to be exposed to nature and its natural systems, thereby gaining the benefits of contact with nature or natural elements (Maller, 2009). Children have a natural bond with, and a need to explore nature, this also known as biophilia. Biophilia can occur in any human as it is a natural feeling of the connection to nature. Opportunities to learn about the natural world must be provided for biophilia to develop in a child. When children are unable to experience nature, biophobia may occur. *Biophobia* is defined as the fear or dislike of nature, resulting in the possible perception of a child seeing nature as a disposable resource (White & Stoecklin, 2008). To promote healthy developmental stages, providing opportunity for play and investigation through continuous contact with nature is essential (White & Stoecklin, 2008).

Nature deficit disorder is the term for children experiencing withdrawal of contact with nature and unrestricted play in interior environments (Driessnack, 2009). Due to the design and construction of the built environment, nature deficiency can be more commonly seen in children (McGee & Marshall-Baker, 2015). Many schools still contain classrooms with little to no windows, which can limit the amount of nature the student is exposed to. Nature deficiency and biophobia are linked. Biophilic design may help solve the effect of nature deficiency in children. Biophilic design is a process in which natural elements are incorporated into the interior spaces of the built environment (Gillis & Gatersleben, 2015). Kellert (2005) developed a framework for biophilic elements, which includes: environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships. When individuals are exposed to natural views such as landscapes, their

wellbeing has been shown to improve through increased positive feelings and a drop-in blood pressure and muscle stiffness (Minton, & Batten, 2016). Furthermore, green spaces, defined as areas with landscaping such as trees, plants, and grass have been shown to reduce stress and maintain or recover direct attention (Carrus, Pirchio, Passiatore, Mastandrea, Scopelliti, & Bartoli, 2012). Therefore, to add exterior elements like green spaces to the interior could provide some of the same benefits. Biophilic design requires an awareness of nature and the biophilic elements in the built environment. Awareness of nature is significant for children between the 8 to 12 age range because it directly affects their environmental development towards nature and natural systems. By exposing individuals to aspects of nature, their awareness increases to help them understand why they may feel calmer or less stress when in direct contact with certain elements of nature such as plants or animals.

Therefore, this study sought to determine the effects of biophilic attributes in elementary school classrooms with fourth and fifth-grade students. The expectation was that the presence of the biophilic attributes in the day to day environment of these classrooms would improve students' awareness of nature. There is a total of 1,845 public elementary schools consisting of grades PK-8, in the state of North Carolina (Department of Public Instruction, 2016). By having a better understanding of how biophilic attributes contribute to student awareness of nature the research could be beneficial to those schools and students.

CHAPTER II

REVIEW OF LITERATURE

This chapter is divided into three sections, the theoretical framework, educational settings, and student age. The first section discusses the theoretical framework, Attention Restoration Theory, Stress Reduction Theory, and Biophilia, within the study. Biophilia, is "the idea that humans possess a biological inclination to affiliate with natural systems and processes" (Kellert, Heerwagen, & Mador, 2008, p.3). Biophilia was first introduced by E. O. Wilson in 1984 and has been researched by several disciplines within education and healthcare settings. There are two main theories, Attention Restoration Theory and Stress Reduction Theory that relate to biophilia in the proposed research.

Theoretical Framework

Attention Restoration Theory

Attention restoration theory (ART) is grounded in cognitive psychology. The theory was developed in 1989 by Kaplan and Kaplan. ART suggests that exposure to nature restores attention (Kaplan and Kaplan, 1989). In the 1970s, Kaplan and Kaplan followed participants in a wilderness program in which people were in the woods for up to two weeks at a time. The participants reported to the researchers during and after their time in the wilderness. Participants reported thinking more clearly and feeling peaceful. The participants felt more at peace when in nature as opposed to participating in a physical activity in the woods such as rock climbing (Kaplan & Talbot, 1983).

ART can be applied to environments with children, where there is trouble focusing attention on tasks. According to the Center for Disease Control and Prevention, one in five children each year are living with some type of mental disorder (Children's Mental Health Report, 2018). Some of the most common mental disorders among children ages 3 to 17 include Attention Deficit Hyperactive Disorder (ADHD), behavioral or conduct problems, anxiety, and depression (Children's Mental Health Report, 2018). According to Taylor & Kuo, (2009) symptoms of attention deficit in children with ADHD may decrease after exposure to nature.

Studies have been conducted providing evidence that natural elements are important factors on a human's health and wellbeing (Irvine & Warber, 2002; Taylor et al., 2009). Irvine and Warber (2002) tested the importance of reincorporating natural elements into the design of interiors, in this study specifically healthcare facilities. Literature was collected using theoretical and empirical articles between the dates of 1960-2001. The context used to select literature was well-being in regard to physical, psychological-emotional, social, and spiritual. The articles were then quantitatively reviewed concentrating on theories, hypotheses, and experimental evidence. Findings showed the relationship of the interior elements to the setting of the environment is crucial (Irvine & Warber, 2002). Through ART, psychological effects on stress can be reduced and deficits in attention can be restored or minimized, social health is promoted, and aggressive behavior is lessened (Irvine & Warber, 2002).

Taylor & Kuo, (2009) investigated the importance of exposure to nature in children using ART. The study included twenty-five children ranging from 7 to 12 years

old that were professionally diagnosed with ADHD. During the study, a series of puzzles that presented attentional fatigue were given to the children. After the completion of the puzzles, each participant walked through three different outdoor environments (an urban park, a downtown area, and a residential area) – each with similar landscapes, ambient noises, and minimal pedestrian traffic levels. After each walk, the participants rated their experience. Findings showed the children were able to concentrate on tasks better after a walk in the park and rated it as a more positive experience than the downtown and residential areas (Taylor et al., 2009). This research suggests that schools should implement green spaces and natural elements for children to walk in throughout the day to provide attention restoration.

Two studies were conducted at a senior in Australia by Rosenbaum, Sweeney, & Massiah (2014) to understand how senior center activities affect a patron's health. The first study was conducted to look at the perceived restorative qualities of the center and consisted of the center manager and 11 patrons who frequent the center, all of which participated in an hour-long recorded interview. The first study concluded that many patrons felt restored when participating in the senior center activities, as it became a distraction from their lives outside of the center. The second study built off the first and focused more of ART and the fatigue relief. In this study, 85 patrons were surveyed on restoration, fatigue, quality of life, and behavior. The surveys were divided into patrons who found the center restorative, n=37 and non-restorative, n=48. Findings showed that patrons who found the center restorative reported lower levels of mental exhaustion, bodily fatigue, energy fatigue, and productivity fatigue (Rosenbaum et al.,2014). There

was also a higher quality of life and emotional well-being reported during a patron's time at the center when perceived as restorative. The restorative group also felt encouraged to interact with others at the center (Rosenbaum et al., 2014). This research suggests the importance of perceptions of restorative environments and may be applied to this study.

The four distinct characteristics of ART, these include being away, fascination, extent, and compatibility (Carrus et al., 2012; Kaplan, 1995). Being away involved placing yourself in a natural setting for a prolonged break (Kaplan, 1995). The location does not have to be distant and can include mountains, lakes, stream, forests, oceans, and/or meadows. Kaplan (1995), explains fascination as providing processes for people to be captivated with nature, the elements of nature allow someone to think about other things as well as the natural patterns that are pleasing to the eye. The natural elements must hold an individual's attention such as snow fall, formation of clouds, sunsets, or leaves on tree falling (Kaplan 1995). Extent includes the distance to the natural environment, it may be either a small area or large region. It may also function at a conceptual level of connecting oneself to past eras and past environments which would lead to a larger scope (Kaplan, 1995). Examples for extent may include roof top gardens, ponds, streams, and walking paths. Last of all, compatibility is comprised of natural settings and human preferences, people function more easily in the natural environment than they do in a designed setting (Kaplan, 1995).

The Attention Restoration Theory (ART) involves two types of attention, voluntary and involuntary. Voluntary attention (also known as direct attention) is understood as the brain's ability to concentrate (Irvine & Warber, 2002). Involuntary

attention can be understood as effortless, it is the ability to concentrate on things that are not routinely engaging (Irvine & Warber, 2002).

Through contact with nature, attention is redirected providing mental stimulation towards the tasks in schools. ART becomes an important theory in schools as students have trouble focusing on tasks in the classroom, which can be seen from the high levels of distractions in the classroom environment. By implementing natural elements into the classroom, the natural elements would assist in restoring their attention aiding in their ability to concrete on tasks in the classroom.

Stress Reduction Theory

Stress reduction theory (SRT) was developed in 1983 by Altman and Wohlwill. SRT is used to explain emotional and physiological reactions to the natural environment. By exposing a person to the natural environment, a positive response is activated, with exposure to nature the person can experience a decrease in stress (Kaplan, Talbot, Altman, & Wohlwill, 1983). This theory created a theoretical basis for biophilia through the person-nature relationship (Carrus et. al, 2012). The Stress Reduction Theory differs from Attention Restoration Theory, as SRT primarily focuses on the reduction of stress with exposure to nature and ART focusing on the restoration of attention with exposure to nature.

Studies have been conducted to test the effects of natural environments in healthcare settings (Daykin, Byrne, Soteriou, & O'Connor, 2008; Ulrich, Simons, Losito, Fiorito, Miles, & Zelson, 1991). Daykin, Byrne, Soteriou, & O'Connor (2008) reviewed 600 papers focused on environment, design and art in healthcare settings over a 20-year

timeframe. The study concluded that the type of environment, design, and art work in the healthcare environment can positively or negatively affect patients. By exposing patients to natural settings, they recovered from stress faster and reduced the length of stay. Patients also preferred natural light and views, overall linking the reduction of stress and recovery to natural environments.

Ulrich et al. (1991), evaluated the benefit of nature by visually exposing subjects to scenes found in nature and the urban environment. The study involved 18 Swedish subjects from the Lund Institute of Technology, each subject was exposed to 60 colored slides representing aspects of nature with water, large amounts of vegetation, or urban environments without water or vegetation. The subject rated their feelings before and after the slides were shown. Electrocardiogram (EKG), pulse transit time (PTT), spontaneous skin conductance responding (SCR), and frontalis muscle tension (EMG) were all measured during the first two and a half minutes for base reading and monitored throughout the slides. The study concluded that scenes with water were more beneficial to the participant's stress levels providing a more calming effect than scenes of urban environments (Ulrich et al. 1991).

SRT has been an associated theory for biophilia and can be directly applied to a school setting as students have a need to reduce stress in the classroom. By implementing biophilic design in classrooms, the Stress Reduction Theory can assist school students in reducing stress levels and create positive experiences with natural environments.

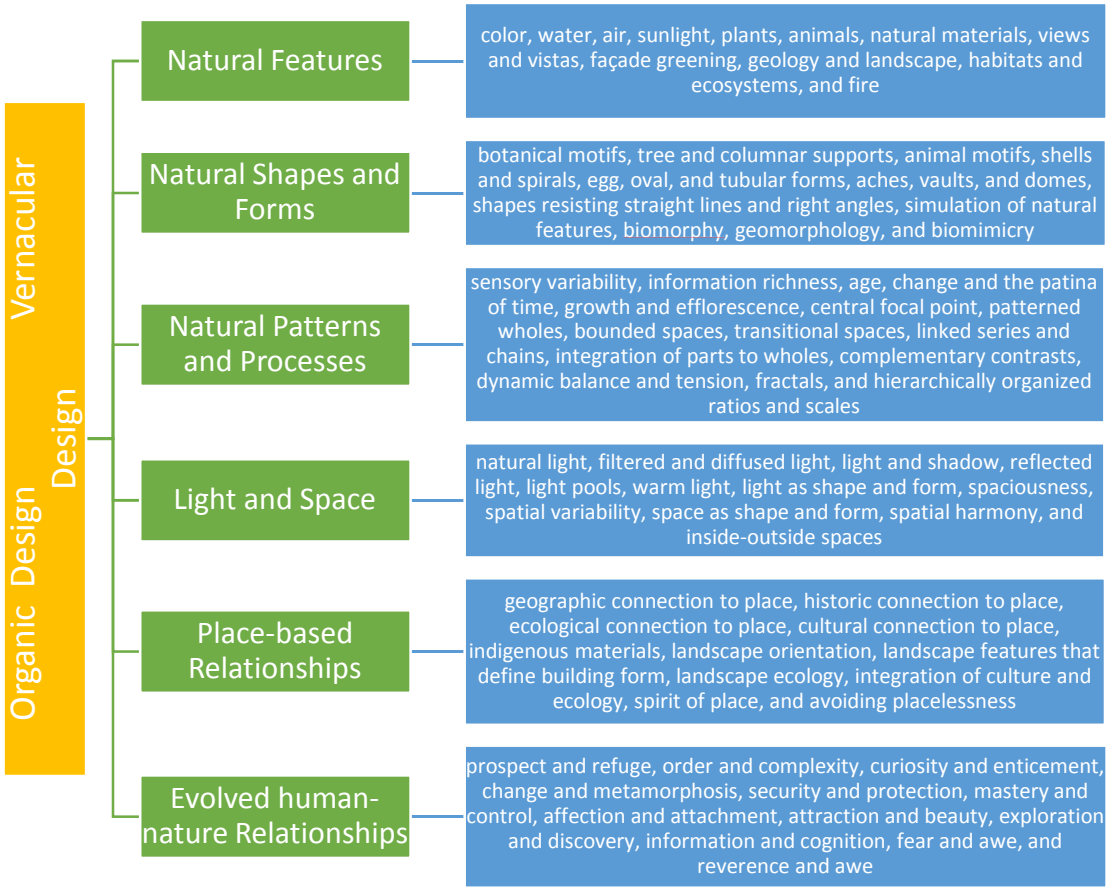
Biophilia

Biophilia, introduced by E. O. Wilson in 1984, is the emotional connection humans have to other living organisms (Kellert, et al., 2008). Biophilia hypothesis, written by Kellert (2008) hypothesized that humans need exposure to nature for their wellbeing (Kellert et al., 2008). The basis for the biophilia hypothesis has been taken from the Attention Restoration Theory (ART) and the Stress Reduction Theory (SRT). Both theories suggest environments can be stressful and people may be able to recover from stress and fatigue through exposure to nature (Gillis & Gatersleben, 2015).

Biophilic Design

Biophilic design is based off of the biophilia hypothesis (Gillis, & Gatersleben, 2015) and describes the design application of biophilia into the built environment Kellert (2005) Research on biophilic design suggests that the built environment can become more restorative through implementing natural elements. Biophilic design has been acknowledged in the last decade with the publication of the "14 Patterns of Biophilic Design" by Terrapin. Biophilic design is also being incorporated into several building rating systems, including the Version 4 of the LEED rating system, Version 1 of the WELL Building Standards, and Version 3 of the Living Building Challenge. However, the original and most comprehensive categorization of biophilic design is described by Kellert and is separated into two dimensions, six elements, and 72 attributes, see Figure 1.

Figure 1. Biophilic Design Dimensions, Elements, and Attributes



Kellert (2005) categorized the biophilic dimensions within biophilic design as *organic* and *place-based*. *Organic* is defined as building spaces and forms that directly, indirectly, or representatively provoke an attraction for the natural environment (Kellert, 2005). *Place-based* is described as the design of the built environment to conform to a particular physical or cultural place which is inhabited (Kellert, 2005). In 2008, Kellert and colleagues refined the biophilic design into six biophilic design elements and roughly 72 attributes of biophilic design (Kellert, et al., 2008). The six biophilic design elements are broadly categorized as environmental features, natural shapes and forms, natural

patterns and processes, light and space, place-based relationships, and evolved human nature relationships (Kellert, et al., 2008). Each element is categorized as either organic or place-based. Kellert, et al., (2008) explains *environmental features* consists of twelve biophilic attributes including the use of animals, color, water, air, views and vistas, façade greening, geology and landscape, sunlight, plants, natural materials, habitats and ecosystems, and lastly, fire. *Natural shapes and forms* consist of 11 biophilic attributes including the use of images of botanical motifs, tree and columnar supports, animal motifs, shells and spirals, egg, oval, and tubular forms, aches, vaults, and domes, shapes resisting straight lines and right angles, simulation of natural features, biomorphy, geomorphology, and biomimicry (Kellert, et al., 2008). *Natural patterns and processes* consist of 15 biophilic attributes including the use of sensory variability, information richness, age, change and the patina of time, growth and efflorescence, central focal point, patterned wholes, bounded spaces, transitional spaces, linked series and chains, integration of parts to wholes, complementary contrasts, dynamic balance and tension, fractals, and lastly, hierarchically organized ratios and scales (Kellert, et al., 2008). *Light and space* consists of 12 biophilic attributes including the use of natural light, filtered and diffused light, light and shadow, reflected light, light pools, warm light, light as shape and form, spaciousness, spatial harmony, spatial variability, space as shape and form, and inside-outside spaces (Kellert, et al., 2008). *Place-based relationships* consists of 11 biophilic attributes including the use of geographic connection to place, historic connection to place, ecological connection to place, cultural connection to place, indigenous materials, landscape orientation, landscape features that define building form,

landscape ecology, integration of culture and ecology, spirit of place, and avoiding place lessness (Kellert, et al., 2008). The last biophilic element Kellert, et al., (2008) explains is *Evolved Human-Nature Relationships* consisting of 12 biophilic attributes including the use of prospect and refuge, order and complexity, curiosity and enticement, change and metamorphosis, security and protection, mastery and control, affection and attachment, attraction and beauty, exploration and discovery, information and cognition, fear and awe, and lastly, reverence and spirituality (Kellert, et al., 2008).

Human exposure to biophilic design attributes can occur through three experiences of nature: direct, indirect, or vicarious. Direct experience is defined as being physically present in the natural setting that has not been designed where contact with plants and animals occur (Maller, 2009; Kellert, 2005). Indirect contact with nature would be considered physical contact with representations of plants and animals or an artificial form of nature (Maller, 2009; Kellert, 2005). Vicarious experience, also known as symbolic, is living organisms and environments portrayed through images, representations, or metaphorical expressions of nature (Maller, 2009; Kellert, 2005).

Several studies have been conducted on biophilic design in healthcare settings (Huelat, 2008; Ulrich et al., 1991; Gillis & Gatersleben, 2015; Whitehouse, Varni, Seid, Cooper-Marcus, Ensberg, Jacobs, & Mehlenbeck (2001); McGee & Marshall-Baker, 2015). Gillis, & Gatersleben, (2015), looked at peer-reviewed literature on people's perceptions and attitudes, behaviors, experiences, and feelings towards the natural and built environment in context with biophilia. Specifically focusing on three biophilic experiences including direct experience of nature, indirect experience of nature, and

experience of space and place that contribute to positive well-being and overall health of an individual (Gillis, & Gatersleben, 2015). In the category of direct experience with nature, the attribute of plants was most documented both in the built environment and found in nature. The attribute of natural light has been discussed extensively regarding the positive effects it provides to occupants in an interior environment, but there is little documentation on the restorative aspects of natural light. The attribute of water is restorative in both sight and noise, in addition to the clarity and quality also playing an important factor in being considered restorative. Research regarding plants includes positive morale and increased productivity. Natural materials have a need for more research in reference to biophilic design needing to be expanded past the material of wood. Overall, the literature reviews found that there are overlapping attributes between biophilic design and restorative design, therefore, it becomes difficult to distinguish clearly between the two types of design (Gillis, & Gatersleben, 2015). Finally, the literature revealed that the category of biophilic design may fall under restorative design and the Attention Restoration Theory can be used as a framework for a restorative experience. Biophilic design can be advantageous to the occupants of an interior environment through the implementation of attributes found in nature on human health and wellbeing (Gillis, & Gatersleben, 2015). Some of the benefits of biophilia and contact with nature include improved attention and memory (Kellert, 2008). Exposure to nature and natural elements may enhance a person's everyday life through health, leisurely activity, emotional and spiritual benefits (Baldwin, Powell, & Kellert, 2011).

The implementation of biophilic design in the built environment creates what is known as a restorative environment for the occupants of the space. A restorative environment is known as environments that produce positivity, draws attention without added stress or demand, and can aid in the recovery of mental fatigue and stress more quickly and fully (Gillis & Gatersleben, 2015). These environments are opposite of what many people are used to in urban environments, which are usually stressful, demanding, and over stimulate individuals.

A study conducted by Whitehouse, Varni, Seid, Cooper-Marcus, Ensberg, Jacobs, & Mehlenbeck (2001) looked at how a garden influenced children, parents, and staff in a hospital. The study took place over a two-week period with over 200 participants. Behavior mapping and tracking, as well as surveys and interviews were conducted and used to understand how people reacted to the garden. Many people visited the garden to relax and rest and reported feeling more relaxed and less stress or content. The adults who visited the garden reported the fountain with the sound of running water to be their most enjoyed feature (Whitehouse et al., 2001). While the children reported both the fountain with the sound of running water and artwork consisting of a windmill, shadow wall, constellation wall, dinosaurs, and animal tiles to both be their favorite feature tied at 83%. Another aspect to the study was to understand how the consumer satisfaction with the healing garden influenced the participants. Of the 52 people interviewed, 50% of them said the garden increased their satisfaction with the hospital, 72% would recommend others to visit the garden, 20% would recommend the hospital to others based on the healing garden, and lastly, 74% or participants thought hospitals should

have healing gardens (Whitehouse et al., 2001). Consumers also reported an overall better quality of service provided by the hospital staff due to positive mood changes from the garden (Whitehouse et al., 2001).

The Biophilic Design Matrix (BDM) to aid in assessing the amount of biophilic attributes in the existing classrooms. McGee and Marshall-Baker (2015) developed the Biophilic Design Matrix to assist designers or other specialists in identifying and quantifying biophilic features through a visual inventory of interior spaces. The framework for this instrument is based off Kellert's list of 72 biophilic attributes to apply to solely interior environments. The BDM includes a scoring of whether the attributes are present in the interior environment or not and allows for both photographic documents and a frequency count for each biophilic attribute. Due to biophilic attributes being commonly present in hospital settings, the BDM was tested in 24 child life play spaces in the South Atlantic region of the U.S. The researchers took images of each room and tallied frequencies to score the biophilic quality of each space. It was concluded there was an inter-rater reliability of 89% and 94% to assess biophilic attributes in the built environment (McGee & Marshall-Baker, 2015).

Although there is documentation on nature and restorative environments along with their benefits towards an individual, there is a need for research in Biophilic Design and the effects of specific biophilic attributes on the interior environment. Biophilia has been applied extensively to patients in healthcare settings, but there is limited research in other built environments such as schools. This study aims to provide a starting point for more research to be conducted in educational settings.

Biophilic Design in Rating and Certification Systems

As the well-being of occupants in the built environment continue to be assessed, biophilic design is being included in rating and certification systems in the design industry. The criteria provide guidelines for those involved in the design, operations, and maintenance of interior spaces to integrate aspects of biophilia to help toward the certification process. Two such certification programs include: The Living Building Challenge and the WELL Building Standard.

Living Building Challenge

The Living Building Challenge is a holistic set of performance standards that certifies with new construction, renovations, and exterior spaces such as landscaping and infrastructure projects (International Living Future Institute, 2018). The Living Building Challenge has three types of certifications, net zero, petal, and living. Each program consists of seven Petals, which act as performance categories: Place, Water, Energy, Health & Happiness, Materials, Equity and Beauty. There is a total of twenty imperatives distributed among the seven petals. Imperatives are specific strategies or goals that help provide understanding for a topic or guideline. If the imperative is not met, the petal cannot be achieved toward certification.

There are three requirements or imperatives within the Health and Happiness Petal, one of which includes biophilic design. Requirement nine, "Biophilic Environment" is weighted the same as all the other requirements. Under this requirement, project teams must explore the project's biophilic design potential, develop biophilic

basis, plan and apply biophilic attributes to the project (International Living Future Institute, 2018).

The Living Building Challenge also includes a biophilia design initiative that is used as a resource for designers and architects (2018 International Living Future Institute, 2018). The initiative provides a resource for ideas, events, and networking opportunities, as well as access to network archives and file resources related to biophilic design. Designers may also develop their own draft of biophilic implementation strategies and documents to the Living Building Challenge (International Living Future Institute, 2018).

This rating system can be used to certify educational environments. The Perkins Seed Classroom in Seattle, WA and the Discovery Elementary School in Arlington, VA are private schools that achieved certified living status. The certification fee can be anywhere from $5000 to $15000, which can limit public schools with restricted funding (International Living Future Institute, 2018).

WELL Building Standard

The WELL Building Standard is a building certification program that focuses exclusively on health and well-being of individuals in the built environment (International WELL Building Institute, 2018). The WELL Building Standard can be used for new construction and renovation projects and is currently piloting the second version. Version 2 contains 11 concepts including air, water, nourishment, light, movement, thermal comfort, sound, materials, mind, community, and innovations. The concept of biophilia was previously recognized by the WELL Building Standard (2018) by its inclusion as three features within the certification system. Within version 2

biophilia is integrated within three features under the Mind concept, Access to Nature, Restorative Spaces, and Enhanced Access to Nature. Access to nature specifically asks for a descriptive narrative on how the project will integrate and encourage access to nature within the built environment (International WELL Building Institute, 2018). Direct connection to nature must be achieved through at least two of the following: plants, water, light, or nature scenes. Indirect connection to nature is to occur using color, patterns, natural materials, or images. Lastly, the space layout in juxtaposition to placement of the natural elements shall enhance occupant exposure (International WELL Building Institute, 2018).

Restorative Spaces has two parts one focuses on the interior spaces and the second focuses on exterior spaces (International WELL Building Institute, 2018). The International WELL Building Institute (2018) explains that each part requires the space be available to all occupants. These spaces must meet be designed for relaxation and not for the purpose of work; adhere to accessible design, have dimmable lighting options, incorporate sounds from nature, thermal comfort, lightweight furniture, that may be added or removed for comfort, visual privacy, and incorporation of nature through patterns and color; and educational resources informing the occupant why the space was created and how it may be used (International WELL Building Institute, 2018).

Enhanced Access to Nature has one part and must include at least two of the following spaces: 1. outdoor access to nature with at least 25% of the exterior site to include some type of landscaping or gardens accessible to regular building occupants, at least 70% must be plants or natural elements, and a narrative must be

included discussing the access to nature (International WELL Building Institute, 2018). 2. Indoor access to nature through indoor plants in direct line of sight to at least 75% of occupied spaces, if water features are included water safety must be addressed, and a descriptive narrative of how the occupants may enjoy the use of nature incorporated into the space. 3. Views to nature are to be accomplished by at least 75% of occupied spaces in direct line of sight to exterior views of nature and a description of how the built environment encourages the occupants to have constant access to nature. Lastly, 4. Nearby access to nature can be achieved through at least one green space within 1,00 ft walking distance from the built environment, this green space must be at least 1.25 acres. In addition, a narrative must be included encouraging the proximity of the green space to the built environment. (International WELL Building Institute, 2018).

An Environmental Charter School- Middle School in Pittsburgh, Pennsylvania and Sandy Springs Friends School – Upper School in Maryland, USA are schools that have achieved the WELL Building Standard status (International WELL Building Institute, 2018). The importance of biophilic design is continuing to grow through standards and guidelines. More resources and networking are becoming readily available for designers and architects to understand the theory of biophilia and implement it in new construction and renovations.

Educational Settings

Educational settings will be the primary focus of this study to understand the implications on children in the learning environment. As children spend a majority of

their day in a classroom, special attention is needed in the design of educational environments to allow for children to reap the benefits of contact with nature (Maller, 2009; Kellert, 2005). Several studies have been conducted on biophilic design in healthcare settings (Huelat, 2008; Ulrich et al., 1991; Gillis & Gatersleben, 2015; McGee & Marshall-Baker, 2015). Hands-on contact with nature is essential to a child's development to aid children's emotional, mental, and social health. Perceptions of educators on how nature effects the students become instrumental in the promotion of nature incorporated into the educational environment (Maller, 2009). Two important factors that create an effective educational setting for children are stress reduction and maintaining or recovering direct attention (Carrus, et al., 2012). If the children are less stressed in the classroom, they will be able to focus more attention on class assignments. Recovering their attention, the task can be understood without added stress on the student. These factors are connected to psychological variables that relate to the child's well-being and cognitive development (Carrus, et al., 2012). By acknowledging awareness of nature, children may start to be able to recognize the positive implications nature has on them and have a desire to spend more of their time in nature.

Along with the benefits of having an overall better wellbeing, the amount of landscaping such as plants or trees that students are exposed to can affect their academic performances (Wu, McNeely, Cedeno-Laurent, Pan, Adamkiewicz, & Dominci, 2014). A study investigating test scores from 905 Massachusetts public elementary schools with various levels of green surroundings between 2006 to 2012 found that the higher

exposure students have to ‘greenness’, the better the academic performance in both subjects of Math and English (Wu et. al, 2014).

Tanner (2009) assessed elements of interior and exterior educational settings to identify and test design strategies that could influence student learning outcomes in fifth-grade students in 19 Georgia school districts. This study evaluated patterns of movement and circulation, which included outside walkways, paths, public areas, reference, and outdoor spaces; patterns of daylighting including natural light in classrooms and source of light; and patterns of views including views overlooking life, unrestricted views, living views, functional views, and green areas (Tanner, 2009). Tanner (2009) found that the evaluated patterns of movement and circulation had positive implications such as better test scores and suggested for schools focus on modifying existing buildings or designing new schools around these elements (Tanner, 2009).

A study by Carrus, Pirchio, Passiatore, Mastandrea, Scopelliti, & Bartoli, (2012), researched the importance of outdoor green spaces and the impact of experience in relation to these green spaces on children ages 18-36 months. Preliminary interviews with the child-care personnel identified two key moments in children’s daily routines: structured activities with educators and free play. The study consisted of 16 children in a recently opened childcare center in Rome, Italy. During free play in the daycare and exterior green spaces, the children were observed regarding visual-spatial tasks and social behavioral. The study found, external green spaces for children during school correlated with better performances in activities requiring direct attention as well as producing positive social relations and stress reduction (Carrus et al., 2012). When students were in

green spaces, they had socialized with one another more in group play and there was also a higher level of self-organized play. The results also showed less of a need for teacher interventions such as help requests from teachers for tasks. The authors address that student performance can be enhanced after exposure to green space (Carrus et al., 2012).

Two high-poverty middle schools in one mid-Atlantic state were used for this study, looking at the effects of building conditions on students (Uline, Tschannen-Moran, and Wolsey, 2009). One school was located in an urban setting with students of grades six to eighth and one in a rural setting with grades four to eighth, each with similar built environment quality and student performance levels. Observations, focus groups, and interviews were conducted with a group of 20 students, parents, teachers, and administrators at each school. The interviews and focus groups were concentrated on the interior of the school, specifically examining conditions and features that affected learning. Results revealed both schools created a sense of place, educational environment, and interior attributes for the students. Connections among students along with the built environment were developed through the climate. The building conditions and design of a school fosters a sense of place, control, competence, and commitment to the place and its purpose for its students (Uline, Tschannen-Moran, and Wolsey, 2009).

Hathaway, Hargreaves, Thompson, & Novitsky (1992) studied fourth-grade elementary school students' academic performance and attendance in different lighting conditions over two years. Five different school locations were used for this study, all fourth-grade students with 71 students at Site 1; 37 students at Site 2; 48 students at Site 3; 59 students at Site 4; and 113 students at Site 5. In addition to the five sites, there were

four different types of lighting used including high-pressure sodium vapor (HPSV) lamps, full spectrum fluorescent lamps, a full spectrum fluorescent with UV supplements, and cool-white fluorescent lamps. Site 1 was lit HPSV lamps with access to natural light, classrooms at site 2 were lit with the full spectrum lamps. Both sites 3 and 5 were lit with the same type of lighting, the full spectrum lights with UV supplements. Lastly, site 4 was lit with the white fluorescent lamps. Results showed that students at sites 2, 3, and 5 had a greater attendance rate, and higher academic achievement compared to site 1. Overall the study concluded that daily exposure to certain types of electric lighting can cause poor attendance rates and performance. Specifically, the indirect high-pressure sodium vapor lamps negatively affected the students at site 1 (Hathaway et al., 1992). They found that full spectrum lighting positively affected students' academic performance. Specifically, those students learned faster, had higher test scores, and 1/3 fewer absences due to illness resulting in about 3.5 fewer absent days per year (Hathaway, et al., 1992).

While lighting has been shown to affect students' performance and attendance, sound may also affect a student's performance and lack of attention in the classroom. An elementary school in Indonesia looked at 24 rooms through one elementary school to determine the noise levels of the school and the potential negative outcomes noise may have on student performance (Burchari, & Matondang, 2017). The study measured noise levels in the existing conditions as well as around the school and administered questionnaires to the students in the school regarding noise effecting their learning abilities. According to Burchari, & Matondang (2017), noise levels in elementary schools

can bring negative physiological side effects to students such as dizziness and emotional or uncomfortable feelings as well as learning experiences and student performance.

Schools are becoming increasingly more important in a child's development, therefore an access to nature is essential to the children (Maller, 2009). The research involving natural views and how they benefit the student needs to be built upon in the classroom. There is a need to study how nature can directly influence and effect the students in the built environment.

Student Age

Stages for a child's development occur in three stages: early childhood (ages ¾ to 7), early/middle grade school (ages 8 to 12), and adolescence (ages 13 to 17) (Maller, 2009). During the early childhood development, the focus on the development of compassion between a child and natural world occurs (White & Stoecklin, 2008). The most productive way to foster the relationship of child to animal is through live animal contact, animal-based stories, and songs. Developing empathy to the natural world is essential to latter stages of environmental education. The essential developmental phase for the early/middle grade school range is exploration, meaning a bond to the earth. Here children seek adventures in neighborhoods and communities to explore and experience the wild and semi-wild natural world. Activities that are focused towards exploration include: hunting and gathering, creating imaginary worlds, treasure hunts, exploring natural landscapes, following pathways and streams, and caring for animals and gardens (White & Stoecklin, 2008). Lastly, social action begins at age 12, at this stage a child will start to discover their self and specifically focusing on maturing into an adolescent role

and feeling connected to society. An inclination to save the world can be seen, if children adequately developed empathy and exploration in earlier developmental phases. Lastly, there is an attentiveness towards the sense of environmental preservation at a local level (White & Stoecklin, 2008). The importance of exposure to nature on a child during these developmental phases help shape the attitude the child has towards nature.

Another study created a research model for schools to determine if the potential of hands-on contact with nature would improve the emotional wellbeing and social relationships of primary-aged school children. Maller (2009), conducted interviews with 30 principals, teachers and professionals in the environmental education industry from 27 institutions over a year to determine educators' perceptions of the benefits of connections with nature on children's mental, emotional, and social health. The key findings from the study as through the perceptions of educators were that contact with nature improves a child's confidence and interest with school. Individuals in the study had different perceptions of what types of contact with nature in schools would be most benefit to the students and educators spending time with the children on a regular basis, were intrigued to learn how to enhance the children's personal development through contact with nature. Connectedness to other people, particularly for the middle and upper primary school children ages 8 to 12, was a major outcome of this model. The educators believed an added benefit on hands-on contact with nature in education was that by connecting children to school, they may continue to partake in learning and their school community. The most important developmental age for children is the middle-childhood age of 8 to 12 and can directly affects mental growth and development (Maller, 2009). Contact with

nature promotes attentive abilities in children and effects their motor coordination (Maller, 2009).

At the early/middle grade school level, children explore and learn their place in the world through environmental education. This would include discovering and experiencing wild and semi-wild nature found in neighborhoods and communities (Baldwin, Powell, & Kellert, 2011). At this age, plants that inhabit wildlife are more of an interest to the children (Baldwin, Powell, & Kellert, 2011). To enhance a child's social, mental, and emotional help, they need physical contact with nature (Maller, 2009).

There is an increase in research on the benefits of nature on children, specifically at the middle-childhood age. The research on age should be expanded to understand the precise attributes of nature that positively influences the children as green space could be a large variety of objects in nature. There are also gaps in research of how long biophilic attributes should be implemented in a setting to understand the lasting impacts on children. In addition, there is not a known quantity of biophilic attributes that should be implemented in the built environment to study the lasting effect on children when exposed to biophilic attributes. This study attempts further understand the implications of biophilic design on elementary school children in a classroom creating restorative effects on students and increasing their awareness of nature.

CHAPTER III

METHODOLGY

The goal of this study was to determine if exposure to biophilic attributes affected students' awareness of nature in elementary school classrooms. Awareness of nature was measured through the pre-test and post-test narratives, in the form of an open-ended writing assignment. The intervention, or independent variables, were biophilic attributes light, water, plants, animals, air, natural colors, and naturalistic shapes and forms. The dependent variable is children's awareness of nature. The instrument, sample, data collection, and data analysis will be described in this chapter. The quasi-experimental study included a pre-test, followed by the implementation of biophilic attributes in the two classrooms a week later, and a post-test five weeks after the implemented biophilic attributes remained in the classrooms. Data collection occurred two times, during pre-test and post-test.

Research Questions

The research will use a quasi-experimental design, to determine how biophilic design affects children's awareness of nature in an elementary school setting.

1) How does biophilic design influence children's awareness of air in an educational environment?
2) How does biophilic design influence children's awareness of water in an educational environment?

3) How does biophilic design influence children's' awareness of plants in an educational environment?
4) How does biophilic design influence children's' awareness of animals in an educational environment?
5) How does biophilic design influence children's' awareness of light in an educational environment?
6) How does biophilic design influence children's' awareness of natural material in an educational environment?
7) How does biophilic design influence children's' awareness of color in an educational environment?

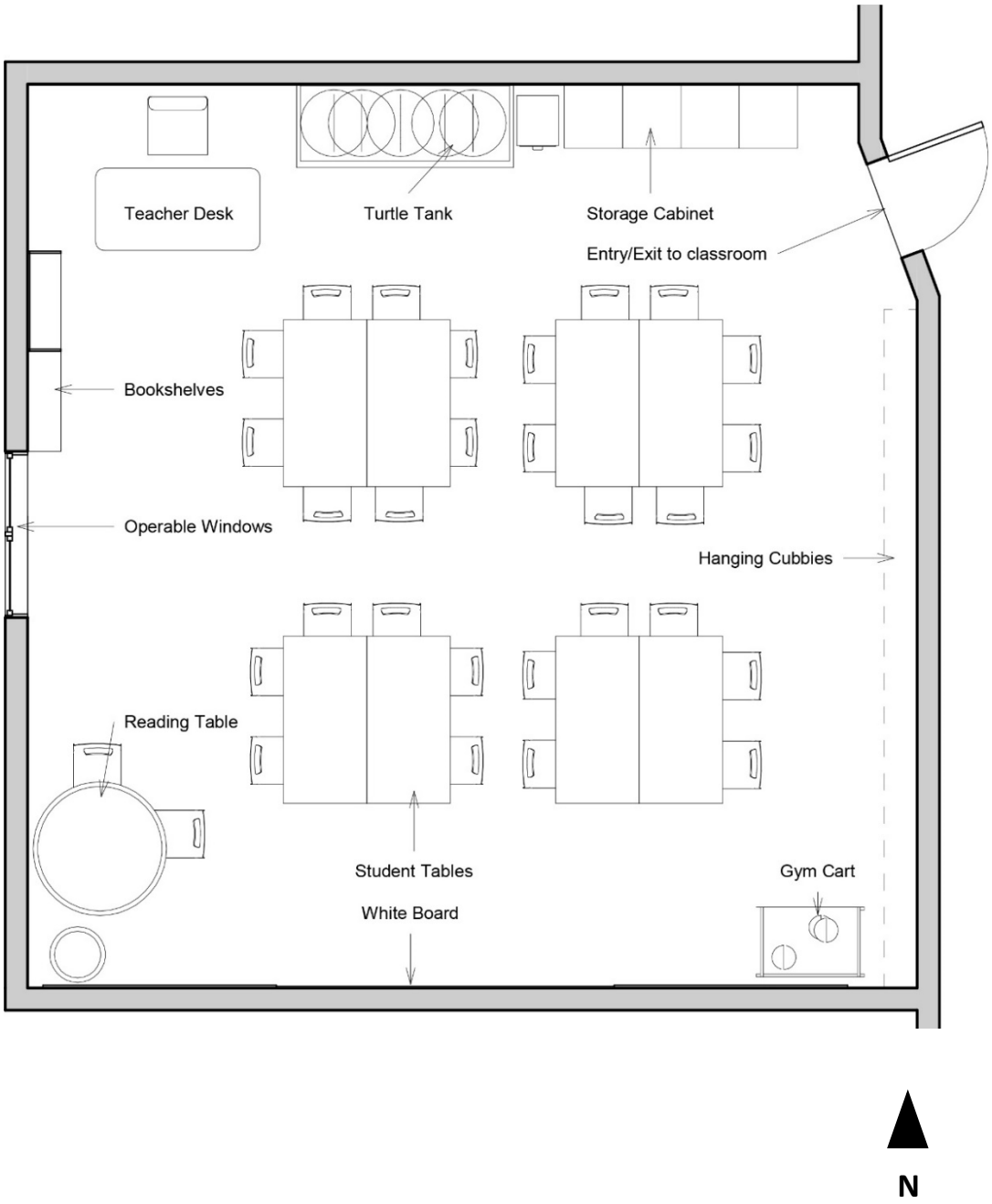
Site

Two elementary school classrooms in Queen's Grant Community Charter School located in Mint Hill, North Carolina were used for this study. Queen's Grant Community Charter School is a public charter school that was established in 2002, had roughly 755 students enrolled at the time of data collection, and included kindergarten through eighth grade. The school is S.T.E.M. oriented focusing on science, technology, engineering, and mathematics. The sample included children in fourth and fifth-grade. The age of the students was not asked, therefore estimates the typical age in the fourth and fifth-grade levels were used, typically range in age from 8 to 12 years old. One fifth-grade and one fourth-grade classroom at Queen's Grant Community Charter School were used for this study. There were four sample groups, one class from the fourth-grade and three classes from the fifth-grade. The fifth-grade classes which are identified in this study as Core 1,

Core 2, and Core 3, all share the same classroom, at different times of the day. Each core spends an average of one and half hours in the classroom at one time rotating through various times of the day.

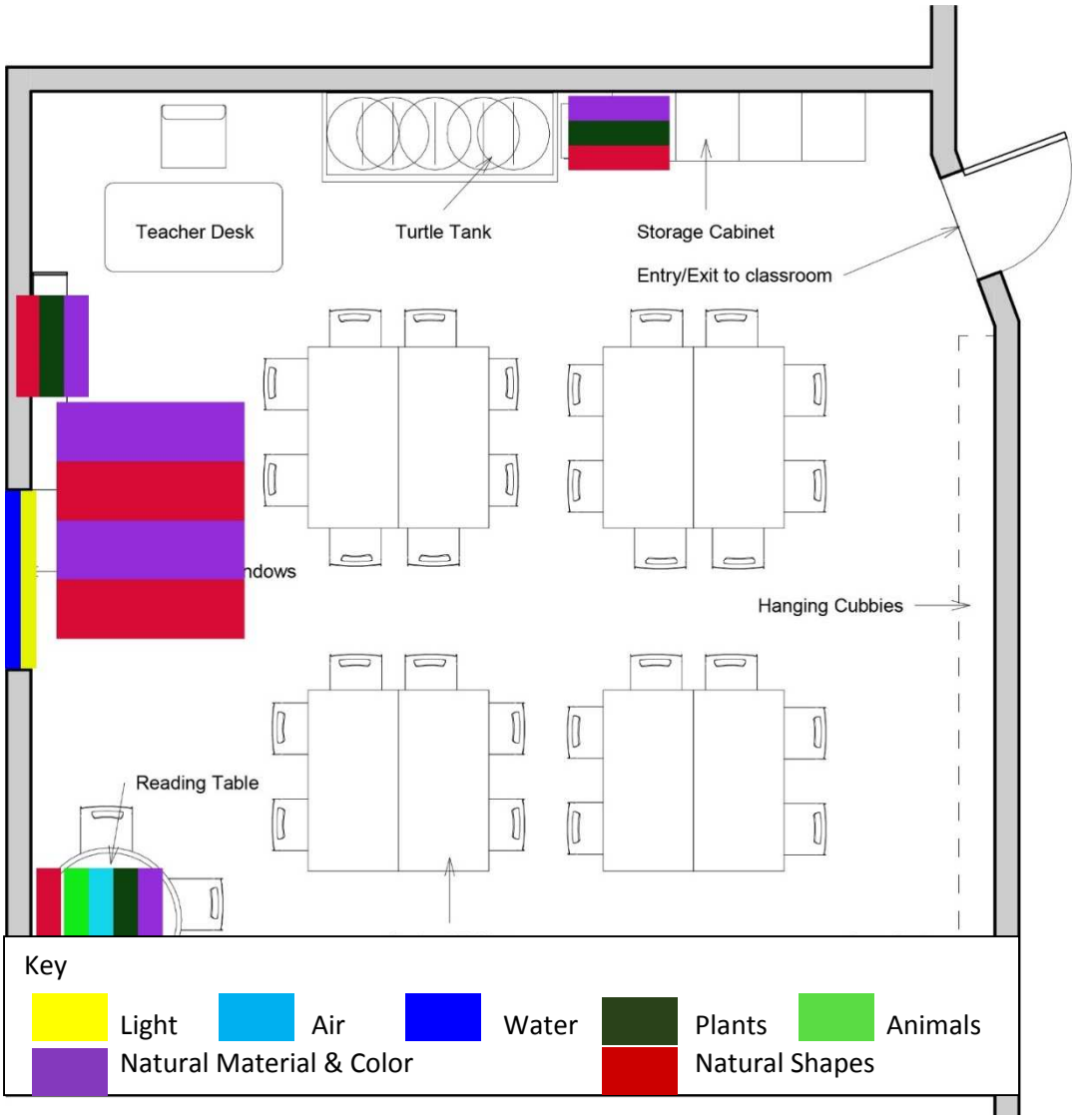
The fourth-grade classroom had 27 students in the class, three of which were not included in the study due to either a non-consent from the parent of the student or the student being absent for one of the administered instruments. The fourth-grade classroom was primarily used a mathematics classroom and the fifth-grade classroom was used as a science classroom. The fifth-grade classroom contained three cores, which were classes that rotated throughout the day with the same teacher. There were 28 participants in the fifth-grade core 1 class, three of which were not included in the study due to either a non-consent from the parent of the student or the student being absent for one of the administered instruments. There were 28 students in the fifth-grade core 2 class, ten of which were not included in the study due to either a non-consent from the parent of the student or the student being absent for one of the administered instruments. There were 28 students in the fifth-grade core 3 class, four of which were not included in the study due to either a non-consent from the parent of the student or the student being absent for one of the administered instruments. The fourth-grade classroom had a total of 24 students and fifth-grade classroom had a total of 72 students participate in the study. There was only one class to participate from the fourth-grade classroom because the schedules for students in both grades were not similar enough to allow for the same amount of time in the classrooms.

Figure 2. Fifth-grade Floor Plan



The fifth-grade classroom is roughly 715 square feet, contained two operable windows with views of an exterior garden, Figure 2. After using the Biophilic Design Matrix to examine the existing biophilic attributes, it was determined that there were 28 biophilic attributes present in the fifth-grade classroom. These biophilic attributes included: color, water, air, plants, animals, natural materials, views and vistas, botanical motifs, tree and columnar supports, representations of animals, egg, oval, and tubular forms, shapes resisting straight lines, sensory variability, age, change, and the patina of time, central focal point, bounded spaces, transitional spaces, integration of parts to wholes, natural light, filtered and diffused light, reflected light, light pools, warm light, spaciousness, spatial variability, geographic connection to place, ecological connection to place, and indigenous materials, Appendix B. After evaluating the existing biophilic quality of the classroom, the researcher examined the 72 attributes to determine which attributes could be implemented in the classroom. The attributes of water, air, plants, animals, light, natural materials, and color were selected by the researcher to be implemented in both classrooms. These attributes were selected because many of the 72 attributes were inapplicable to an elementary school grade level. The seven chosen attributes were selected due to being categorized in the Environmental Features element of biophilic design. The twelve attributes listed in this category are the most identifiable in the built environment. The other six elements of biophilic design contained complex attributes for an elementary school student to fully comprehend. The seven selected attributes were able to be implemented into a classroom more easily through being combined with one another.

Figure 3. Fifth-grade Biophilic Attribute Locations



The fourth-grade classroom, is roughly 715 square feet, contains two operable windows with views of a playground area and trees, Figure 3. After using the Biophilic Design Matrix to examine the existing biophilic attributes, it was determined that there were 21 biophilic attributes present in the classroom: color, air, natural materials, views and vistas, botanical motifs, tree and columnar supports, representations of animals, egg, oval, and tubular forms, biomimicry, central focal point, patterned wholes, bounded spaces, transitional spaces, natural light, filtered and diffused light, light and shadow, reflected light, warm light, light pools, spaciousness, and spatial variability, Appendix B. After evaluating the existing biophilic quality of the classroom, the researcher examined the 72 attributes to determine which attributes would be implemented in the classroom. The attributes of water, air, plants, animals, light, natural materials, and color were selected by the researcher to be implemented in both classrooms. The seven chosen attributes were selected due to the same reasoning as the fifth-grade classroom attributes, they are categorized in the Environmental Features element of biophilic design. The twelve attributes listed in this category are the most identifiable in the built environment. As the same attributes were implemented in both classrooms, the attributes were able to be implemented into the classroom more easily through being combined with one another.

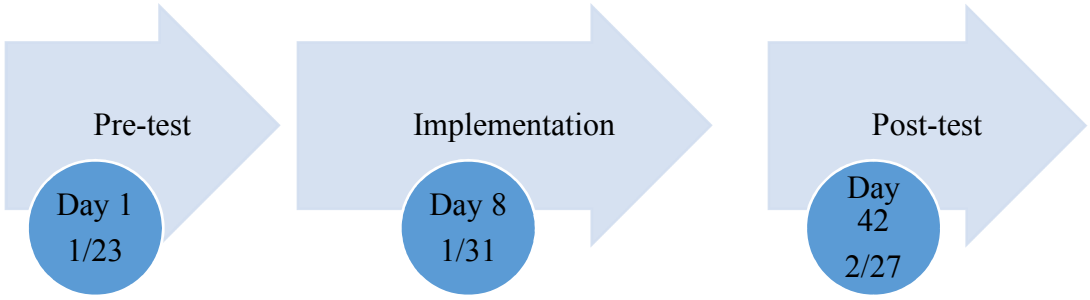
Figure 4. Fourth-grade Classroom

Figure 5. Fourth-grade Biophilic Attribute Locations

Procedure

The study took place over a six-week timeframe, the schedule is shown in Figure 6. The pre-test was administered to the students shortly after returning from winter break towards the end of January.

Figure 6. Timeline



Prior to determining which biophilic elements would be implemented in each classroom, a biophilic matrix was used to document the quantity and types of biophilic attributes in the classrooms. The Biophilic Interior Design Matrix (BDM), provides a numeric score through inventorying a space on the type of biophilic design elements and their subset attributes (McGee & Marshall-Baker, 2015). Using the BDM allowed for the two classrooms to be assessed to understand which biophilic attributes were existing in the space before the study started and what attributes could be expanded upon for the study. The BDM was not used to score the spaces, each category was evaluated and given either a check or X mark in the table to indicate if the types and amount of biophilic attributes, Appendix B. Photographs were used to document for the existing attributes present in each classroom. This information was used to determine the quantity and types of biophilic attributes that would be used during the intervention.

Each classroom was evaluated for illumination and sound levels to determine the existing built environment conditions that the students encounter daily in the classroom. Sound levels within each classroom were measured on a teacher work day, for an accurate measurement of the sound levels in the existing conditions of the classroom without the added noise from students. The measurements were taken three times and then averaged in three locations within the classroom; center of the classroom, standing next to the windows, and standing next to the door, see Table 1. The illumination levels were recorded in each classroom during three lighting conditions; daylight only, electric light only, and a combination of daylight and electric lighting, see Table 2. The measurements were taken during the existing conditions evaluations, there was cloud coverage during one reading, which lowered the amount of natural light in the classroom.

Table 1. Decibel Readings (dbA*)*

Decibel Readings			
Classroom	Center of Room	Windows	Door
Fifth-grade	37.0 dbA	36.3 dbA	37.3 dbA
Fourth-grade	33.6 dbA	34 dbA	36.3 dbA

Table 2. Illumination Readings (lux)

Illumination Readings			
Classroom	Natural light	Artificial Light	Combination
Fifth-grade	95.5 lux	194.3 lux	271.3 lux
Fourth-grade	250 lux	242.6 lux	293 lux

Upon finalization of the instrument, materials were submitted, reviewed, and approved by the UNCG Institutional Review Board (IRB). The IRB determined that this study did not constitute human subjects research as defined under federal regulations [45 CFR 46.102 (d or f)] and did not require IRB approval. Study# 17-0165 was stamped for approval from the IRB office (Appendix C), parental (Appendix F) and student consent forms (Appendix G) have been stamped and were given to the teachers for distribution to both parents and the students before starting the study. Additional approval was required by Queens Grant Charter School (Appendix D). After receiving approval, the stamped and approved documents were given to the two teachers who distributed them to the parents and their students. All signed consent forms were collected before the administration of the instrument. rate. The instruments were not collected by the researcher, if parental consent was not given. Each student was given the same number or identifier from the teacher for the data to be compared for the pre-test and post-test. In the case where an instrument was received in the pre-test and not the post-test or vice versa, the instrument was excluded from the study because the data could not be compared. The students were given the instrument and told to write as much or as little as they wanted and were not assisted by the teachers during the duration of this assignment.

Instrument

The instrument consisted of an in-class writing assignment in the form of a narrative response to a prompt, see Appendix A. The assignment was developed with the teachers to ensure that the students would be capable of comprehending the prompt. The question, "Write about an experience you had with your family or friends. What did you see, feel, taste, hear, and smell?" was open ended. The prompt was written to lessen nature bias, in that the prompt is generic but also makes the student think about their five senses, which would result in more descriptions from each student.

The instrument was piloted with three children ranging in ages of 8 to 12 to gauge the difficulty of assignment before being administered by the two teachers in the classrooms. Reading and comprehension levels for this age group was found to be acceptable the pilot testing and therefore was unaltered for this study.

Figure 7. Existing Biophilic Attributes in Fifth-grade Classrooms. (a) Cubbies; (b)Teaching Wall; (c) Window Wall; (d) Back Wall (All images original to researcher).

(a)

(b)

(c)

(d)

Figure 8. Existing Biophilic Attributes in Fourth-grade Classroom. (a) Cubbies; (b)Teaching Wall; (c) Back Wall; (d) Window Wall (All images original to researcher).

(a)

(b)

(c)

(d)

The Intervention

The biophilic attributes that were implemented in the classrooms consisted of: light, water, plants, animals, color, natural materials, and naturalistic shapes and forms, see Table 3. This study focused specifically on the seven biophilic attributes of air, water, plants, animals, light, natural materials, and color found in the element category of environmental features. Air as a biophilic attribute is significant in the "quality, movement, flow, and stimulation of other sense" (Kellert, 2008, P.7). Water is important through "the perception of quality, quantity, movement, and clarity" (Keller, 2008, P.7). Plants are a basic need of humans as a food source and may enhance comfort, satisfaction, well-being, and performance in the interior built environment (Kellert, 2008). Natural materials are preferred over artificial material because they are not stagnant Natural material weathers and patinas through the course of nature. Color is symbolic recognition of the world around us, there is an innate human attraction to colorful and natural tones. Light for this study takes into consideration natural, electric light, filtered and diffused light. Natural light provides comfort and can improve a person's well-being in the built environment. Filtered and diffused light can be used to alleviate glare from sunlight and stimulate a person through the visual connection of interior to exterior spaces (Kellert, 2008).

Air was also included in this study as each classroom had operable windows, the teachers agreed on days with nice weather to open the windows, allowing for natural air to circulate through the classroom. Light was provided by opening or partially opening the blinds allowing daylight to enter the room. The blinds were left open through the

study much of the day, except for closing them for the use of the projector. The teachers informed the researcher that this occurred a couple of times throughout the study, specifically when the weather was nice. The attribute of light was also provided in the fish tank through the LED light, giving the teacher and students the ability to alter the color of the tank. Water and animals were provided through a fish tank. Several potted plants were supplied for the study, these will consist of aloe vera, sanservieria (Snake plant), peace lily, and succulents two panda plants, one leatherpetal, and one ogre ear. The potted plants counted as two biophilic attributes, plant and color. Natural materials and naturalistic shapes may be provided through shells and rocks in plants, fish bowls, and carpet tiles representing elements such as stones, moss, sand, and water. See figures 2 and 4 for fourth and fifth-grade furniture plans with intervention.

Table 3. Biophilic Attributes

Biophilic Attributes						
Light	Air	Water	Plants	Animals	Natural materials and color	Naturalistic shapes and forms
Blinds opened or partly opened, LED in tank	Operable windows and doors	Fish tank	Potted plants	Fish in fish tanks	Shells and rocks in the fish tanks	Shells and rocks in the fish tanks

Both classrooms received the same six biophilic attributes as listed in Table 3. Succulents were chosen for each of the classrooms because of the low maintenance. The

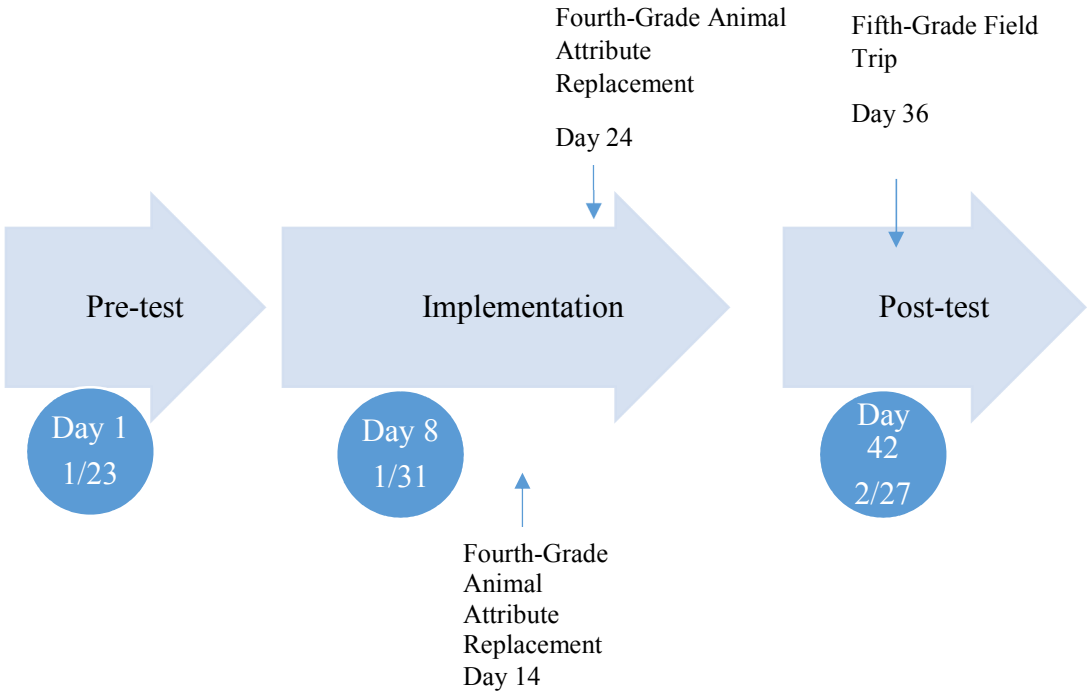
terrarium contained leatherpetal also known as Graptopetalum. These plants are perennial succulents and grow in a rosette form. Planting soil, colored sand, and colored shells were also present in each terrarium. All the plants chosen for the classrooms were easy to maintain and provided unique textures such as fuzzy leaves or unique shapes such as resembling an ear of the mythological creature, the ogre.

Each classroom had the same three-gallon fish tank containing plants and fish. Five live plants were in each tank were one el nino fern, anubias frazeri, two amazon swords, one compacta, and one bag of river rock shallow aquarium gravel. Eight fish were in each tank: four neon tetras, three skirt tetras, and one green emerald cory catfish. Each tank has an LED light featuring seven selectable color options: amber, aqua, blue, green, purple, red, and white and counted as the attribute of light. The color changing LED allowed for variety of lighting for the students and fish environment. The fish were categorized as the biophilic attribute of animals for the fish but can also be color. Plants were counted as both the attribute of plants, but also color.

Lastly, the two classrooms received 16, 24” x 24” carpet tiles that represented natural systems found in nature. In this case the classrooms received carpets that looked like stone pavers with moss growing on them in both the fourth and fifth-grade classrooms, in addition the fourth-grade classroom also received carpet tiles that mimic waves in the ocean. The two collections added to the classrooms were Human Connections and Net Effects Collections by Interface. Because these were samples given to the researcher by a carpet representative, there was a limit on the number of tiles for the classroom. The flooring material represented the biophilic attribute of natural

materials, color, water, and plants, see figure 10 for fourth-grade implementation images and figure 11 for fifth-grade implementation images, all images are original to the researcher. By implementing carpet tiles in the classrooms, the teacher or students were able to move the tiles around the classroom to create an interactive feature.

Figure 9. Expanded Timeline



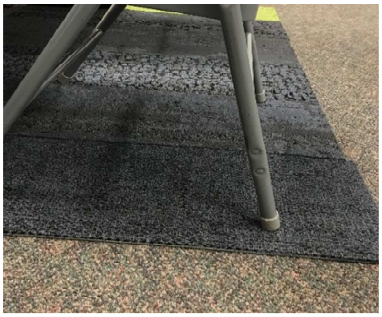
During the intervention there were a couple of issues that occurred between the two classrooms. The fourth-grade classroom encountered some tank issues with fish and plants dying. As the study was on going, one of the teachers lost some fish and plants; the other had no issues keeping the biophilic attributes alive. The classroom was visited twice during the study to replenish plants and new fish. The first time the researcher revisited the classroom, it was to replace 6 out of the 8 fish. The researcher returned about a week

later to replace another 2 fish and a plant in the tank. It was later revealed that the kids were over feeding the fish and the tank was not being properly cleaned.

The students in the fifth-grade classroom took a three-day school camping trip before the post-test was administered. All the fifth-grade students who participated in this field trip were involved in many outdoor activities such as canoeing, hiking, and learning outdoor skills. The students were able to hold animals such as snakes, rabbits, and turtles, as well as interact with animals along trails.

Figure 10. Fourth-grade Biophilic Attributes Implemented. (a) Net Effects Carpet Tiles; (b) Human Connections Carpet Tiles; (c) Potted Succulents; (d) Fish and plants; (e) Fish Tank; (f) Terrarium. (All images original to researcher***).***

(a)



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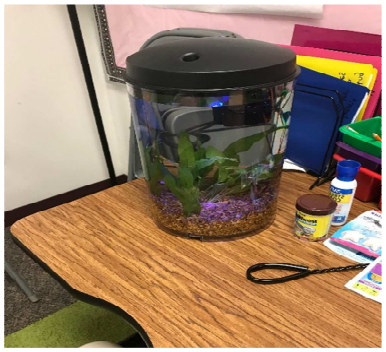
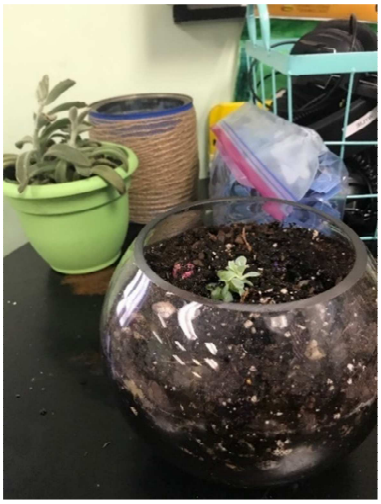


(e)

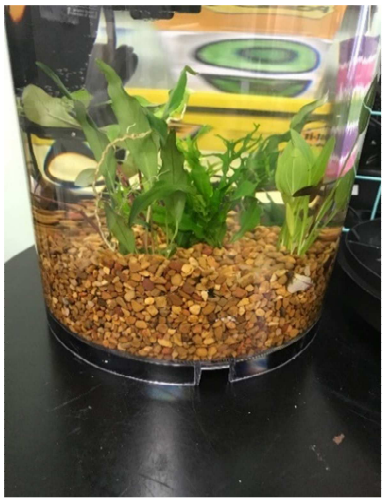
(f)

Figure 11. Fifth-grade Biophilic Attributes Implemented. (a) Plants and stones in tank; (b) Terrarium; (c) Fish Tank; (d) Human Connections Carpet Tiles; (e) Potted Succulents; (f) Potted Succulents. (All images original to researcher).

(a)



(b)



(c)

(d)

(e)

(f)

Data Collection

Data collection consisted of a pre-test and a post-test administered by the teachers to their fourth and fifth-grade students. The students in both classrooms during the pre-test and post-test were administered the same instrument with the same completion time.

The students were given 30 minutes to complete the assignment, which was a narrative. Before the researcher collected the assignments, all identifying information was removed by the teacher and each assignment with be given a numbered code (e.g., 1, 2, 3, 4, C1-1, C-2-6, C3-13, etc.) to preserve anonymity. Classroom one and two both acted as the experimental classroom to eliminate bias of seasons changing during this exploratory study. Each pre-test and post-test administered consisted of the same instrument.

The instrument was administered again five weeks after the invention by the teachers. The students were given 30 minutes to finish the post-test. The teachers removed all identifying information and code each assignment by a numerical value to differentiate between the pre-test code. After completion of the instrument being administered to the students, the researcher collected the coded assignments for analysis.

Data Collection and Coding

Data collection occurred through the list of biophilic attributes (light, use of air, water, plants, animals, natural colors, and naturalistic shapes and forms). All narratives were scanned into folders and sent out to the two code reviewers that coded the narratives. This study used two graduate students who assumed the role of code reviewer to eliminate bias. The code reviewers obtained the narratives along with instructions (see Appendix D) defining each biophilic attribute. The instructions were explicit in how the reviewers were to code the student narratives and given examples if narrative context was unclear. Many of the attributes could be counted for more than one category, context was also extremely important to determine the frequency counts. For example, if the student mentions an animal, it is considered animal in the biophilic attributes because it is literal.

But if the student mentions a statue of an animal, it is a representation of an animal. The reviewers counted the number of times light, air, water, plants, animals, natural materials, natural colors, and naturalistic shapes and forms were referenced with the student narratives. There were differences in the counts between the code reviewers. Therefore, a third person counted and coded the attributes. In the pre-test, there were 14 discrepancies between the two code reviewers coding with water, animals, and natural material. Both the pre-test and post-test resulted in discrepancies in the student narratives or instrument. Of the 72 student narratives collected in the fourth and fifth-grade classrooms, there were several discrepancies discovered among the two reviewers. The categories of water, plants, and animals had the most inconsistencies for counts. After the third counts were finished, the counts were compared with the two coders. The third counts aligned in all but two instances with the first code reviewer and were used in the analysis. The researcher then analyzed the numeric counts of the coding using nonparametric statistics. The analysis was conducted using frequencies and t-test to compare the pre-test coding with the post-test coding.

CHAPTER IV

FINDINGS

The objective of this research is to report findings of the awareness of biophilic attributes in an elementary school classroom. Reported results of the research for the pre-test and post-test are recorded from the two grade levels in Queens Grant Charter School. This chapter discusses the analysis and results of the study for both pre-test and post-test for each research question among the two grade levels. SPSS, a statistical analysis program, was used during the analysis process to compare the awareness of nature in the pre-test and post-test using the paired samples t-test.

1) How does biophilic design influence children's awareness of air in an educational environment?
2) How does biophilic design influence children's awareness of water in an educational environment?
3) How does biophilic design influence children's awareness of plants in an educational environment?
4) How does biophilic design influence children's awareness of animals in an educational environment?
5) How does biophilic design influence children's awareness of light in an educational environment?

6) How does biophilic design influence children's awareness of natural materials in an educational environment?
7) How does biophilic design influence children's awareness of color in an educational environment?

Table 4. Summary Table of Fourth-grade

	Air		Water		Plants		Animals		Light		Material		Color		Total		% of Change
Grade	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	POC
Fourth	3	7	22	11	3	5	9	15	1	0	2	5	5	1	45	44	-2%

Table 5. Summary Table of Fifth-grade Core 1

	Air		Water		Plants		Animals		Light		Material		Color		Total		% of Change
Grade	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	POC
Fifth Core 1	5	8	42	51	7	25	38	45	0	3	13	30	1	1	106	163	35%

Table 6. Summary Table of Fifth-grade Core 2

	Air		Water		Plants		Animals		Light		Material		Color		Total		% of Change
Grade	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	POC
Fifth Core 2	9	14	8	30	15	24	10	35	2	4	1	7	2	0	47	114	59%

Table 7. Summary Table of Fifth-grade Core 3

	Air		Water		Plants		Animals		Light		Material		Color		Total		% of Change
Grade	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	POC
Fifth Core 3	1	3	8	37	5	19	3	59	0	3	1	20	1	1	19	142	87%

Data Preparation

The data collected for both the pre-test and post-test for all four classes were organized to conduct a paired-samples t-test. The paired-samples t-test is a statistical analysis used to determine if there is a statistical difference of compared means. The analysis began by looking at the counts for the fourth-grade and fifth-grade classrooms. The first step for the analysis was to combine all four classes, due to the extreme variation of results, the data could not be combined for all grade levels.

The data were analyzed using paired sample *t*-test by separating the fourth and fifth-grader's scores. There was not a significant difference in the awareness in the pre-test (M=3.00, SD= 2.62) and the awareness in the post-test (M= 2.93, SD=3.24) at the p=.949, see Tables 8 and 9. Calculated p-values less than 0.05 can generate random error, there is a low probability (5%) that data are significant by chance. These results suggest that the presence of the biophilic attributes in the fourth-grade classroom did not influence the student's awareness of nature. Specifically, the results suggest that when biophilic attributes are present, student awareness did not significantly increase or decrease.

Table 8. Descriptive Statistics for Fourth-grade

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	3.0000	15	2.61861	.67612
	Post-Test	2.9333	15	3.23964	.83647

Table 9. Paired-samples t-test for Fourth-grade

Paired Samples Test

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	Pre-Test - Post-Test	.06667	3.93640	1.01637	.066	14	.949

To compare the awareness of biophilic attributes in fifth-grade, all three classes were combined and a paired-samples t-test was conducted to compare the awareness of

aspects of nature in the pre-test and post-test. There was a statistically significant difference in the awareness between the pre-test (M=3.01, SD= 3.21) and he post-test (M= 7.35, SD=5.01) at the p=0.000, see Tables 10 and 11. These results suggest that the presence of the biophilic attributes in the fifth-grade classroom influenced the student's awareness of nature. Specifically, the results suggest that when biophilic attributes are present, the student awareness increases.

Table 10. Descriptive Statistics for Fifth-grade Classes

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	3.0175	57	3.20987	.42516
	Posttest	7.3509	57	5.00532	.66297

Table 11. Paired-samples t-test for Fifth-grade Classes

Paired Samples Test

	Paired Differences					
	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre-test – Post-test	-4.33333	5.63260	.74606	-5.808	56	.000**

Note. ** p < .000

Pre-test & Post-test Biophilic Attributes Results

Fourth-grade Pre-test & Post-test Biophilic Attributes Results

Next an analysis was conducted on each individual biophilic attribute tested, air, water, plants, animals, light, natural materials, and color for the fourth-grade classroom.

A paired-samples t-test was conducted to compare the awareness of each of the biophilic attributes in the pre-test and post-test. There were no significant findings to report for the fourth-grade classrooms, therefore, the biophilic attributes did not influence the awareness of aspects of nature for the class.

Table 12. Descriptive Statistics of Fourth-grade Biophilic Attributes

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Air	Pre-test	.20	15	.561	.145
	Post-test	.47	15	.743	.192
Water	Pre-test	1.47	15	1.807	.467
	Post-test	.73	15	1.100	.284
Plants	Pre-test	.20	15	.414	.107
	Post-test	.33	15	1.291	.333
Animals	Pre-test	.60	15	1.404	.363
	Post-test	1.00	15	3.071	.793
Light	Pre-test	.07	15	.258	.067
	Post-test	.00	15	.000	.000
Material	Pre-test	.13	15	.516	.133
	Post-test	.33	15	.816	.211
Color	Pre-test	.33	15	.816	.211
	Post-test	.07	15	.258	.067

Table 13. Paired-samples t-test of Biophilic Attributes for Fourth-grade

Paired Samples Test

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Air	Pre-test Post-test	-.26667	.88372	.22817	-1.169	14	.262
Water	Pre-test Post-test	.73333	2.37447	.61308	1.196	14	.252
Plants	Pre-test Post-test	-.13333	1.40746	.36341	-.367	14	.719
Animals	Pre-test Post-test	-.40000	3.56170	.91963	-.435	14	.670
Light	Pre-test Post-test	.06667	.25820	.06667	1.000	14	.334
Material	Pre-test Post-test	-.20000	1.01419	.26186	-.764	14	.458
Color	Pre-test Post-test	.26667	.88372	.22817	1.169	14	.262

Note. * p < .05; ** p < .000

There was not a significant difference in the awareness of air between the pre-test (M=.20 SD= .56) and the post-test (M= .47, SD=.74) at the p=.262, see Table 17. There was not a significant difference in the awareness of water between the pre-test (M=1.47 SD= 1.81) and the post-test (M= .73, SD=1.10) at the p=.252. There was not a significant difference in the awareness of plants between the pre-test (M=.20 SD= .41) and the post-test (M= .33, SD=1.29) at the p=.719. There was not a significant difference in the awareness of animals between the pre-test (M=.60 SD= 1.46) and the post-test (M= 1.00, SD=3.07) at the p=.670. There was not a significant difference in the awareness of light between the pre-test (M=.07 SD= .26) and the post-test (M= .00, SD=.00) at the p=.334.

There was not a significant difference in the awareness of natural materials between the pre-test (M=.13 SD= .52) and the post-test (M= .33, SD=.82) at the p=.458. There was not a significant difference in the awareness of color between the pre-test (M=.33 SD= .82) and the post-test (M= .07, SD=.26) at the p=.262.

Fifth-grade Pre-test & Post-test Biophilic Attributes Results

Subsequently, an analysis was conducted on each individual biophilic attribute tested, air, water, plants, animals, light, natural materials, and color for cores one through three of the fifth-grade classroom. A paired-samples t-test was conducted to compare the awareness of each of the biophilic attributes in the pre-test and post-test. There were several statistically significant findings to report for the fifth-grade classroom, therefore, the biophilic attributes influenced the awareness of nature for the class, see tables 16 and 17.

Table 14. Descriptive Statistics of Fifth-grade Biophilic Attributes

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Air	Pre-test	.2632	57	.48279	.06395
	Post-test	.4386	57	.77960	.10326
Water	Pre-test	1.0175	57	1.80763	.23943
	Post-test	2.0702	57	1.93520	.25632
Plants	Pre-test	.4737	57	.92785	.12290
	Post-test	1.1930	57	1.68437	.22310
Animals	Pre-test	.8947	57	1.75951	.23305
	Post-test	2.4386	57	2.65933	.35224
Light	Pre-test	.0351	57	.26491	.03509
	Post-test	.1754	57	.46762	.06194
Material	Pre-test	.2632	57	.66886	.08859

	Post-test	1.0000	57	1.29560	.17161
Color	Pre-test	.0702	57	.31958	.04233
	Post-test	.0351	57	.18564	.02459

Table 15. Paired-samples t-test of Biophilic Attributes for Fifth-grade

Paired Samples Test

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Air	Pre-test	-.17544	.86855	.11504	-1.525	56	.133
	Post-test						
Water	Pre-test	-	2.29457	.30392	-3.463	56	.001*
	Post-test	1.05263					
Plants	Pre-test	-.71930	1.80034	.23846	-3.016	56	.004*
	Post-test						
Animals	Pre-test	-	3.09418	.40983	-3.767	56	.000**
	Post-test	1.54386					
Light	Pre-test	-.14035	.54898	.07271	-1.930	56	.059
	Post-test						
Material	Pre-test	-.73684	1.36965	.18141	-4.062	56	.000**
	Post-test						
Color	Pre-test	.03509	.32541	.04310	.814	56	.419
	Post-test						

Note. * $p < .05$; ** $p < .000$

There was a significant difference in the awareness of water between the pre-test (M=1.02, SD= 1.81) and the post-test (M= 2.07, SD=1.94) at the p=.001, see Table 12. There was a significant difference in the awareness of plants between the pre-test (M=.47 SD= .93) and the post-test (M= 1.19, SD=1.68) at the p=.004. There was a significant difference in the awareness of animals between the pre-test (M=.89 SD= 1.76) and the post-test (M= 2.44, SD=2.66) at the p=.000. There was a significant difference in the

awareness of light between the pre-test (M=.04 SD= .26) and the post-test (M= .18, SD=.47) at the p=.059. There was a significant difference in the awareness of natural materials between the pre-test (M=.26, SD= .67) and the post-test (M= 1.00, SD=1.30) at the, p=.000. These results suggest that the biophilic attributes of water, plants, animals, light, and natural materials in the fifth-grade classrooms influenced the student's awareness of nature.

There was not a significant difference in the awareness of air between the pre-test (M=.26 SD= .48) and the post-test (M= .44, SD=.78) at the p=.133. There was not a significant difference in the awareness of color between the pre-test (M=.07, SD= .32) and the post-test (M= .04, SD=.19) at the p=.419. These results suggest that the biophilic attributes of air and color did not influence the student's awareness of nature in the fifth-grade classroom.

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

The main objective of this study was to assess awareness of biophilic design attributes in an elementary school classroom. This was tested by introducing biophilic attributes in two classrooms, one fourth-grade and one fifth-grade classroom. Students were administered an instrument, which was a student narrative, once before the biophilic attributes were introduced and once after implementation. The instrument was coded and statistically analyzed to determine if the biophilic attributes influenced the awareness of nature.

There were statistically significant differences between the pre-test and post-test, as detailed below. The researcher did not further investigation of outside factors that may influenced the results of the study. From the data collected, it can be concluded that the biophilic attributes positively influenced the fifth-grade students' awareness of nature. Students within the fourth-grade classroom showed no significant change between the pre-test and post-test. This was initially surprising because the fourth-grade students spent 30 minutes more per day in the classroom than the fifth-grade students. However, there were several factors that may have affected the results, such as several of the implemented biophilic attributes dying during the implementation period, the level of interest in participation of the study from the teacher, and a class fieldtrip. Observations made from the researcher suggest that several visits to the fourth-grade classroom due to

maintenance of biophilic attributes implemented in the classroom, could have skewed the results. Students did not seem interested in the biophilic attributes once things died, specifically the fish in the fish tank. There were a couple of plants in the fish tank that also died, needing to be replaced. The fifth-grade students took a three-day school camping trip before the post-test was administered, which may have affected the student's frequency counts. All of the fifth-grade students who participated in this field trip were involved in many outdoor activities such as canoeing, hiking, and learning outdoor skills. The students were able to hold animals such as snakes, rabbits, and turtles, as well as interact with animals along trails. This school field trip most likely influenced the post-test results, 39 of the narratives focused on the class trip. The post-test was administered 2 days after the students returned from this trip. Lastly, findings may have been skewed due to the teacher enthusiasm in the biophilic attributes, in the fifth-grade classroom the teacher was excited to participate in the study, the excitement toward the biophilic attributes may have influenced the students in the classroom. Similarly, patrons feeling positive about the environment, may encourage other patrons to positively perceive the space or a senior center manager promoting activities at the center to engage patrons in certain programs (Rosenbaum et al., 2014).

In addition, the class subject studied with the fourth-grade classroom may have also influenced how the students reacted to the attributes. When the students were in this classroom, the subject they were learning about was mathematics. The class was a mathematics classroom; therefore, the attributes did not relate to the subjects the student were learning, which may have caused disinterest. Lastly, the researcher was not able to

select the teachers who participated, they were assigned by the school. The attitude of the teacher may have resulted in a negative experience for students. If the teacher did not have a positive outlook on the biophilic attributes, it may have directly influenced the attitude of the students towards the attributes implemented in the classroom. Research by Whitehouse et al. (2001) explains the significance of increased consumer satisfaction among hospital occupants after spending time in a garden located at the hospital. Specifically, the positive mood changes in hospital staff, resulting in an overall better quality of service (Whitehouse et al., 2001). It can be concluded that a similar circumstance occurred in this study, the teacher's frustration towards the attributes negatively influenced a student's positive awareness of the implemented biophilic attributes.

Nevertheless, there were interesting findings within the fourth-grade classroom. The percentage of change between the pre-test and post-test was -2% in the fourth-grade classroom. Meaning that there was a decrease of awareness of biophilic attributes after implementation, possible due to the negative impact of the death of the fish. Several of the fish died within the first week, February 6 and sat in tank decomposing for days before the researcher could get out to the site to clean the tank out and replace the fish. The second visit was to replace all the fish and a couple of plants in the tank. Two of the replacement fish died the day before the study ended. Although this is the natural condition of life, the dying attributes may have negatively influenced the study.

The most written about biophilic attribute for the pre-test in fourth-grade classroom was water with a mean of 1.4667, the least written about attribute for the pre-

test was light with a mean of .07. Children favor water features where running water can be heard (Whitehouse et al., 2001). A couple of examples of students discussing water include; “My family and I went to the aquarium, I touched a tiger shark in the water and it felt rough….I got to touch a stingray, it felt slimy and wet and the water smelled bad.” Many of the student narratives discussed some type of water feature in an aquarium or in a pool or beach with sound of waves or water attracted them to that specific activity. Although there was little written about lighting, the examples written about pertained to artificial lighting. “My family and I went to Winterfest where we saw many lights and some rides were sparkling with lights.” The attribute of light did impact some of the students when they wrote about their experiences, but when it was mentioned it was in reference to a type of artificial lighting such as Christmas lights and in little depth. Lighting may have been written about least due to light being a complex attribute for elementary school students to understand.

The biophilic attribute written about most in the fourth-grade classroom for the post-test was animals with a mean of 1.00, whereas the least influential biophilic attribute was light with a mean of 0.00. A couple of examples of how the students wrote about animals in the post-test include; “When I went to Tiger World, I saw a kangaroo, lions, monkeys, wolves, birds, snakes, leopards, a tiger, geese, and snow tigers…. I felt the back of multiple cockatoos and a kangaroo.” “I saw geckos, iguanas, and lizards, I also saw a lot of exotic colors on them. I touched lizards and they felt slimy and scaly…. I heard singing and birds.” The attribute of light was not discussed by any of the students in the post-test. Christmas lights were mentioned in the pre-test, but the time of year may

have played a role in the written about experiences, the attribute of light may be too complex for an elementary school student to comprehend. According to Whitehouse et al., (2001), children prefer scaled spaces contoured to their size with colors, flowers, animals, and waterfall sounds that seem inviting. In many of the narratives, students described animals that are attractive through color or pattern, which may indicate why this attribute was discussed most frequently in the post-test.

The fifth-grade class showed a statistically significant difference between the pre-test and the post-test data set. The percentage of change between the pre-test and post-test was 35% in fifth-grade core 1, 59% for core 2, and 87% for core 3. This could mean that there was a positive correlation between the implemented biophilic attributes and awareness of nature. The biophilic attribute that had been written about most frequently in fifth-grade in the pre-test was water, with a mean of 1.075. This means that the biophilic attribute water was mentioned the most in the pre-test, whereas the least influential biophilic attribute was light with a mean of .0351. Examples of the biophilic attribute water in the pre-test include: “Last year while I was in the water, I felt some fish nibbling my toes and when I caught that bass, it bit me and I threw it back in the water.”; “I could feel the air on my face on the coasters and the cool water in the slides.” Example of light in the pre-test is, “The sun gleamed on the water….and at night with my flashlight so bright.”

The biophilic attribute that had was written about most frequently in fifth-grade in the post-test was animals, with a mean of 2.4386. Whereas the least influential biophilic attribute was color with a mean of .0351. There was a change of awareness of biophilic

attributes between the pre-test and post-test on these students, but there could also be underlying factors contributing to the change such as the enthusiasm of the teacher and the class field trip. In the post-test the student examples for animals are, “An experience I had with my family was the Ark Encounter, I saw dinosaurs and animals from back then.”; “Then in class I felt a rabbit, turtles, and snakes.”; “I hear a woodpecker pecking on the wood” The four statistically significant biophilic attributes for the fifth-grade classes were water, plants, animals, and material. During the post-test coding, it could be noted that the students described their five senses in depth. A couple of examples are, “I tasted different plants, there was one that tasted like mint gum.”; “I smelt mud, water, and grass.”; “My family and I went to the beach and I don’t know why but the sand felt so cold. I picked up a sea shell and it’s like I could hear the water from the beach.”

The subject taught in the fifth-grade classroom was science, which may also have played a role in the attention to natural elements in the classroom. Each of the four influential biophilic attributes could have been written about as a result of the three-day school field trip to the outdoor school. The attribute of water may have positively influenced the students on their class trip as the children canoed and participated in other water activities, some of the student described the clarity of the water, which becomes an important role in being restorative (Gillis, & Gatersleben, 2015). Animals may have been more influential as the children were able to hold animals at the school such as snakes, lizards, birds, and turtles.

Further investigation is needed to determine how biophilic attributes influence the awareness of children. An interesting finding in the results were that both the fourth and

fifth-grade classes wrote about water as their highest attribute in the pre-test and the lowest attribute was light. This may be due to the reflections of their summer activities involving pools or water activities at a park or beach or coming off winter break where many of the families vacationed to coastal locations as the data was collected during early January. Light may have been discussed least because it may too complex of an attribute for students of this age group to fully understand or acknowledge.

The results of the pre-test indicated that animals were the most influential, or written about most frequently by the students, in both the fourth-grade and fifth-grade classes. This research reinforces the findings from White & Stoecklin (2008), that children from the ages of 8 to 12 have a higher interest in learning through wild and semi-wild worlds, specifically focusing attention on the care of animals. The influence of animals could be contributed to many of the students having pets or friends that have pets or that some teachers at the school have class pets. The results varied from fourth to fifth-grade for the lowest significant post-test biophilic attribute. For the fourth-grade class the attribute mentioned the least amount in the narrative assignment was light. While findings in elementary schools showed light to improve academic performance, aid in learning faster, and having fewer absences from school, the attribute did not enhance student awareness in either classroom (Olson & Kellum, 2003). This may be attributed to reasons similar to those of the pre-test, the students may be too young to acknowledge lighting in an everyday occurrence. The low interest in light could also have resulted to the blinds being closed during the periods were students were in the classroom, not allowing students views of the field and sunlight to peer into the classroom. Due to the

study not being in a controlled environment, there is no way of knowing how long the blinds were kept opened or closed during the school day.

The fifth-grade students lowest biophilic attribute was color. Although color was not referenced as much with the students, it would support the research that children are more interested in plants or animals found in nature (Baldwin, Powell, & Kellert, 2011). When the students wrote about plants and animals, they often referenced color, such as the green grass or used their creativity in free play to image wildlife, e.g., a teal spotted cheetah. In comparing the two grades, the fourth-graders use color to be descriptive, as the fifth-grade students rarely mentioned descriptions using color. Overall between the two classrooms, the results suggest that the biophilic attributes of air, light, and color did not influence the student's awareness of nature. As these attributes are ubiquitous in our natural and built environments, the student may look past these attributes.

Limitations

The limitations of this study include only one location being used for the study. Future research should replicate the study with more classes within a school and select teachers who are interested in participating in the study. It would also be interesting to replicate the study with more schools and a variety of grade levels. The purposive sampling procedure decreased the generalizability of findings as well as the study not being generalizable to all grade levels and locations of the school. Being a charter school, the class schedules may be run slightly different than a public school. The class periods vary per grade level and the students rotate classrooms for different class subjects. The school subjects taught in the charter school may also vary as the school is

science, technology, engineering, and mathematics, also known as S.T.E.M. oriented. Therefore, the study should be repeated with randomly selected classrooms at numerous elementary schools. In addition, the instrument for the study was customized for the specific grade level and may not be applicable to other grade levels.

The largest limitations were the two different school subjects taught in each classroom and the fifth-grade field trip before the study concluded. In the future it would be advised to replicate the study with teachers who are teaching the same class subject to understand what type of role the subject plays on the students when biophilic attributes are implemented. Future research should also check with teachers for upcoming class trips that may influence the results. In addition, the timing of the fifth-grade class trip closer to the end of the study may have skewed the collected data.

Lastly, the researcher had to rely on the teachers in the fourth and fifth-grade classrooms to maintain some of the biophilic attributes, such as keeping the fish and plants alive during the six-week timeframe. As the study was on going, one of the teachers lost some fish and plants; the other had no issues keeping the biophilic attributes alive. One of the classrooms was visited twice during the study to replenish plants and new fish. The first time the researcher revisited the classroom, it was to replace 6 out of the 8 fish. The researcher returned about a week later to replace another 2 fish and a plant in the tank. It was later revealed that the kids were over feeding the fish and the tank was not being properly cleaned. Therefore, in future research it is advisable to preemptively check on the biophilic attributes that are living to ensure the participants in the study do

not perceive negativity from the attributes and the teacher or supervisor of biophilic attributes understands how to fully care for them.

Future research may include further investigating awareness of nature being linked to wellbeing within elementary school children. As the student's awareness of nature increased significantly with plants and animals, research can be built upon by teachers and staff at schools through implementing small changes in the classroom to improve the overall well-being of students in the classroom. This study did not address the role of the teacher in the classroom, it was unknown if they reinforced the importance of the implemented attributes or engaged students with the biophilic attributes. Therefore, future research should include a narrative or type of documentation from the participating teachers.

Conclusion

Exposure to nature is essential for an elementary school students' development to create a bond to the natural systems and engage in learning (Maller, 2009). When exposed to nature, a child in this age group is more apt to focus on caring for animals and gardens, exploring landscapes, and use their creativity to create invented worlds (White & Stoecklin, 2008). Biophilic attributes can be used in classrooms to nurture natural tendencies and allow for developmental growth.

There is a lack of research on biophilic design in educational settings. We still do not know the length of time needed for positive lasting effects on children when exposed to biophilic attributes, nor the specific number of attributes needed to fully understand the positive effects on students. There is a need for more research to be conducted in

elementary school settings to determine how biophilic design effects awareness of nature in children. Implementing biophilic design in elementary school classrooms is important due to certain biophilic attributes aiding student performance, attendance, and reduction of stress (Olson & Kellum, 2003; Wu et. al, 2014; Carrus, et al., 2012). Contact with nature also promotes children's mental, emotional, and social health (Maller, 2009), becoming increasingly important in implementing attributes in an educational setting to better assist in stress reduction and attention restoration.

Due to budgetary restrictions placed on schools, there may be limited funds to update classrooms or other areas within the school building. The implementation of biophilic design attributes can accommodate limited budgets through low economic design modification to the classroom. The Stress Reduction Theory and Attention Restoration Theory paired with Biophilic Design can help bring awareness of nature to the students through these biophilic attributes assessed in the classroom. The research suggests how implementing small changes in the classroom can improve the awareness and attention towards nature in the classroom. These changes may be inexpensively applied to any school and classroom. For example, a teacher can incorporate plants into the classroom that require little to no light and are low maintenance. The plants would improve the indoor air quality and introduce natural color and texture, which can focus a student's attention on the plants.

This research may also be applied to existing renovations and new construction of schools. Designers should consider the existing conditions of the classrooms that may affect a students' ability to learn and focus. Designers and architects should pay special

attention to the amount and type of lighting in the classroom, both natural and electric (Tanner, 2009). The classroom windows should not be obstructed to allow for natural views to help student restore and redirect their attention. Operable windows would allow for a change in air flow for the students. Water can be implemented through graphic representations, such as water droplets on a resin panel or through carpet tiles with a water visual. Animals may also be implemented into a school through graphic representation. For example, an abstracted pattern of animal print like zebra strips or leopard print added to fabric in a media center. Natural shapes and forms may be achieved by the designers through types of flooring or furniture applications. There are many flooring manufacturers that offer organic visuals on luxury vinyl tile or carpet tiles. Lastly, the implementation of natural color can be achieved through pulling tones found in nature for a subtle design with small accents of color as you would find in the woods.

As students spend most of the time in classrooms, implementing biophilic attributes in a classroom may be essential in restoring attention through exposure to natural systems. Students in this study demonstrated an awareness of nature through biophilic attributes. It was found that water and animals were the most influential biophilic attributes among the two grade levels in the pre-test and post-test. This research suggests that with minimal effort and cost, schools can increase student's awareness of nature.

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APPENDIX A

INSTRUMENT

Baseline

Student Name _____ Date _____

Writing prompt:

Write about an experience you had with your family or friends. What did you see, feel, taste, hear, and smell?

Directions: Explain your experience in as much detail.

APPENDIX B

BIOPHILIC DESIGN MATRIX

4th grade classroom

Biophilic Design Matrix Sample		Instructions: Please place an x in the Scale column if the attribute is found in the interior of any of the images and add a brief description of what you identified in the Features column. The last column is where you cut and paste an image of the attribute for record/clarification. A general comment space is available at the end. No need to add up the scale or save. Google Drive will automatically save your responses. Thank you! Access to the photos will be sent to you separately.			
Biophilic Design Attributes			Scale	Features	
#	Attribute	Description	Add an x if found	Description	Image(s)
Environmental features- most obvious and well recognized nature characteristics					
1	Color	Any type of color	x X	curtains, pillows, books, paper, flowers	
2	Water	Any type of water			
3	Air	Natural ventilation, (e.g., operable windows and outdoor access)	X	operable windows	
4	Plants	Actual plants in any form (alive or previously alive)			
5	Animals	Actual animals in any form (alive or previously alive)			
6	Natural materials	Not artificially made and coming from the environment (e.g., wood, stone, metal, and paper)			
7	Views & vistas	Exterior views of natural features such as vegetation	X	trees, fields	
8	Fire	Fire providing comfort and civilization when controlled with color, warmth, & movement			
Natural shapes & forms- nature representations and simulations					
9	Botanical motifs	Representations found in shapes, forms & patterns of plants & vegetative matter	X	pumpkins, colored pictures	
10	Tree and columnar supports	Appearance or simulation of treelike shapes, including rounded/ columnar supports	X	light	
11	Animal	Representations of animals (e.g., animal forms, claws, & heads) may be highly stylized	X	whales on curtains	
12	Shells & spirals	Invertebrate representations with the most common being shell and spiral forms, bees & their hives, flies, butterflies, insects, spiders & their webs			

13	Egg, oval & tubular forms	Often used as design element details and seen in ornament & structural purposes such as columns, molding, & fountains	X	rubber base
14	Arches, vaults, domes	Copy of these forms found in nature for decorative or functional purposes including beehives, nests, shell forms, and cliffs often found in decorative, & functional purposes		
15	Shapes resisting straight lines	Shapes such as sinuous, flowing or adaptive to forces found in nature; nature features rarely are revealed as straight lines or right angles		
16	Simulation of natural features & biomorphy	A simulation rather than replication of natural form; ornamentation or decoration of imagined forms are vaguely reminiscent of those naturally found		
17	Geo-morphology	Replicating or embracing nearby geology or landscaping next to the building in the interior		
18	Biomimicry	Nature as a model; the imitation of functions found in nature can include the shapes of both animals & plants but focuses on function over replication of form	X	botanical motif on wall
Natural patterns & processes- properties derived from natural features & processes				
19	Sensory variability & information richness	Levels of: visual complexity, light, sound, touch, smell, &/or other sensory environmental conditions, for a sensuous & intellectually challenging environment		
20	Age, change & the patina of time	Age showing such as in wear or growth particularly by organic forms like wood but even inorganics like stone, efflorescence		
21	Central focal point	A singular point of reference or interest in a space	X	white board
22	Patterned wholes	A variability united, unique individual parts becomes organized in a pattern (e.g., mosaic wall art)	X	botanical motif on wall
23	Bounded spaces	As in a delineated space with clear boundaries, defined territories & place demarcations		

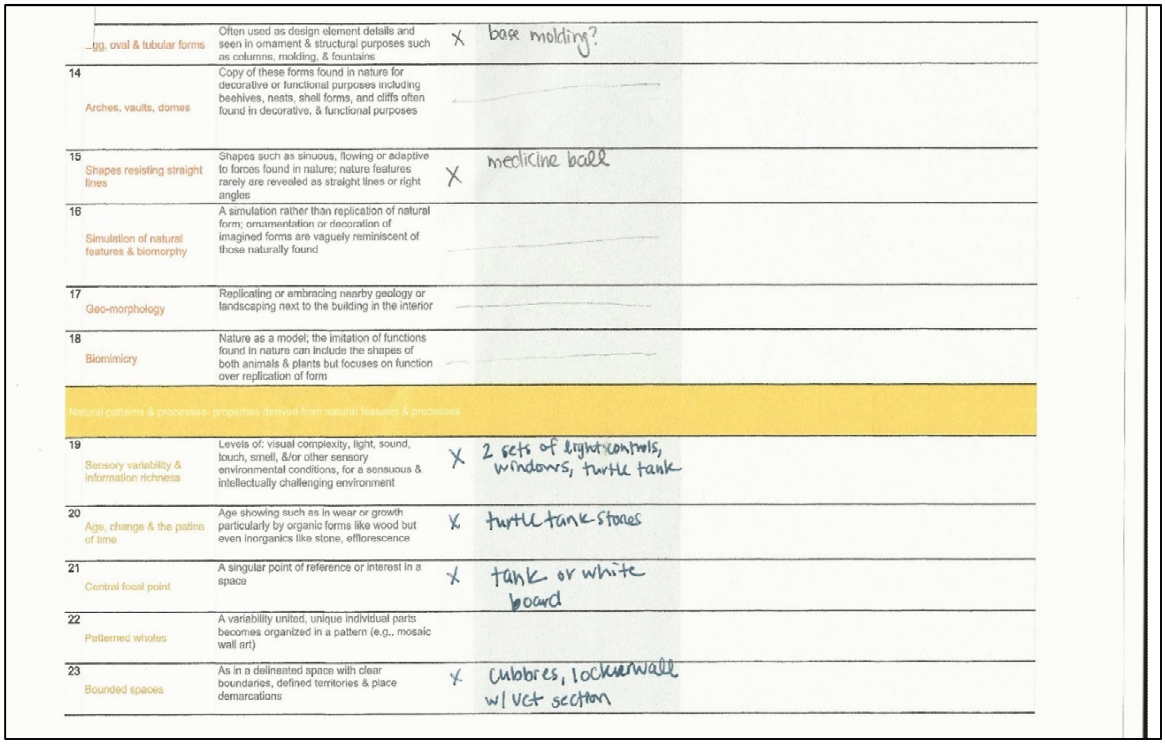
24	Transitional spaces	A space providing access between spaces, including hallways, bridges, etc.	X	hallway leading into room
25	Linked series & chains	Spaces connected that bring you from one space to another in a series		
26	Integration of parts to wholes	Individual distinct components together create a greater whole (e.g., small wood planks can make up a wood floor)		
27	Complementary contrasts	The blend of contrasting features or opposites, like light & dark, open & closed, high & low		
28	Dynamic balance & tension	Different or contrasting shapes, forms & materials may foster a sense of strength & durability, this blending of varying forces often produces a quality of creative tension that makes static forms appear organic		
29	Fractals	Fractals appear similar from both near & far, implying that the degree of irregularity &/or fragmentation is identical at all scales, mathematically self-similar but not exact copies, like snowflakes and or leaves of the same tree; nested scaling hierarchy (e.g. Gothic arches within arches)		
30	Hierarchically organized ratios & scales	Ratios or scales arithmetically or geometrically based can be seen in naturally occurring patterns [e.g., golden ratio, golden sections, golden proportion, golden spiral, & Fibonacci's sequence (0,1,1,2,3,5,8,13,21,34...) such as the head of a sunflower & the petals of an artichoke, these can be highly complex patterns yet seem organized]		
Light and Space- light qualities and space relationships				
31	Natural light	Daylight/ sunlight access	X	windows
32	Filtered & diffused light	Modulated daylight, to reduce glare (e.g., blinds & shades)	X	blinds
33	Light and shadow	Light & dark or shadowed spaces	X	lamps & reading area
34	Reflected light	Light reflecting off surfaces such as light colored walls, ceilings & reflective bodies like water & shiny surfaces, may provide sparkle	X	table tops / walls
35	Light pools	Pools of connected light in a series (may include shadow) on the floor or wall drawing you from one area to another	X	reading area?

36 Warm light	Warm lighting: the warm glow, sunlight, or fire is often surrounded by areas of darker	X	lamps
37 Light as shape & form	Natural light manipulated to create form (e.g., light shaft)		
38 Spaciousness	Openness or large open space is often complemented with sheltered areas surrounding it	X	hanging cubbies
39 Spatial variability	Changes of light, mass & scale such as ceiling heights, room widths, etc. for visual variety in the definition of the space (hopefully balanced with unity to create spatial harmony, see spatial harmony)	X	hanging cubbies
40 Space as shape & form	Space that is manipulated into form or shape		
41 Spatial harmony	Harmony in a space is often seen in a unifying commonality among the varied light, mass & scale with a defined boundary		
42 Inside-outside spaces	Interior spaces that appear connected to the outside environment, like porches, foyers & interior gardens		
Place-Based Relationships- culture together with ecology, rooted in the local geography			
43 Geographic connection to place	Connection of the space to the geography of the site, offers familiarity (e.g., use of local features, siting of the room, selection of views, etc.)		
44 Historic connection to place	Relation to the past through the marking of the passage of time; linking the past to the present, fostering a culture's collective memory (e.g., historical images)		
45 Ecological connection to place	Connection to local, dominate ecological & biogeographical features of the region (e.g., mountains, deserts, rivers, oceans)		
46 Cultural connection to place	Integrated history, geography & ecology of an area (e.g., architectural heritage of a people, particularly its treasured and distinctive vernacular/local forms)		
47 Indigenous materials	Local or native materials		

48	Landscape orientation & landscape features that define building form	The siting of the interior for biometeorological conditions like sunlight, wind direction, water drainage, etc. for integrating the building with the environment/ landscape that embellishes or defines the building or interior design and connects the interior to the exterior (e.g., Falling Water)		
Human-Nature Relationships- paired biological needs				
49	Prospect AND refuge	A place with the ability to survey the distance/ a view of the entire space with a place of protection/ separated from spaciousness		
50	Order AND complexity	A balance of structured organization with intricacy of detail that together appears orderly designs that meld order with complexity stimulate the desire for variety in a controlled manner		
51	Curiosity AND enticement	Spaces that elicit exploration, discovery, creativity or mystery		
52	Change AND metamorphosis	Present in growth, maturation & metamorphosis & seen when one form or state changes to another		
	Total score		1	
	Final comments/suggestions			

5th grade classroom

Biophilic Design Matrix Sample			Instructions: Please place an x in the Scale column if the attribute is found in the interior of any of the images and add a brief description of what you identified in the Features column. The last column is where you cut and paste an image of the attribute for record/clarification. A general comment space is available at the end. No need to add up the scale or save. Google Drive will automatically save your responses. Thank you! Access to the photos will be sent to you separately.	
Biophilic Design Attributes		Scale	Features	
# Attribute	Description	Add an x if found	Description	Image(s)
Environmental features- most obvious and well recognized nature characteristics				
1 Color	Any type of color	x X	walls, floor, fabric, rug, books	
2 Water	Any type of water	X	turtle tank	
3 Air	Natural ventilation, (e.g., operable windows and outdoor access)	X	operable windows	
4 Plants	Actual plants in any form (alive or previously alive)	X	one plant	
5 Animals	Actual animals in any form (alive or previously alive)	X	two turtles	
6 Natural materials	Not artificially made and coming from the environment (e.g., wood, stone, metal, and paper)	X	stones in turtle tank, paper on walls	
7 Views & vistas	Exterior views of natural features such as vegetation	X	box garden outside windows	
8 Fire	Fire providing comfort and civilization when controlled with color, warmth, & movement			
Natural shapes & forms- nature representations and simulations				
9 Botanical motifs	Representations found in shapes, forms & patterns of plants & vegetative matter	X	fake trees & plants, pumpkin, image of trees, quilts	
10 Tree and columnar supports	Appearance or simulation of treelike shapes, including rounded/ columnar supports	X	fake trees	
11 Animal	Representations of animals (e.g., animal forms, claws, & heads) may be highly stylized	X	stuffed animals, images of animals	
12 Shells & spirals	Invertebrate representations with the most common being shell and spiral forms, bees & their hives, flies, butterflies, inspects, spiders & their webs			



	…gg, oval & tubular forms	Often used as design element details and seen in ornament & structural purposes such as columns, molding, & fountains	X	base molding?
14	Arches, vaults, domes	Copy of these forms found in nature for decorative or functional purposes including beehives, nests, shell forms, and cliffs often found in decorative, & functional purposes		
15	Shapes resisting straight lines	Shapes such as sinuous, flowing or adaptive to forces found in nature; nature features rarely are revealed as straight lines or right angles	X	medicine ball
16	Simulation of natural features & biomorphy	A simulation rather than replication of natural form; ornamentation or decoration of imagined forms are vaguely reminiscent of those naturally found		
17	Geo-morphology	Replicating or embracing nearby geology or landscaping next to the building in the interior		
18	Biomimicry	Nature as a model; the imitation of functions found in nature can include the shapes of both animals & plants but focuses on function over replication of form		
	Natural patterns & processes- properties derived from natural features & processes			
19	Sensory variability & information richness	Levels of: visual complexity, light, sound, touch, smell, &/or other sensory environmental conditions, for a sensuous & intellectually challenging environment	X	2 sets of light controls, windows, turtle tank
20	Age, change & the patina of time	Age showing such as in wear or growth particularly by organic forms like wood but even inorganics like stone, efflorescence	X	turtle tank stones
21	Central focal point	A singular point of reference or interest in a space	X	tank or white board
22	Patterned wholes	A variability united, unique individual parts becomes organized in a pattern (e.g., mosaic wall art)		
23	Bounded spaces	As in a delineated space with clear boundaries, defined territories & place demarcations	X	cubbies, lockerwall w/ vct section

24	Transitional spaces	A space providing access between spaces, including hallways, bridges, etc.	X	hallway into classroom
25	Linked series & chains	Spaces connected that bring you from one space to another in a series		
26	Integration of parts to wholes	Individual distinct components together create a greater whole (e.g., small wood planks can make up a wood floor)	X	VCT & carpet floor
27	Complementary contrasts	The blend of contrasting features or opposites, like light & dark, open & closed, high & low		
28	Dynamic balance & tension	Different or contrasting shapes, forms & materials may foster a sense of strength & durability, this blending of varying forces often produces a quality of creative tension that makes static forms appear organic		
29	Fractals	Fractals appear similar from both near & far, implying that the degree of irregularity &/or fragmentation is identical at all scales, mathematically self-similar but not exact copies, like snowflakes and or leaves of the same tree; nested scaling hierarchy (e.g. Gothic arches within arches)		
30	Hierarchically organized ratios & scales	Ratios or scales arithmetically or geometrically based can be seen in naturally occurring patterns [e.g., golden ratio, golden sections, golden proportion, golden spiral, & Fibonacci's sequence (0,1,1,2,3,5,8,13,21,34...) such as the head of a sunflower & the petals of an artichoke, these can be highly complex patterns yet seem organized]		
Light and Space- light qualities and space relationships				
31	Natural light	Daylight/ sunlight access	X	windows
32	Filtered & diffused light	Modulated daylight, to reduce glare (e.g., blinds & shades)	X	blinds + curtains
33	Light and shadow	Light & dark or shadowed spaces		
34	Reflected light	Light reflecting off surfaces such as light colored walls, ceilings & reflective bodies like water & shiny surfaces, may provide sparkle	X	white walls
35	Light pools	Pools of connected light in a series (may include shadow) on the floor or wall drawing you from one area to another	X	table tops

36	Warm light	Warm lighting: the warm glow, sunlight, or fire is often surrounded by areas of darker	
37	Light as shape & form	Natural light manipulated to create form (e.g., light shaft)	
38	Spaciousness	Openness or large open space is often complemented with sheltered areas surrounding it	
39	Spatial variability	Changes of light, mass & scale such as ceiling heights, room widths, etc. for visual variety in the definition of the space (hopefully balanced with unity to create spatial harmony, see spatial harmony)	
40	Space as shape & form	Space that is manipulated into form or shape	
41	Spatial harmony	Harmony in a space is often seen in a unifying commonality among the varied light, mass & scale with a defined boundary	
42	Inside-outside spaces	Interior spaces that appear connected to the outside environment, like porches, foyers & interior gardens	
Place-Based Relationships- culture together with ecology, rooted in the local geography			
43	Geographic connection to place	Connection of the space to the geography of the site, offers familiarity (e.g., use of local features, siting of the room, selection of views, etc.)	X globe/maps
44	Historic connection to place	Relation to the past through the marking of the passage of time; linking the past to the present, fostering a culture's collective memory (e.g., historical images)	
45	Ecological connection to place	Connection to local, dominate ecological & biogeographical features of the region (e.g., mountains, deserts, rivers, oceans)	
46	Cultural connection to place	Integrated history, geography & ecology of an area (e.g., architectural heritage of a people, particularly its treasured and distinctive vernacular/local forms)	
47	Indigenous materials	Local or native materials	X turtle rocks

48	Landscape orientation & landscape features that define building form	The siting of the interior for biometeorological conditions like sunlight, wind direction, water drainage, etc. for integrating the building with the environment/ landscape that embellishes or defines the building or interior design and connects the interior to the exterior (e.g., Falling Water)			
Human-Nature Relationships- paired biological needs					
49	Prospect AND refuge	A place with the ability to survey the distance/ a view of the entire space with a place of protection/ separated from spaciousness			
50	Order AND complexity	A balance of structured organization with intricacy of detail that together appears orderly designs that meld order with complexity stimulate the desire for variety in a controlled manner			
51	Curiosity AND enticement	Spaces that elicit exploration, discovery, creativity or mystery			
52	Change AND metamorphosis	Present in growth, maturation & metamorphosis & seen when one form or state changes to another			
		Total score	1		
	Final comments/suggestions				

APPENDIX C

IRB APPROVAL

THE UNIVERSITY of NORTH CAROLINA
GREENSBORO

OFFICE OF RESEARCH INTEGRITY
2718 Beverly Cooper Moore and Irene Mitchell Moore
Humanities and Research Administration Bldg.
PO Box 26170
Greensboro, NC 27402-6170
336.256.0253
Web site: www.uncg.edu/ori
Federalwide Assurance (FWA) #218

To: Emily Miller
Interior Architecture
Interior Architecture

From: UNCG IRB

Authorized signature on behalf of IRB

Approval Date: 11/14/2017
Expiration Date of Approval: 11/13/2018

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)
Submission Type: Initial
Expedited Category: 7.Surveys/interviews/focus groups
Study #: 17-0165
Study Title: Implementing Biophilia in Elementary Schools

This submission has been approved by the IRB for the period indicated. It has been determined that the risk involved in this research is no more than minimal.

Study Description:

The study is an assessment of how biophilic design influences the awareness of nature in an educational environment. The purpose of this study is to understand if children are aware of natural systems when exposed to biophilic attributes in an elementary school classroom. The method used in this study will be a quasi-experiment design in which a pretest or baseline measurement will be taken. Following the implementation of the intervention, and re-administering the narrative as a posttest.

Study Regulatory and other findings:

- This research, which involves children, meets criteria at 45 CFR 46.404 (research involving no greater than minimal risk). Permission of one parent or guardian is sufficient.

Investigator's Responsibilities

Signed letters, along with stamped copies of consent forms and other recruitment materials will be scanned to you in a separate email. **Stamped consent forms must be used unless the IRB has given you approval to waive this requirement.** Please notify the ORI office immediately if you have an issue with the stamped consents forms.

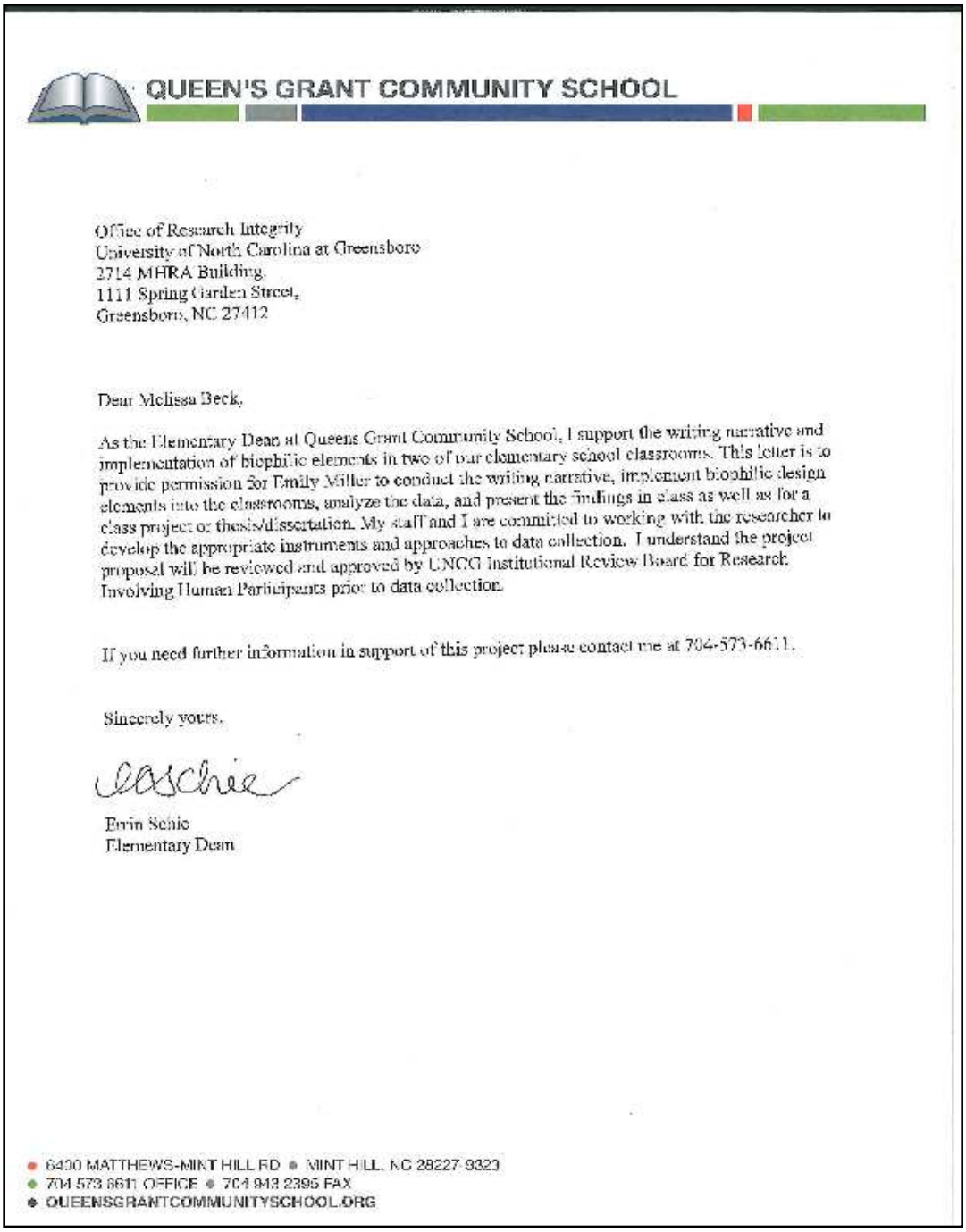
Please be aware that valid human subjects training and signed statements of confidentiality for all members of research team need to be kept on file with the lead investigator. Please note that you will also need to remain in compliance with the university "Access To and Retention of Research Data" Policy which can be found (http://policy.uncg.edu/university-policies/research_data/

CC:
Amanda Gale, Interior Architecture

Page 1 of 1

APPENDIX D

SCHOOL APPROVAL



QUEEN'S GRANT COMMUNITY SCHOOL

Office of Research Integrity
University of North Carolina at Greensboro
2714 MHRA Building
1111 Spring Garden Street,
Greensboro, NC 27412

Dear Melissa Beck,

As the Elementary Dean at Queens Grant Community School, I support the writing narrative and implementation of biophilic elements in two of our elementary school classrooms. This letter is to provide permission for Emily Miller to conduct the writing narrative, implement biophilic design elements into the classrooms, analyze the data, and present the findings in class as well as for a class project or thesis/dissertation. My staff and I are committed to working with the researcher to develop the appropriate instruments and approaches to data collection. I understand the project proposal will be reviewed and approved by UNCG Institutional Review Board for Research Involving Human Participants prior to data collection.

If you need further information in support of this project please contact me at 704-573-6611.

Sincerely yours,

Erin Schie
Elementary Dean

6400 MATTHEWS-MINT HILL RD • MINT HILL, NC 28227-9323
704 573 6611 OFFICE • 704 943 2395 FAX
QUEENSGRANTCOMMUNITYSCHOOL.ORG

APPENDIX E

CODING INSTRUCTIONS

1. Read through the biophilic design descriptions provided with these directions. Each biophilic attribute has a description provided with the corresponding attribute.

2. Look at each narrative, they are broken down into four sections each located in their own folder. Fourth-grade with 22 student narratives, fifth-grade core 1 with 25 student narratives, fifth-grade core 2 with 22 student narratives, ad fifth-grade core 3 with 15 student narratives.

3. Read through each narrative first just understand the story being told by each student.

4. Circle each of the attributes in the narrative that falls under the following categories listed below and on the excel sheet.

5. Count how many times the biophilic attribute is written in the narrative.

a. For example: if the student mentions an animal, it is considered animal in the biophilic attributes because it is literal. But if the student mentions a statue of an animal, it is a representation of an animal.

b. Another example would be if the student mentions a person specifically in their narrative, it would be counted as animal being a living being. But if the student mentions people or is general with a group, there would not be a biophilic attribute counted. Additional examples may include: “Camping” would not count as views and vistas unless it states that they are camping in nature with landscaping or natural views because it is an activity.

d. “Beach” would count as water, air and views because it is a natural exterior view. Beach would be considered water because it’s associated with water. Lastly, it would be air because of natural ventilation.

e. The context of each narrative is extremely important when figuring out if an attribute will count or not.

Color Any type of color

Water Any type of water

Air Natural ventilation, (e.g., operable windows, wind of any kind, and outdoor access)

Plants Actual plants in any form (alive or previously alive)

Animals Actual animals in any form (alive or previously alive)

Natural materials Not artificially made and coming from the environment (e.g., wood, stone, metal, and paper)

Animal Representations of animals (e.g., animal forms, claws, images, & heads) may be highly stylized

Natural light

Daylight/ sunlight access

Filtered & diffused light

Modulated daylight, to reduce glare (e.g., blinds & shades)

Light and shadow

Light & dark or shadowed spaces

Reflected light

Light reflecting off surfaces such as light-colored walls, ceilings & reflective bodies like water & shiny surfaces, may provide sparkle

Light pools - Pools of connected light in a series (may include shadow) on the floor or wall drawing you from one area to another

Warm light -Warm lighting: the warm glow, sunlight, or fire is often surrounded by areas of darker

Light as shape & form

Natural light manipulated to create form (e.g., light shaft

APPENDIX F

PARENTAL CONSENT FORMS

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

CONSENT FOR A MINOR TO ACT AS A HUMAN PARTICIPANT: LONG FORM

Project Title: **Implementing Biophilic Attributes in Elementary Schools**

Principal Investigator: Emily Miller

Participant's Name: _____

General information?
Your child is being asked to take part in a research study of an assessment of how biophilic design influences the awareness of nature in an educational environment. Your child's participation in the study is voluntary. You may choose for your child not to join, or you may withdraw your consent for him/her to be in the study, for any reason, without penalty. Biophilic design is incorporating natural elements and system in the interior environment to benefit the occupants of the environment. Biophilic design has positive impacts on patients in hospitals, however there is limited research in other interior environments. Nature has numerous amounts of benefits on children primarily during their developmental stages which happens to be elementary school. Nature can reduce stress and promote directed attention among other elements of promoting wellbeing.

Research studies are designed to obtain new knowledge. This new information may help people in the future. There may not be any direct benefit to your child for being in the research study. There also may be risks to being in research studies. If you choose for your child not to be in the study or you choose for your child to leave the study before it is done, it will not affect your relationship or your child's relationship with the researcher or the University of North Carolina at Greensboro.

Details about this study are discussed in this consent form. It is important that you understand this information so that you can make an informed choice about your child being in this research study.

You will be given a copy of this consent form. If you have any questions about this study at any time, you should ask the researchers named in this consent form. Their contact information is below.

What is the study about?
This is a research project. Your child's participation in this project is voluntary. The purpose of this study is to understand if children are aware of natural systems when exposed to biophilic attributes in an elementary school classroom. The research project is a narrative assignment

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given to the children in the classrooms twice. Immediately following the first narrative assignment in the two classrooms, biophilic attributes will be added to the environments. The biophilic elements will consist of water, plants, fish, natural materials, and natural colors. Light will be implemented in the space through blinds opened or partially opened, air will be implemented through operable windows, water through a small fish tank, plants through potted plants, animals through fish in the fish tanks, and both natural materials and colors, and naturalistic shapes and forms will be implemented in the space through shells and rocks in the fish tanks and terrariums. After four weeks of these attributes being implemented, the narrative assignment will be administered to the students for the second and final time.

Why are you asking my child?
Your child has been asked to participate because they are an elementary school student who spends five days a week in an educational environment.

What will you ask my child to do if I agree to let him or her be in the study?
If you agree to allow your child to participate in this research project, your child will be given the narrative assignment from their teacher at the beginning of the study and again at the end of the course of six weeks. The narrative will require the students to write a response to the questions: "Write about an experience you had with your family or friends. What did you see, feel, taste, hear, and smell?" Two classrooms from Queens Grant Charter School, have been asked to participate in the research project. The children is in the both classrooms, will interact with the implemented biophilic elements added to their classrooms. The only task your child will complete is the narrative twice during this research project. Emotional distress may occur due to the fact that any classroom assignment can be stressful to a student. However, the researcher has worked with the teachers of record to create the assignment so that it would fit the students' ability at their academic level. The assignment will be fit into the current curriculum and given the allotted amount of time that is necessary for the students' to complete the assignment. If your child does not participate in the study, they will work on another assignment given by the teacher.

What are the dangers to my child?
"The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants." There are no anticipated risks, emotional distress may occur due to the fact that any classroom assignment can be stressful to a student. However, the researcher has worked with the teachers of record to create the assignment so that it would fit the students' ability at their academic level. The assignment will be fit into the current curriculum and given the allotted amount of time that is necessary for the students' to complete the assignment. The students will not miss any class time for their participation in this study.

If you have questions, want more information or have suggestions, please contact Emily Miller who may be reached at (814) 771-6761 or emmille5@uncg.edu. My adviser for this research is Professor Amanda Gale, you can reach Prof. Gale at ajgale@uncg.edu.

If you have any concerns about your rights, how you are being treated, concerns or complaints about this project or benefits or risks associated with being in this study please contact the Office of Research Integrity at UNCG toll-free at (855)-251-2351.

Are there any benefits to society as a result of my child taking part in this research?
The benefit of this research project to society is the positive implications biophilic design may have on a classroom environment. This research may lead to the future design of classrooms and schools.

Are there any benefits to *my child* as a result of participation in this research study?
The wellbeing of your child may be improved through increased positive feelings. Your child may also have reduced stress and focus attention after exposure to these natural elements.

Will my child get paid for being in the study? Will it cost me anything for my kid to be in this study?
There are no costs to you or payments to you or your child as a result of participation in this study.

How will my child's information be kept confidential?
All information obtained in this study is strictly confidential unless disclosure is required by law. All of the data collected on the students will be anonymous, as all identifying information will be removed from the assignment narrative prior to receiving the assignment. The data obtained from this study will be stored on my computer which is password protected, it is also not left unattended unless in a secure location (locked office or home).

What if my child wants to leave the study or I want him/her to leave the study?
You have the right to refuse to allow your child to participate or to withdraw him or her at any time, without penalty. If your child does withdraw, it will not affect you or your child in any way. If you or your child chooses to withdraw, you may request that any data which has been collected be destroyed unless it is in a de-identifiable state. The investigators also have the right to stop your child's participation at any time. This could be because your child has had an unexpected reaction, has failed to follow instructions, or because the entire study has been stopped.

What about new information/changes in the study?
If significant new information relating to the study becomes available which may relate to your willingness allow your child to continue to participate, this information will be provided to you.

Voluntary Consent by Participant:
By signing this consent form, you are agreeing that you have read it or it has been read to you, you fully understand the contents of this document and consent to your child taking part in this study. All of your questions concerning this study have been answered. By signing this form, you are agreeing that you are the legal parent or guardian of the child who wishes to participate in this study described to you by Emily Miller.

_____ Date: _____
Participant's Parent/Legal Guardian's Signature

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APPENDIX G

STUDENT CONSENT FORMS

Study Title: **Implementing Biophilic Attributes in Elementary Schools**

My name is Emily Miller.

What is this about?
I would like to talk to you about adding Biophilic elements in elementary schools. I want to learn about your awareness of nature through biophilic design. Biophilic design is adding things you may see in nature into the classroom, like plants or animals.

Did my parents say it was ok?
Your parent(s) said it was okay for you to be in this study and have signed a form like this one

Why me?
We would like you to take part because you are an elementary school student who spends five days a week in a classroom.

What if I want to stop?
You do not have to say "yes", if you do not want to take part. We will not punish you if you say "no". Even if you say "yes" now and change your mind after you start doing this study, you can stop and no one will be mad at you.

What will I have to do?
You will be given a writing assignment and asked by your teacher to complete it in as much detail as you can. After it is finished, you will turn the assignment into your teacher. After six weeks, you will be given the same writing assignment and asked to complete this assignment again.

Will anything bad happen to me?
Nothing bad will happen to you.

Will anything good happen to me?
You may become less stressed and have positive feelings.

Do I get anything for being in this study?
You will not receive anything for participating in this study.

What if I have questions?
You are free to ask questions at any time.

If you understand this study and want to be in it, please write your name below.

_____ _____

Signature of child Date

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