ABSTRACT

MONSUR, MUNTAZAR. Does Childcare Architecture Matter? Investigating how Indoor-Outdoor Spatial Relations Influence Child Engagement and Teacher Motivation. (Under the direction of Robin C. Moore).

School/classroom architecture as a possible influence on children's learning is an emerging issue in the fields of design and education. Previous studies indicate that both indoor and outdoor environments can influence child and teacher behavior. However, very few, if any, empirical studies have investigated how the relationship between the indoor and the outdoor environment influences learning and motivation to teach. The purpose of this correlational study is to investigate the influence of specific architectural indoor-outdoor features of the classroom environment on teaching and learning behaviors. Data were gathered in 22 preschool classrooms with 26 teachers/caregivers and approximately 295 children in selected childcare centers in Wake County, North Carolina. Classroom-built environmental attributes were measured using validated rating scales. Both systematic observation and a questionnaire survey were employed to collect data concerning child engagement and teacher motivation. Classroom indoor-outdoor spatial relations were measured using four proposed new affordance scales: for doors, windows, views, and transitional spaces. Findings indicate that improved conditions of classroom indoor-outdoor relationships enhance both child engagement and teacher motivation, even after controlling for other significant environmental and demographic variables. Analysis using hierarchical multiple regression indicates window affordance and view affordance score as significant predictors that explain variation in teacher motivation. Teachers were likely to be more motivated in engaging children with hands-on lessons when scores associated with windows and views from the classrooms were higher. Increased window and view affordance scores were positively associated with the percentage of engaged children. Teachers were more likely to use natural elements to teach children in classrooms with higher qualities and quantities of windows and views. No substantial relationships were found for the other two indoor-outdoor hypothesized contributors: door and transitional space affordance. Study findings suggest that specific architectural attributes of preschool classrooms (windows and views) may support teacher motivation and child engagement in childcare settings. The findings may be used to influence childcare center building policy and design guidelines and to inform architects, educators, and policy makers.

Does Childcare Architecture Matter? Investigating how Indoor-Outdoor Spatial Relations Influence Child Engagement and Teacher Motivation

by
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DEDICATION

To my loving wife Rozalynne, without whose love, support and continued patience this work would not have been possible. Also, to my daughter Obarita — the source of all my joys and inspirations to work for a better environment for children all around.

BIOGRAPHY

Muntazar Monsur is an architect from Bangladesh who joined the PhD-Design program in NC State in August 2011. Besides his dissertation research, he also worked as a research assistant in the Natural Learning Initiative (NLI) at the College of Design. Muntazar has received numerous awards for his research work, including an EDRA Student Design Award (2014), second prize in the 9th Annual Graduate Research Symposium in NC State (2014) and EDRA Best Student Paper Award (2012). In NLI, he was involved in several nationally significant projects including the National Guidelines for Nature Play and Learning Places. Muntazar received both his bachelor's and master's degrees in architecture from the Department of Architecture at the Bangladesh University of Engineering and Technology (BUET), Dhaka, where he also worked as a lecturer from 2007 to 2011. He secured the highest grades in his undergraduate class, which earned him the Shamsunnahar Khanam Memorial Gold Medal in 2007 in BUET. Muntazar has also worked as an assistant architect in the Bureau of Research, Testing and Consultation (BRTC) in BUET from 2007 to 2011, where he was involved as a design team member in numerous architectural projects. He was an important member of the design team of the first earthquake simulation lab in Bangladesh. Muntazar is also a GIS enthusiast who has worked on and published GIS course contents for architectural education. He has presented his research projects in a number of conferences, including Environmental Design Research Association (EDRA) 45 in New Orleans (2014), Architectural Research Centers Consortium (ARCC) in Charlotte (2013), EDRA 43 in Seattle (2012). Muntazar was among only three nominees by the NC State University Graduate School who represented the school's excellence in research in the Graduate Education Day held in the NC General Assembly in 2014. Besides his research career, Muntazar is an accomplished musician who writes and tunes children's songs in Bangla. He is married to Rozalynne Samira, a current PhD candidate at the Department of Plant and Microbial Biology at NC State and father to a beautiful 4-year-old girl, Obarita.

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I would like to thank the NLI for the constant support and work opportunities, which helped me to continue my overseas education here in Raleigh. I would also thank all my wonderful colleagues in NLI for their help and cooperation in my NLI works. I am grateful to Dr. Jianxin Hu, Assistant Professor of Architecture here in NC State, for supporting the GSSP for my seventh and final semester in the program. I am especially grateful to Sarah Konardi for her tremendous help to the RISF project which supported my GSSP in Fall 2014.

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My artist parents, Professor Abul Monsur and artist Nazlee Laila Mansur, are a constant source of inspiration. They never stopped giving their love and support for my academic endeavors and helped me every day to reach this level of education.

Last but not least, this study was not possible without the countless sacrifices of my wife and best friend Rozalynne, who, despite her tremendous work load as a PhD candidate at the Department of Plant and Microbial Biology here in NC State, shared all the responsibilities and took care of me and my daughter throughout my research.

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Chapter 1 : Introduction

Throughout history, architecture has both accommodated and constrained behavior, and it is not surprising that considerable discussion of behavioral research for architectural design has occurred (Lang, 1974). Schools, including childcare environments, are among the four most important environmental settings in the lives of the children alongside home, neighborhood, and nature (Irwin & Joachim, 1978). How the architectural design of a school influences children's as well as teachers' behavioral outcome is an emerging issue both in the fields of design and environmental behavior research. However, very few studies have provided empirical evidence on the relationship between architectural variables and children's and teachers' behavior in childcare/preschool settings.

Since the early 1970s, with the growing amount of criticism and dissatisfaction with highly praised architectural projects, the need for undertaking research into the complex relationship between human behavior and the built environment has been evident in the field of design (Burnette, 1971). From the architects' position, that realization has generated a lot of concern, resulting in information produced by architects that is based on intuition rather than research and, therefore, lacks empirical grounds. Lang has labeled this phenomenon as architects being skeptical of "scientific optimism"(1974). When it comes to the point of design issues in childcare centers and preschools, it is a difficult to find research studies examining the impact of architectural variables on children's and teachers' behavior. The current study is centered on such issues of behavioral consequences of architectural design – investigating how indoor-outdoor spatial relations influence child engagement and teacher motivation in childcare settings.

1.1 Present Scenario of Childcare Environment

Over the last several decades, with an increasing number of families with working parents, the need for quality care for children under the age of 5 has become an extremely important issue in many parts of the world. In the U.S., nearly 11 million children under age 5 are in some type of childcare arrangement every week, which is more than 50% of the total population of children in that age range in the country (Laughlin, 2013). On average, children of working mothers spend 35 hours a week in childcare (Laughlin, 2010). For those children, undoubtedly, childcare settings are as important as their home environments. The quality of childcare has a lasting impact. A National

Institute of Child Health and Human Development (NICHD) report found that high-quality childcare leads to more positive outcomes even during the teenage years (CCAA, 2012). Higher quality care predicted higher cognitive–academic achievement at age 15, with escalating positive effects at higher levels of quality (Vandell, Belsky, Burchinal, Steinberg, & Vandergrift, 2010). Unless children gain minimal social competence by the age of six years, they have a high probability of being at risk throughout life (Denham & Burton, 1996). The *preschool age*, defined as the age range from 3 years to 5 years (GSA, 2003) is the time when children rapidly develop their language and communication skills through sensory and motor activities with peers and adults. During these years, children assimilate environmental experiences and information, which enhances their cognitive abilities (McDevitt & Ormrod, 2002). Unfortunately, an inadequate number of exemplifying research studies is available that could contribute to the improvement of environments that are so crucial for children.

Quality childcare environments are also important for teachers and caregivers, and are not just for children. The number of teachers and caregivers who work in center-based settings in the United States is more than one million (Brandon, Stutman, & Maroto, 2011). It can be said without a doubt that any research investigating childcare architecture and its impact on children and teachers' behavior may benefit a significant proportion of the population.

1.2 Lack of Research on 'Where' Education Occurs

Eberhard (2009) stated that since changes in the environment change the brain, consequently, changes in the environment change our behavior. Therefore, it is possible to argue that architectural design can change our brain and behavior. It is understandable that architecture contributes to the learning experience of young children and it can contribute to positive learning outcomes as well. Unfortunately, educational research has focused on what is taught and how it is taught. According to Sanoff (2009), what has received too little attention is the physical environment in which education occurs. Childhood, play, learning, teaching and designed environments are all interrelated concerns. Early childhood institutions are much more than just institutions for education and care. Children spend most of their waking hours in such environments (Goelman & Jacobs, 1994) and that reason should, in itself, prompt investigation into the impact the designed physical environment has on them (Martin, 2006). An early childhood institution like a preschool or a childcare center carries high significance for healthy development because it is usually here where children are introduced to the outside world. As a starting point, childcare settings provide an important domain for research on physical environments' influence on children's learning behavior as well as teacher motivation. In the Bio-Ecological Model as proposed by the eminent child psychologist Urie Bronfenbrenner (2009), an early childhood institution would represent a *Micro-System* that contains the developing child that has a direct influence on the child. Failure to realize the importance of childcare settings as the earliest learning institutions in the lives of many children would prolong the gap that exists between education and built-environment research. Like the contemporary practices in healthcare design (Zimring et al., 2008), education should also promote evidence-based design by emphasizing credible research findings to guide and influence design processes of childcare centers, schools and colleges.

1.3 Why Indoor-Outdoor Space?

In this study, indoor-outdoor relationship is defined as the degree by which the indoor classroom environment is visually and physically connected to the outdoor (or vice versa). It denotes the level of visibility and accessibility of the outdoor environment from the indoor classroom. The question worth asking is: why is it important to study indoor-outdoor spaces when there are so many different aspects of the architectural design of a childcare setting?

Here, we turn to Maria Montessori, who inspired present study with her visionary interest in connecting indoor classroom activities to the outdoor (Moore & Cosco, 2007). The legendary physician and educator, best known for her philosophy of education which now bears her name had always advocated the potential to involve the outdoors in order to enrich the learning experiences of the indoors. In the historical photo below (Figure 1-1), taken almost 75 years ago (1939), Maria Montessori is seen teaching a group of four-year-old children during her exile to India (photo courtesy: *The Hindu*, February 1, 2010). Her deliberate choice of the classroom space, the open verandah of the Olcott's bungalow, expresses her inclination for rich indoor-outdoor spatial relations for a learning environment. Her visions were further supported by other eminent educators and experts as well (Moore & Cosco, 2007; Olds, 2001), who address the numerous potential benefits of indoor-outdoor relations for early childhood education.

Figure 1-1: Maria Montessori with children at Olcott's bungalow (*The Hindu,* 2010)

Furthermore, contemporary theories on environment-behavior relations indirectly support the need to investigate the role of indoor-outdoor spaces in preschool classrooms. The "biophilia hypothesis" posits that humans have an innate affinity toward life and life-supporting environments (Wilson, 1984). Child advocacy expert Richard Louv, in his influential work about the divide between children and the nature, discussed the lack of nature in the lives of today's wired generation. He calls it "nature deficit disorder"—and he points to it as a cause of some of the most disturbing childhood trends, such as the rises in obesity, attention disorders, and depression (Louv, 2008). Indoor-outdoor relationship is an efficient way to increase interactions with nature when children and teachers are in an enclosed classroom environment. The merit of such indoor-outdoor relations should be subjected to serious empirical research because it is the key to increase the amount of *naturalness* inside a classroom.

For example, having visual access to nature is known to be beneficial across a wide range of contexts (Benfield, Rainbolt, Bell, & Donovan, 2013). Research supports the benefits of window views and natural features for patients' recovery, productivity in office spaces, residential satisfaction, and children's self-discipline. Similar studies (Heschong, 2003; Matsuoka, 2010; Tanner, 2009) in classrooms and other educational settings have investigated the associations between window views and academic performance; however, such studies are rare for early childhood institutions.

Numerous research studies have found associations between daylight and adults' productivity, comfort and satisfactions (Dasgupta, 2003). But studies investigating daylight impact on children's educational environment are few. And when it comes to preschool age children, daylight literature is even more limited and scarce. A direct consequence of indoor-outdoor spatial relationship is the amount and quality of daylight.

1.4 Purpose

The study aims to uncover the mechanism by which indoor-outdoor relationships of space in a preschool classroom influences child engagement and teacher motivation. The purpose of this research is to provide empirical evidence to support the theory that early childhood learning environments can benefit from indoor-outdoor relationship of space with increased levels of child engagement and teaching motivation. It is expected that findings of this research will guide design decisions, not only for the architect/designer, but for teachers, educators, childcare regulators and policy makers.

1.5 Significance of the Study

The study makes significant contribution to several areas.

1.5.1 Contribution to Environment-Behavior Research

Key findings of the study are consistent with the theory of environment-behavior research. They support the argument that built-environment variables (indoor-outdoor spatial relations in a preschool classroom) may be associated and influence human behavior (child engagement and teacher motivations). There is a growing knowledge base on the relationship between specific built-environment variables and human behavior. However, research looking into the school environment and children's behavior is rare (Martin, 2006). Conventional studies on motivation for teachers also focus on social, behavioral, educational or interactional processes (Alam & Farid, 2011; Bishay, 1996); physical or built environments are largely neglected. This research aims to address this gap in the realm of environment-behavior research between designed environment and learning/teaching behavior.

1.5.2 Methodological Innovation

The study provides a systematic way of measuring indoor-outdoor spatial relationship in preschool classroom environments. Although established scales are available to measure indoor learning environments, like the ECERS-R (Harms, Clifford, & Cryer, 2005), and outdoor environments, such as the POEMS (DeBord, Hestenes, Moore, Cosco, & McGinnis, 2005) for preschool and childcare settings, no scale exists that can rate the degree of indoor-outdoor relationship of space and all pertinent variables. This study, based on evidence from several previous studies (DeBord et al., 2005; Heschong, 2003; Matsuoka, 2010; Olds, 2001; Tanner, 2009), proposes a set of four measurement scales to rate the quantities and learning affordances of indoor-outdoor spatial relationships – doors, windows, views and transitional spaces. The proposed scales are validated by daylight measurement (Day Light Factor) in the 22 sample classrooms. The study is also innovative in its approach to measuring child engagement and teaching motivation. The complexity of these behavioral notions in a classroom environment was addressed by establishing multiple constructs of both child engagement and teacher motivation. Child engagement was defined with both positive (collective engagement level, percentage of engaged children) and negative (percentage of distracted children, number of behavioral guidance directives by teachers) indicators. Teaching motivation was realized in terms of both researcher-observed and teacher-reported evidences of hands-on lessons. Both observational and survey data were collected to objectively measure the dependent variables. Using both observational and questionnaire data increased the validity and reliability of the indicator measurements of teaching motivation.

1.5.3 Comprehensive View of an Educational Setting

The intent of this study is to provide a comprehensive view of the learning environment by taking both children and teacher variables into account. Research studies looking into either child or teacher behavior may not delineate a complete picture. To understand how a built-environment influences learning, it is essential to investigate mechanisms at both ends – teaching and learning;

children and teachers. Teaching and learning are two simultaneous inter-related processes in a classroom. The role of indoor-outdoor spatial relations in a learning environment is best explained by investigating how it influences child engagement and teacher motivation. For example, a teacher may use a view through a window to help children increase their vocabulary, such as color words, movement words, parts of the body words, etc. In return, children have an opportunity to be *engaged* in stimulating, active learning. Addressing both variables may add to the predictive power of the study in explaining the contributions of indoor-outdoor spatial relationships to learning engagement and teacher motivation.

1.5.4 Exploring the Pedagogy of Architecture

In eighteenth- and early nineteenth-century Europe, gardens and architecture were understood as important instruments in pedagogical theory and practice, and were often deployed as primary instruments in the education of young children (Diana, 2012). The present research resuscitates the trend by finding out the pedagogical values of certain architectural elements like doors, windows, views, and transitional spaces. A hope for the study findings is to establish a direct link between these elements and learning affordances in a preschool classroom, showing pathways of further research on the pedagogy of architecture. The methodology used here may apply in the future to similar investigations in other educational environments like schools, colleges and universities.

1.5.5 Direct Design Implications from Empirical Research Findings

A further aim of the study is to interpret and guide design. It explains statistically how specific design characteristics of doors, windows, views and transitional spaces may motivate children's learning engagement and teacher motivation. Unlike intuition, statistical findings will establish more credible information about the possible relations between architectural design and educational activities in preschool classrooms. The research does not draw its conclusion on the statistical evidence; rather, the findings are translated into a model classroom design, which depicts zoning principles and detailed design guidelines to maximize the effects of indoor-outdoor spatial relations on teaching and learning affordances. Also, the scales mentioned earlier to systematically measure indoor-outdoor spatial relations have potential in both fields of design and research.

Chapter 2 : Literature Review

The aim of a literature review is to provide a process for the problem statement and to inform every phase of the research (Groat & Wang, 2001). This chapter attempts to address the body of existing information in a wide variety of disciplines, which has conceptual relevance for this particular topic of inquiry: how indoor-outdoor spatial relations influence child engagement and teacher motivation. Objectives of the literature review are threefold (Figure 2-1) – 1) define the specific topic of inquiry, 2) locate the topic of interest in a larger domain of relevant research, and 3) explore plausible mechanisms to execute the research and define a direction for the conceptual framework and methodology of the study.

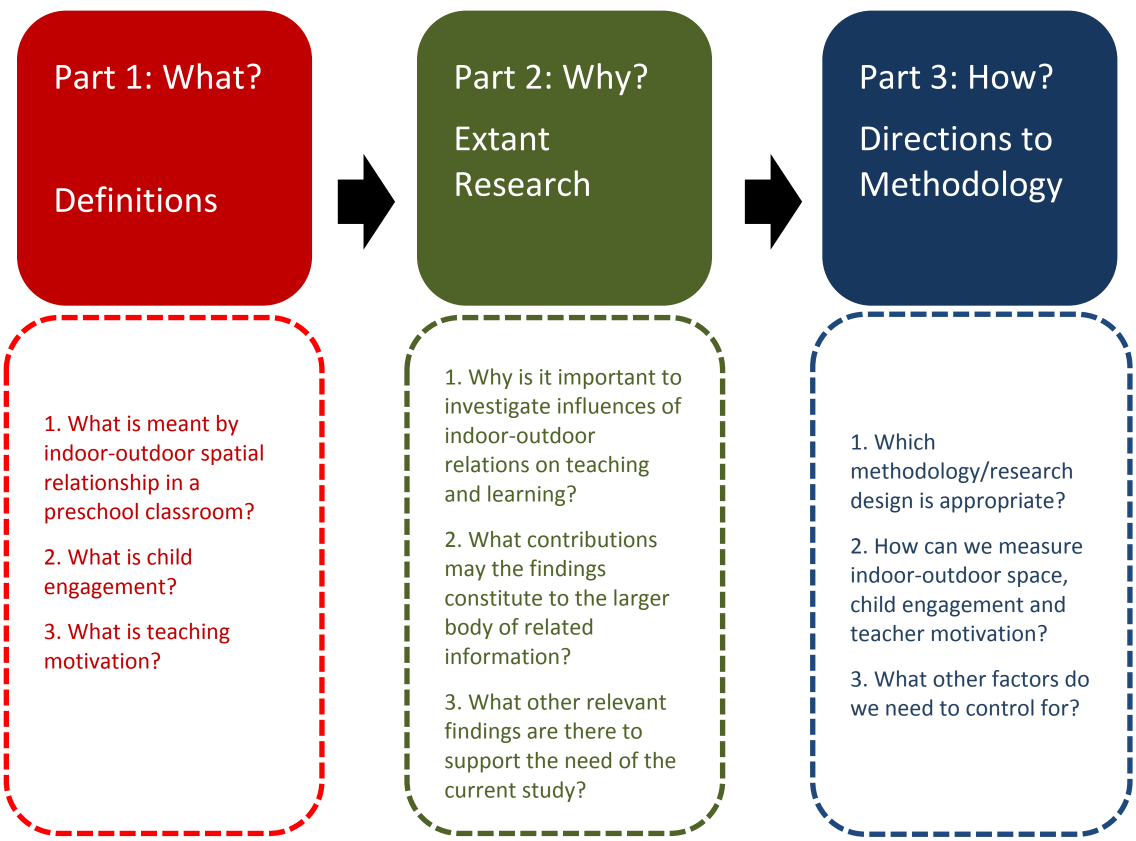


Figure 2-1: Aims of literature review

Figure 2-2 explains the step-by-step arrangement of the literature review chapter

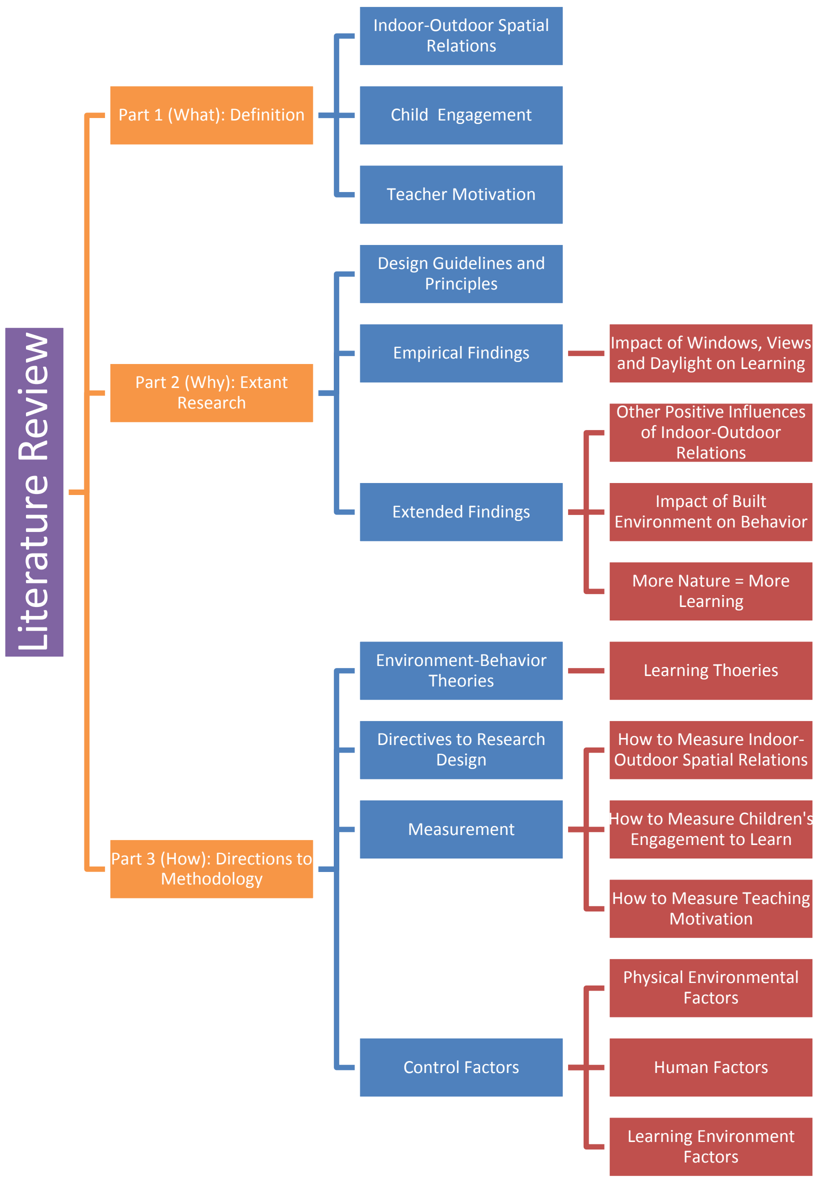


Figure 2-2: Literature review branching

The first part looks into different literature sources to find an appropriate definition for indoor-outdoor spatial relations to provide understanding about this specific architectural characteristic of a preschool classroom design in the context of teaching and learning. This part also explores relevant literature on child engagement and teacher motivation. The second part consists of three sub-sections that elaborately discuss previous literature on the relevant topic and attempt to find this research's place in the broad spectrum of past studies. The three sub-sections summarize three groups of literature that address the effect of indoor-outdoor spaces on teaching and learning behavior in the preschool classroom environment.

To assist in developing conceptual framework and methodology, the third and final part discusses different models and inherent methodological perspectives that can guide the present study.

2.1 Part 1: Definitions

This part defines the variables of this research. The independent variable is the indoor-outdoor relationship of space in preschool classrooms. Dependent (outcome) variables are child engagement and teacher s' teaching motivation. The study focuses on how the independent variable influences the behavioral outcomes. Before proceeding to why this research is necessary to explore this relationship, it is important to define the predictor(s) and the outcome measures of this research.

2.1.1 What is Indoor-Outdoor Relationship of Space in a Preschool Classroom?

To define indoor-outdoor relations in a preschool classroom, first the study needs to look into the definition of the classroom itself. A preschool classroom is an architecturally defined area that hosts a group of preschool age children (mostly 3 to 5 years of age) and their teacher(s) (GSA, 2003). The classrooms for this age group are supposed to be as open as possible, allowing supervision and the penetration of natural light. The classroom contains the required spaces for all recommended activities, as well as spaces for personal care. It should be flexible enough to support variable demographics of the clientele as well as to allow program adjustments to serve fluctuating demand for childcare services.

A primary literature source for understanding the meaning of indoor-outdoor spatial relations in the context of preschool classroom is Olds's (2001) *Childcare Design Guide*. For Olds, indoor-outdoor relationships of space from children's and teachers' points of view is all about accessibility and continuation and it emphasizes creating direct access from each group room to an outdoor play area. She also mentions that usable transitional space should be sufficiently deep (no less than 6 feet) and be shaded. Olds's discussion of indoor-outdoor connection mainly emphasizes the spatial relationships. However, several studies (Benfield et al., 2013; Matsuoka, 2010) provided empirical proof that *visual access (view)* between indoors and outdoors is also important in terms of learning behavior and performance (see 2.2.2). Although Olds's definition is limited to physical access between indoor and outdoor, it points out successful key architectural elements that are measured and investigated in this research.

The study focuses on a specific architectural phenomenon – indoor-outdoor spatial relations in a preschool classroom. Surprisingly, an elaborate literature search has returned only a few results. Few writings were found that had actually discussed the architectural aspects of indoor-outdoor relationship of space. Rainey (1988) defined indoor-outdoor relationships as the ways architecture meets surrounding landscape. A given landscape confronts the designer with a vast array of constraints and opportunities that must be addressed with clarity and decisiveness if architectural work is to respond successfully to basic human needs. According to Rainey, the history of architecture and landscape architecture reveals three modes of relationship between architecture and landscape: *contrast, merge, and reciprocity*. *Contrast* juxtaposes architecture with the natural and cultural landscape. A building's scale and profile provide a powerful counterpoint to its immediate setting. *Merger,* the polar opposite of contrast, describes when a building is made to appear as an integral part of its natural and cultural landscape. *Reciprocity* is the most frequently employed of the three strategies in which building and landscape modify and shape one another. This hypothetical classification is helpful to comprehend the complexity of architecture-landscape interrelations; however, Rainey's definition and classifications are limited in the sense that they do not provide scientific measures of such indoor-outdoor spatial relationships.

Based on the above discussion, the current study defines indoor-outdoor spatial relations as the combination of physical (e.g., exterior doors, transitional spaces) and visual (e.g., windows, views, skylights) access between enclosed indoor classroom environment and the immediate surrounding outdoor environment (landscape) of that classroom. Here, all mentioned architectural elements must connect the indoor environment to the outdoors – physically and/or visually. For example, doors which open directly to the outside would only be considered for this definition. Interior doors connecting the classroom with other interior spaces (e.g., lobby, other classrooms, etc.) are not included as indoor-outdoor elements. The same criterion applies for windows as well.

2.1.2 Defining Child Engagement and Teacher Motivation

Teaching and learning are two central activities in a classroom. The quality of a classroom is governed by the qualities of teaching and learning activities by the children and their teachers. The National Research Council, in its compilation report titled *Early Childhood Assessment: Why, What and How*, has included motivation (approach toward learning) as one of the five most important domains of child assessment (NRC, 2008). Children's active interest and their engagement in learning is defined as *learning motivation and concentration* (Walsh & Gardner, 2005).Therefore, to understand how specific architectural characteristics influence the learning environment, the research attempts to measure their impacts on learning and teaching motivations.

Teaching and learning are two simultaneous and complementary phenomena within a classroom environment. They are interrelated concerns and one cannot be defined completely without the other. To define children's and teachers' learning behavioral outcomes in a preschool classroom, the researcher revisited the theories of motivation by Ryan & Deci (2000). Regarding children's motivation to learn, the authors talked about two distinct types of motivation. *Intrinsically* motivated behaviors are engagement for the pleasure or the satisfaction derived from performing them (for example, when a child is exploring an object out of curiosity). On the other hand, *extrinsically* motivated behaviors are instrumental in nature. In other words, behaviors are not performed for the activity itself but rather as a means to an end (e.g., when children are involved in activities as per their teachers' directions). Since intrinsically motivated activity is more rewarding in and of itself (by definition), children learn more from this sort of activity, and they retain that knowledge better. Intrinsically motivated children are more involved in their own learning and development. In other words, a child is more likely to learn and retain information when he is intrinsically motivated – rather than extrinsically engaged in some activities because adults tell him to, or in an effort to please another party. When a child is extrinsically motivated, the reward comes from outside the child, it has to be provided by someone else, and it has to be continually given for the child to remain motivated enough to continue the activity (Ryan & Deci, 2000). Motivation in learning leads to persistence — the ability to stay within a task for a reasonably long period of time. While young children cannot concentrate on one activity for long periods of time, there are still measurable differences in the length of time that young children will engage in an activity (NASP, 2003). A highly motivated child will stay involved for a long period of time, whereas an unmotivated child will give up easily (Brophy, 2013). From the above discussion, this study assumes that child engagement is equivalent to children's learning behavior and it is an indicator of the learning environmental quality of a preschool classroom environment. Child engagement is defined as a linear consequence of learning motivation and learning persistence.

Active-learning techniques have emerged as strategies for instructors to promote engagement with both discipline material and learning. The advantages of active learning are widely documented. Integrating active learning strategies into the classroom results in an effective model of teaching because active learning promotes the application of material while it is still being presented (Van Amburgh, Devlin, Kirwin, & Qualters, 2007). Active-learning techniques engage students more deeply in the process of learning course material by encouraging critical thinking and fostering the development of self-directed learning. Preschool age children (3-5 years) are at their preoperational stage of cognitive development (Piaget, 1965). Active learning techniques are particularly important at this stage of development (e.g., children learn better through hands-on activities rather than by listening to explanations from the teacher).

In light of the discussion above, this study defined child engagement as the quality, quantity and duration of self-regulated or active learning behaviors observed among the children in a particular classroom. This definition was later used to develop the measurements of different indicators of child engagement as an outcome variable of the study.

Since this study has defined child engagement as the indicator of learning behavior, teaching motivation can be defined by teachers' enthusiasm to engage and promote children in such activities. For teachers in a classroom, motivation is defined as a process to direct student's behaviors (Ayvacı & Devecioğlu, 2010). The teacher should meet students' needs and abilities, motivate them, reinforce their successful behaviors and prepare a learning environment that helps students reach developmental goals. One study mentions three dimensions of teaching motivation — *warmth/responsivity, control/discipline*, and *time spent on academic activities* (McDonald Connor, Son, Hindman, & Morrison, 2005). Arranging the classroom and preparing the learning environment are important elements to enhance the teaching-learning process (Standing & Havis, 1998). An effectively prepared learning environment enables meaningful and consistent learning. Preschool students are especially curious about their environment and eager to learn from their surroundings (Gibson & Pick, 2000). They want to explore the events around them. For this reason, teachers are responsible for designing learning enhanced environments, including rich stimulants to stimulate students to reach their potential (Ayvacı & Devecioğlu, 2010).

On a different note, Sylvia & Hutchinson (1985) defined teacher motivation as the freedom to try new ideas. Based on the above discussion and for the purpose of this investigation, this study defined teaching motivation as teachers' enthusiasm and innovative practices to engage children in active/hands-on learning, arranging classrooms, and preparing new/creative lessons to facilitate children's learning.

2.2 Part 2: Extant Research

The three bodies of literature discussed in this section are: 1) Design guidelines and principles, 2) Empirical research in the relevant fields and 3) Extent research. The first sub-section (2.1.1) examines clues into existing design guidelines for childcare centers to investigate whether they have identified any emphasis on indoor-outdoor spatial relations. Three design guides are thoroughly investigated. This sub-section also summarizes thoughts of prominent scholars and educators in the fields of child development and design relevant to the problem this study addresses.

2.2.1 Design Guidelines and Principles

Perhaps the boldest statement on the importance of architecture in early childhood learning and teaching is Olds's well-known *Childcare Design Guide* (Olds, 2001), in which she offers specific instructions for providing strong relationships between indoor and outdoor spaces in childcare centers. Her ideas have been incorporated in *Childcare Center Design* Guide by the U. S. General Service Administration (GSA). They also provide guidance for creating stronger bonds between indoor-outdoor spaces in childcare centers by providing well-designed transitional spaces (GSA, 2003).

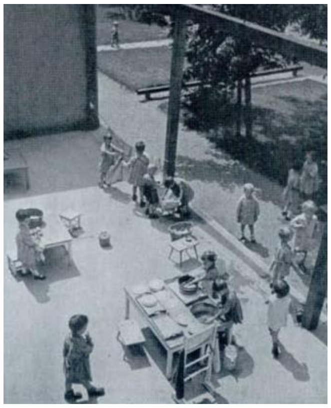


Figure 2-3: Early examples of Montessori school

Figure 2-4: Anita Rui Olds's transitional space

Additionally, the design guidelines by Moore and Goltsman (1992) for promoting children's play recommended a variety of transitions between buildings and the outdoors for preschool classrooms. Educators, at different times, have emphasized the need of indoor-outdoor spatial relations in the learning experience of young children. Moore and Cosco (2007), in their design approach undertaken for naturalizing the Montessori school grounds, mentioned the visionary interest of Maria Montessori, the legendary physician and educator, best known for the philosophy of education which bears her name (Montessori Education, http://www.montessori-namta.org/About-Montessori). Design of early examples of Montessori schools bears signs of that vision for using transition spaces for special activities connecting classrooms to the outdoors (Figure 2-3). A transition space bears the spatial relationship between indoor environment and outdoor environment (Figure 2-4). This is, perhaps, the earliest attempt of a reformist to incorporate indoor-outdoor spatial connections as an important aspect of design for motivating play and learning among young children. Moore and Cosco has further elaborated on the value of indoor-outdoor transitions of space and mentioned that where classrooms meet the outdoors are crucial areas which demand designers' intervention. Such a space can be utilized for various learning activities year-round. For example, indoor plants and seedlings can be planted and flourish indoors for later outdoor planting. The authors also mentioned architects' reluctance regarding the design of appropriate indoor-outdoor spaces. They recognized this deficiency as a lack of collaboration between architects, landscape architects and teachers. Frost and colleagues (Frost, Wortham, &

Reifel, 2001) also gave importance to this indoor-outdoor relationship, mentioning that the best play and learning places for children flow between the indoor and the outdoor settings. The authors also emphasize the need for more research studies to explore the relationship between transitional space and children's activities. Viewpoints of architects or designers are worth sharing as well. Dudek's *Children's Spaces* (Dudek, 2005) is a useful collection focused on design for children, emphasizing schools and schoolyards but including playgrounds, gardens, communities, and digital landscapes. It examines connections between design and children's learning, advocating that children are competent, creative, and need opportunities to express their environmental needs. Architect Prue Chiles shared her experience of design and gave insightful comments on the importance of the inside-outside relationship of classrooms (Chiles, 2005). She mentioned classrooms as evolving landscapes in her design and gave design directions for relating the indoor classrooms to the outdoor classrooms. Although these fragmented clues lack empirical evidence, they are surprisingly unanimous in their claim that an indoor-outdoor spatial relationship is crucial for learning and development.

2.2.2 Empirical Findings: Impact of Indoor-Outdoor Relations in Learning

Surprisingly, schools and other educational settings have often opted for windowless designs with minimal indoor-outdoor relations. Originally proposed as a means for reducing outside noise, distraction, and heating/cooling costs, while increasing space for bulletin boards and bookcases, the windowless classroom is a common design feature in schools (Edwards & Torcellini, 2002). No similar study was found which investigated such windowless design practices for childcare settings and preschool classrooms. Indeed, it is difficult to find empirical research which emphasizes the influence of indoor-outdoor relationships of space on preschool age children's and their teachers' practices. However, a number of studies highlight the importance of windows, views and daylight for better performance in different learning environments. According to the definition in 2.1, both windows and views are determinant design aspects that define the level of indoor-outdoor relations in a classroom, and daylight is a direct consequence of indoor-outdoor spatial relations. Therefore, it is important to look into research studies which provided findings supporting the importance of windows, views and daylight – in other words, indoor-outdoor spatial relations.

Perhaps the two most significant studies in the related fields focusing on the effects of natural light and window views showed that elementary school students in classrooms with larger window areas scored higher in mathematics and reading when compared with those in classrooms with smaller windows and less access to light (Heschong, 2003; Heschong et al., 1999). Those effects were shown even after controlling for factors such as grade level, size of school, and student absences. The latter study, conducted with over 8,000 third to sixth grade students in 450 classrooms in California found a positive relationship between elementary students' test improvement and the presence of daylight in their classrooms. This research provides important information regarding variable definitions, methodology, and measurement techniques. Statistical models were used to examine the relationship between elementary students' test improvement and the presence of daylight in their classrooms, while controlling for traditional education explanatory variables, such as student and teacher demographic characteristics. The study also utilized on-site observations of classrooms and surveys of teachers to provide additional insight into comfort conditions. The study provided empirical evidence that various window characteristics of classrooms had more explanatory power in clarifying variation in student performance, as opposed to more traditional educational metrics such as teacher characteristics, number of computers, or attendance rates. Although it did not look into the indoor-outdoor relationship as a combined phenomenon, many of the independent variables (i.e., window properties, views) were components of the indoor-outdoor relationship as defined by the study reported here. The Heschong (2003) study provides strong empirical evidence that indoor-outdoor spatial relationships contribute to elementary school students' academic outcomes.

A recent study by (Benfield et al., 2013) examined differences across multiple sections of a college writing course in two types of identically designed classrooms—those with a view of a natural setting and those with a view of a concrete retaining wall (Figure 2-5). Results show that students in the natural view classrooms rated the course more positively. Students in the natural view condition also had higher end-of-semester grades. This study provided particular methodological insight and it is among few studies that adopted a natural experimental design.

Figure 2-5: Natural view classrooms had higher end-of-semester grades (Benfield et. al, 2013)

Another study showed that for high school students, views with greater quantities of trees and shrubs from classroom windows were associated with positive academic performance (Matsuoka, 2010). This study revealed findings regarding the influence of indoor-outdoor relationships. Classroom windows were found to be positively associated with standardized test scores, graduation rates, percentages of students planning to attend a four-year college, and fewer occurrences of criminal behavior. In addition, large expanses of landscape lacking natural features were found to be negatively related to these same test scores and college plans. In a similar study, Tanner (2009) found that by rating aspects of classroom circulation, daylighting, and window view separately, using 10-point scales and then assigning a total score to the school using a composite of those ratings, significant variability in standardized test scores could be accounted for by these environmental ratings. Related to window views, more positive scores on vocabulary, language arts, and mathematics were predicted by higher ratings of the types of view present (e.g., larger windows or natural views). Additional research shows that natural views are subjectively important to students and teachers. For instance, Karmel (1965) showed that high school students in windowless classrooms, when asked to draw a picture of the school, were more likely to draw windows when compared with those in classrooms with windows. Likewise, Gulwadi (2006) found that elementary school teachers spontaneously seek out natural, restorative settings during breaks and downtime as a way of coping with stress and daily events. The study by Tanner (2009) reported that when a student needed to take a break from learning, it was easier to get back on track after taking a quick look outside at a pleasant view than after doodling on paper. Tanner (2009) also qualified these views and indicated that not all views were beneficial. He differentiated those views, indicating that while a view of a wall or parking lot was not desirable, *unrestricted views of nature, wildlife* and *human activity areas* may provide students and teachers with a needed *quicker* mental break. A two-year study by Hathaway et al. (1992) examined the effects of different lighting systems on the performance of elementary school children. Simulated natural daylighting replicated full spectrum lighting. The study on fourth grade students concluded that full spectrum lighting, similar to natural lighting, produced positive effects. The students had better attendance, increased academic achievement, and better growth and development than students using classrooms with conventional light. In contrast, negative consequences of a windowless classroom were found in a study by Küller and Lindsten (1992). About 90 children situated in four classrooms differing in respect to access to natural daylight and artificial fluorescent light were investigated for one school year. Results indicate that windowless classrooms were not only associated with decreased academic performance; they also caused severe health consequences such as hormonal imbalance and lower annual body growth. The study concluded that permanent windowless classrooms should be avoided.

While contradictory studies with opposite findings are rare, one study suggests a negative impact on learning due to distractions from a window (Veltri, Banning, & Davies, 2006). Another study (Larson, 1965) found no effect of a windowless classroom on kindergarten to third grade in the children studied. This experimental study exposed children to three settings: a year in existing fenestrated classrooms, a year with all windows removed in the test school and one-half year with the windows restored in the control school.

In summary, most of the literature which found association between indoor-outdoor variables and children's learning outcomes focuses on primary and secondary schools (Hathaway, 1992; Heschong, 2003; Heschong et al., 1999; Tanner, 2009). Two studies looked into high school students' academic outcome (Karmel, 1965; Matsuoka, 2010). Some of the studies were conducted with college students (Benfield et al., 2013; Slopack, 2011). Although the information generated from these studies is valuable, it cannot be generalized to a preschool classroom environment, where children are in critical developmental stages.

2.2.3 Extended Findings: Related Studies that Support the Need for this Research

This sub-section talks about related research findings that indirectly emphasize the importance of beneficial indoor-outdoor space relationships. For example, several studies have linked visual access to the outdoors and daylight conditions to health and well-being (Devlin & Arneill, 2003; Ulrich, 1984; Walch et al., 2005). A number of studies cited in this section show that built environment characteristics influence student and teachers' behaviors and learning activities. These studies looked into architectural variables like classroom size, design, indoor and outdoor environment – which indirectly emphasized the need of a similar study on the impact of indoor-outdoor spatial relations as a specific built-environment characteristic. Growing number of studies have supported the benefits of bringing nature into the learning processes of young children. Indoor-outdoor spatial relations is the main way of bringing nature to indoor classroom environments and these studies also support the need of the present study.

2.2.3.1 Other Positive Influences of Windows, Views and Daylight

Having visual access to nature is known to be beneficial across a wide range of contexts. Two studies have given evidence (Taylor, 2002; Wells, 2000) that views of nature contribute to self-discipline of adolescent girls and cognitive functioning of children. Though relatively small in number, all of these studies demanded further investigation on how indoor-outdoor relationships of space may influence children's behavior in a preschool environment. The first study investigated the role of near-home nature on three forms of self-discipline among children (Taylor, 2002). The aim to the research was to provide empirical evidence of the power of nature for *attention restoration*. The sample of the study was composed of 169 inner-city children randomly assigned to 12 architecturally identical high-rise buildings with varying levels of nearby nature. The results showed that the more natural a girl's view from home was, the better her performance scored in the tests of self-discipline. The second study (Wells, 2000) showed that children who relocated to homes that improved the most in terms of surrounding naturalness tended to have the highest levels of cognitive functioning. The study had a small sample size (N = 17) and the author admitted that since the study was longitudinal (same group of children), the role of naturalness/greenness on cognitive functioning might have been temporary.

A direct consequence of adequate indoor-outdoor relationship is the amount of daylight. Appropriate daylight condition has been found to be associated with less stress and discomfort (Cuttle, 1983), productivity and improvement in job performances (Abdou, 1997; Hedge, 1994), and also mood and satisfaction (Dasgupta, 2003) in adults. Kaplan (1993) reported two separate studies on the presence versus absence of natural window views. In the first case, workers with natural views reported fewer common health ailments in the preceding six-month period and higher job satisfaction. In the second study, natural views were related to increased feelings of privacy and satisfaction; natural views were also associated with lower frustration and increased patience and task enthusiasm. In a similar line of research, having a view of forested settings was related to greater job satisfaction and lower stress in a South Korean sample (Sop Shin, 2007). Research in the area of healthcare and physical well-being has shown that window views can influence health outcomes (Devlin & Arneill, 2003). Seminal work by Ulrich (1984) showed that patients recovering from gall bladder surgery who had views of trees recovered from surgery significantly faster, had fewer negative interactions with nursing staff, and used fewer analgesic medications when compared with those recovering in rooms with a less scenic brick wall window view. The presence of natural light, which is facilitated by the presence of windows, has also been shown to aid in recovery following spinal surgery (Walch et al., 2005). It was also shown that nature views promoted residential satisfaction and overall resident well-being (R. Kaplan, 2001). Most of these studies were conducted in different work environments such as office spaces, residences or hospitals; but findings indicate that similar positive effects of daylight are also likely to motivate teachers and children in preschool classroom environments.

2.2.3.2 Impact of Built Environment on Learning Behavior

There is a complex relationship between the physical structure and arrangement of classrooms, the teachers' practices, students' needs, and the distribution of space (Rivlin & Rothenberg, 1976). Few studies have examined the role of indoor architectural characteristics on children's and teachers' behavior. Sandra Home Martin's literature review titled *The Classroom Environment and Children's Performance – Is There a Relationship* (Martin, 2006) summarizes findings of a number of studies that explored the relationship between various classroom (interior) variables and the performance of children. The author discussed classification of such variables based on empirical findings and discussed them under four broad categories: *function, room organization, the ambient environment, and other environmental factors*. Indoor – outdoor relationship of space was absent from the list of the author; however, this article provided direction regarding investigation of the influences of architectural variables on children and teachers' learning (and teaching) behavioral outcomes. Another study by the same author (Martin, 2002) showed that density of pupil, seating arrangements, room spaciousness, different activity zones and other environmental characteristics may influence teacher and student-centered activities in classroom sets differently. For example, high density and less spaciousness were helpful characteristics for teaching, whereas children-centered lessons were supported by less pupil density and more spatial flexibility. Accordingly, some studies showed that the physical environment can impact student behavior and learning (Banning & Canard, 1986; Cornell, 2002; Earthman & Lemasters, 1996; Veltri et al., 2006). The physical environment, in this context, was identified as the architecture of the classroom. The scope of architectural design included room size, shape, height, furnishings, windows, and lighting. In the article by Veltri, Banning and Davies (2006), it was noted that the physical classroom environment could influence classroom behaviors and class attendance. Cornell (2002) suggested that the physical space or classroom should be a place where students want to be—in fact, that is critical for learning. The study by Earthman and Lemasters (1996) examined the relationship between school buildings, student achievement, and student behavior, and noted strong links between specific physical factors and student performance. Strong links to improved student performance, especially in the area of science, were found in particular in regards to control of the thermal environment, illumination, adequate space, and furnishings.

A number of studies have established the importance of outdoor environment in the lives of young children. The outdoors is the place where the diversity of the natural world is presented in all its sensory glory and if the outdoor environment is sufficiently diverse, children and teachers can together ride the wave of motivation (Moore, 1996). In a study of 41 programs, it was found that in lower quality outdoor environments, children engaged in more functional and repetitive play, while in higher quality outdoor environments, children showed a tendency to display more constructive play. As the quality of the outdoor environment decreased, the frequency of negative behavior increased (DeBord et al., 2005). One research showed that preschool children were more likely to engage in more complex forms of peer play (i.e., interactive and dramatic play) outdoors than indoors (Shim, Herwig, & Shelley, 2001). All these studies indicate that more research is needed to investigate the influences of specific architectural/built-environmental variables on learning and teaching behavioral outcomes in classroom environments.

2.2.3.3 More Naturalness = More Learning

The current study also justifies the importance of this investigation from a different perspective. A growing body of research emphasizes the developmental benefits of bringing nature and the outdoors into the learning process of young children. Hopwood-Stephens (2013) in her book *Learning on Your Doorstep: Simulating Writing through Creative Play Outdoors for Ages 5-9* discusses the health, psychological and cognitive benefits of learning outdoors (p. 1-2) and demonstrates the potential, beneficial effects on the learning process when conducted outdoors. Other research (Hopwood-Stephens, 2013; Lieberman, Hoody, & Lieberman, 2000; Malone & Tranter, 2003; Tai, Haque, McLellan, & Erin, 2006) supports this potential. While learning outdoors is effective and crucial, climatic constraints may restrict such activities during adverse times of the year (e.g., extreme heat; inclement winter weather). So it is important to bring nature indoors both physically and virtually, through window views.

Table 2.1 summarizes the findings of part two (extent research) of the literature review chapter. The scope of the current study is defined by each group of studies. The table systematically addresses the gap in previous research in the relevant fields. The importance of indoor-outdoor relationships of space in learning environments is demonstrated and plenty of studies were found which provided empirical proof of positive influences in indoor-outdoor spatial relations in performance, behavior and activities of students and teachers. However, most of those studies involved only elementary or high school or college students and their teachers. No study was found which investigated the same phenomenon for preschool age (3-5 years) children and their teachers/caregivers.

Table 2-1: Summary of Part 2: Extant research

Category	Sub category	Relevant findings and/or statements	Sources	Scope
Design guidelines and principles	Design guidelines	Strong relationship is needed between indoor and outdoor environment of a preschool classroom	Olds 2001; GSA 2003	Lack empirical findings that indoor-outdoor relations can benefit children and teachers
		A variety of transitions between buildings and the outdoors for preschool classrooms is recommended	Moore and Goltsman 1992	
	Scholarly writings	The best learning places flow between the indoor and the outdoor	Frost, Wortham, & Reifel, 2001	
		Where classrooms meet the outdoors are crucial areas	Moore and Cosco 2007	
Empirical research	Impact of windows, daylight and views in learning	Elementary school students in classrooms with larger window areas scored higher in math and reading	Heschong 2003, 1999	Does not address preschool age children and preschool teachers' behavior
		Classroom windows were positively associated with standardized test scores and graduation rates in high school students	Matsuoka, 2010	
		College students in the natural view classrooms had higher grades	Benfield et. al, 2013	
		Unrestricted, functional and living view help elementary school children's attention restoration	Tanner, 2009	
		Windowless classrooms decreased academic performance	Küller & Lindsten, 1992	
Extended research	Impact of windows, views on health, wellbeing and behavior	Near home nature contributes to self-discipline of children	Taylor, 2002; Wells, 2000	Does not address learning or teaching behavior
		View out the window can influence health outcomes	Devlin & Arneill, 2003	
		Presence of natural light and green view is associated with quicker recovery from surgeries	Ulrich, 1984; Walch et al., 2005	
		Nature views promoted residential satisfaction and overall resident well-being	Kaplan, 2001	
	Influence of built-environment on learning behavior	Space per pupil, seating arrangement, spaciousness, etc., affect both teaching and learning behavior of teachers and students	Martin, 2002	No specific study investigated indoor-outdoor relationship of space
		Classroom movement and circulation pattern have significant effects on learning	Tanner, 2009	
		Architecture of classroom, including size, shape, height, furnishings influence learning and teaching behavior	Banning & Canard, 1986; Cornell, 2002; Veltri et. al, 2006	
		School building characteristics influence students' achievement and behavior	Earthman & Lemasters, 1996	
		Outdoor environment influence children's behavior	Moore, 1996; DeBord et al., 2005; Shim et al., 2002	
	More nature = more learning	Learning outdoors in nature has health, psychological and cognitive benefits	Stephens, 2013	Indirectly support the needs of indoor-outdoor spatial relations
		The students learn better when the lesson incorporates the natural/outdoor environment	Hopwood-Stephens, 2013; Lieberman, Hoody, & Lieberman, 2000; Malone & Tranter, 2003	

2.3 Part 3: Research Design and Methodological Direction

The aim of this section is to compile information about the existing tools and measurement techniques, which may be useful to carry out this study. The conclusion might help to establish the need for developing new tools.

2.3.1 Research Design

Among the discussed research studies which looked into the influences of different indoor-outdoor spatial characteristics on learning outcomes, only one study was found which employed natural experimental methods (Benfield et al., 2013). Natural experimental design was an efficient way of assessing behavioral differences although it proves to be difficult to find identical settings which differ only in indoor-outdoor characteristics. The study by Karmel (1965) was the only study found in this field which took a qualitative approach and assessed the effects of windowless classroom environments by looking into children's drawings. The majority of the studies adopted correlational approach. The correlation strategy is well-suited for exploring the relationship among two or more variables of interest. Unlike experimental research, in which a variable is purposefully manipulated by the researcher, correlation research seeks to document the naturally occurring relationship among variables (Groat & Wang, 2001).

2.3.2 Measurement

The following three sub-sections discuss studies which provided useful guidance to understand different measurement techniques. No single study was found that has comprehensively measured indoor-outdoor spatial relationships of space and its influences in preschool age children's learning and their teachers' motivation.

2.3.2.1 Measurement of Indoor-Outdoor Spatial Relations

Six different research studies (DeBord et al., 2005; GSA, 2003; Heschong, 2003; Matsuoka, 2010; Olds, 2001; Tanner, 2009) which provided useful clues for measuring indoor-outdoor spatial relationships in a preschool classroom environment are discussed here. The *Preschool Outdoor Environment Measurement Scale,* also known as POEMS (DeBord et al., 2005) was useful to understand how specific built-environment characteristics can be measured in a preschool learning environment. Although it is an assessment tool for evaluating the quality of outdoor environments in childcare centers for children 3-5 years old, POEMS incorporates important components (item 1.7 – 1.9) for assessing visual and physical relationships between indoor and outdoor space. Item 1.7 rates the scale of windows— whether or not windows are at children's eye level. Item 1.8 measured the operability of windows — whether or not they can be opened to allow fresh air. This scale used yes/no answer choices for the rating. Detailed criteria for rating the windows in a classroom were found in Lisa Heschong's well-regarded study (2003). Although this study was focused mainly on daylight, it provided useful guidance for measuring windows and views of a classroom. The window characteristics measured in this study included *window orientation, window number and area, window tint, window glare, sun penetration and blinds/curtains over windows*. Both yes/no and Likert Scales were employed to measure these characteristics. This study (Heschong, 2003) also measured availability and number of exterior doors. The GSA guidelines (2003) gave instructions regarding recommended window areas for preschool classrooms for walls facing different directions in new construction (see Table 2-2). The Heschong study (2003) rated three characteristics of the view — view distance, view vegetation and view quality (view activity). The Tanner study (2009) argued that not all views through windows were beneficial. Classroom windows (with views) overlooking outside life was hypothesized as a positive aspect of the school environment. He called it "*patterns of views*" and differentiated those views into five distinct characteristics. They are: (1) views overlooking life, (2) unrestricted views, (3) living views (such as gardens, wildlife, fountains, mountains, and the sky), (4) functional views, and (5) green areas. The study (Tanner, 2009) used a 10-point Likert Scale to rate these characteristics, although 10 points seemed quite vague and difficult for the rating of these characteristics. The Matsuoka study (Matsuoka, 2010) provided comprehensive ratings for the naturalness of a view (Figure 2-6). He used a 0-4 point scale to rate the naturalness in the view where *zero* represented *no view* and a 4 represented *all natural*.

Figure 2-6: Example of the level of naturalness in the view (Matsuoko 2010)

Due to the lack of previous similar studies, establishing the measurement variables of transitional space was challenging. Item 1.9 of POEMS (DeBord et al., 2005) rated whether or not observed classrooms opened directly outdoors into usable transitional space. Olds's book *Childcare Design Guide* (2001) gave a faint clue with no additional guidance when it claimed that a maximally effective transitional space should not be less than 6 feet deep and ideally should be around 15 feet deep.

Table 2-2 summarizes the different measurement techniques to rate architectural indoor-outdoor spatial characteristics. It provided useful guidance for creating a new approach to comprehensively rate indoor-outdoor spatial relations in a preschool classroom environment, discussed elaborately in Chapter 4: Methodology.

Table 2-2: Summary of measurement attributes and teachniques to rate indoor-outdoor space

Indoor-Outdoor Spatial Characteristics	Criteria	Measurement Technique/Criteria	Source
Exterior door	Availability (no exterior door)	Yes/no	Heschong, 2003
	Number (two exterior door)	Yes/no	Heschong, 2003
Window	Scale (windows are at children's eye level)	Yes/no	DeBord et al., 2005
	Operability (can be opened to allow fresh air)	Yes/no	DeBord et al., 2005
	Window orientation (five orientations of windows – primary window facing east, west, north, south, or no window)	Yes/no	Heschong, 2003
	Window area (two conditions – area of view window between desk to door, and high window area, higher than door)	Measured area (square feet)	Heschong, 2003
	Window tint	Scalar (0–2): 0=clear glass, 1= slight tint, 2= heavy tint	Heschong, 2003
	No blinds or curtains	Yes/no	Heschong, 2003
	Window amount	children's spaces in new construction must have a total window area of at least 8 percent of the floor area of the room if windows face *south* directly to the outdoors. 10 percent for *east or west*. 15 percent for *north*.	GSA, 2003
View	Window view	scalar (0–3): 0=no view, 1=near view (<25'), 2=mid view, 3=far view (70'+)	Tanner, 2009
	View vegetation	Yes/no	Heschong, 2003
	View activity	Yes/no	Heschong, 2003
	Views overlooking life	scalar (0–10)	Tanner, 2009
	Unrestricted views	scalar (0–10)	Tanner, 2009
	Living views (such as gardens, wildlife, fountains, mountains, and the sky)	scalar (0–10)	Tanner, 2009
	Functional views	scalar (0–10)	Tanner, 2009
	View green areas	scalar (0–10)	Tanner, 2009
	View naturalness	scalar (0–4)	Matsuoka, 2010
Transitional space	Availability	Yes/no	DeBord et al., 2005
	Depth of transitional space	Measurement (feet)	Olds, 2001

2.3.2.2 Measurement of Child Engagement

Literature in the relevant field argues that when it comes to matters of children's behavioral or academic evaluation, observation techniques are superior to standardized tests (Andersen, 1998;

Bredekamp, 1987; Kamii, 1990). Benefits of observational techniques include its purposeful assessment done during authentic activities in a naturalistic setting without diverting children from natural learning processes (Nilsen, 2013). Self-assessment techniques in small children have been criticized because at an early age a child does not usually obtain a correct appreciation of his or her own thoughts and actions (Perry & Winne, 2006). Systematic observational methods have multiple advantages (Whitebread et al., 2008). First, such methods record what learners actually do, rather than what they recall or believe they do. Second, they allow links to be established between learners' behaviors and the context of the task. Direct observation can simultaneously provide contextually rich data on the setting in which the activity occurs (McKenzie, 2010). Self-report measures such as questionnaires or interviews largely depend on the verbal proficiency of the subject and can be a threat to the validity of a study involving young children. Test scores of children have many alternative explanations, which are beyond the scope of measurement.

Intense involvement of children in a learning context facilitates their overall development.

To objectively measure child engagement, a measurement tool/scale is required which is tested in terms of validity and reliability. The only realistic and valid means of assessing the environment in which children are learning is to conduct observation visits (Walsh & Gardner, 2005). Walsh and Gardner (2005) have proposed three levels of observed learning engagement in children. The three levels are:

Level 1 - Children are very keen at story and playtime.

Level 2- Children appear bored. The majority have dull expressions.

Level 3 – Little or no eagerness is shown by the children.

The Active Learning Inventory Tool (Van Amburgh et al., 2007) provides a validated tool. Although developed for college students, the tool provides important insight and direction for measuring active learning behavior among children. Three indicators for systematic observation of active learning are described:

1. Number of active-learning episodes per lecture.
2. Time per active-learning episode (minutes).
3. Number of different types of active-learning used per lecture.

Following the lead of Van Amburgh et al. (2007) and Walsh and Gardner (2005), measurement strategies were developed and are presented in the methodology chapter (Chapter 4) to assess child engagement.

2.3.2.3 Measurement of Teacher Motivation

Conventionally, most studies examining teacher motivation have assessed motivation through a global motivational orientation at work (Pelletier, Séguin-Lévesque, & Legault, 2002). However, this kind of assessment may be too broad to obtain a clear picture of motivation at work, specifically because respondents are asked to report their beliefs about their job without any specific tasks in mind. Fernet and colleagues (Fernet, Senecal, Guay, Marsh, & Dowson, 2008) argued that *task-based* assessment should be employed instead to assess teachers' motivational orientation. They proposed the Work Tasks Motivation Scale for Teachers (WTMST) (Fernet et al., 2008). The scale was tested for elementary and high school teachers; however, it provided guidelines for determining task-based assessment criteria to evaluate teaching motivation. WTMST instructed participants to rate the importance and time spent doing the following six main tasks – "a) class preparation (e.g., deciding on instruction topics and material, determining the presentation forms and sequences, and establishing the work procedure), b) teaching (e.g., presenting instruction, answering questions, and listening to the students' needs), c) evaluation of students (e.g., constructing assessments and exams, correcting, entering marks, giving remarks to the parents), d) classroom management (e.g., handling discipline, applying the rules, and managing students' interruptions and conflicts), e) administrative tasks (e.g., recording and transmitting absences, building disciplinary files, and participating in meetings with the parents and principals to study disciplinary cases, meetings with teachers, meetings with the administration, meetings with the union, and school assemblies), and f) complementary tasks (e.g., tutorial guidance, involvement in committees, extracurricular activities, continuous improvement training, and extra class monitoring)" (Fernar et al., 2008 p. 259). Many of these tasks are not relevant to a preschool classroom; however, this information is useful in determining the approach to evaluate teacher motivations to engage children in hands-on lessons. One study (Sylvia & Hutchison, 1985) argued that teaching motivation is associated with teachers' enthusiasm to try new ideas. This suggests that teacher enthusiasm to new or different teaching approaches and innovation in creating lessons should also be considered as important aspects of measuring teacher motivation.

2.3.3 Controlling Factors

To ensure that other plausible predictors of child engagement and teacher motivation get *credit* for any shared variability that they may have along with the experimental *indoor-outdoor* variables, the current study must identify such predictors and include them in the study as controlling factors. Previous studies have mainly identified three groups of variables that influence learning and teaching behavioral outcomes in the classroom environment. They are: a) physical environmental factors, b) human factors, and c) learning environment factors. They are briefly discussed below.

2.3.3.1 Physical Environmental Factors

Various physical environmental characteristics are found to contribute in learning behavioral outcomes. A recent study (Wu et al., 2014) which applied remote-sensing techniques to investigate the link between surrounding greenness and school-based academic performance found consistently positive significant association in the spring and negative relation in October due to the "Fall Effect." This study provided evidence that learning behavior and outcomes may be affected by seasonal changes. Built environmental factors other than the indoor-outdoor spatial characteristics that may influence learning outcomes in a classroom were discussed in section 2.2.3.2. One study (Martin, 2002) showed that seating arrangement rows, less space and higher density of pupils were suitable for teacher-centered lessons . However, the same study argued that children-centered lessons in the observed classrooms tended to occur in the rooms with a higher proportion of space per pupil. Classroom movement and circulation patterns (Tanner, 2009), architectural characteristics including size, shape, height, furnishings (Banning & Canard, 1986; Cornell, 2002; Veltri et al., 2006), school building characteristics (Earthman & Lemasters, 1996), as well as outdoor environments (DeBord et al., 2005; Moore, 1996; Shim et al., 2001) may influence children's academic performance, learning behavior and teachers' motivation to teach.

2.3.3.2 Human Factor

Piaget's theory of Cognitive Stages of Development (Piaget, 1965) suggests that age and intellectual development are strong indicators of learning behavior and activities of young children. Studies found that learning behavior of children depends on multiple issues ranging from intellectual factors, gender and age, learning technique and style, health and wellbeing to social-emotional factors, teachers' factors, socio-economic factors, and family characteristics (McDonald Connor et al., 2005). Numerous studies have found links between teachers' academic qualification and students' positive academic outcomes (Barnett, 2003; Bishay, 1996; Darling-Hammond, 1999; Ferguson, 1991; Greenwald, Hedges, & Laine, 1996; Monk, 1994; Wenglinsky, 2000). Although conducted with different age groups, all of these studies concluded that teachers' more advanced education were more effective. One research study investigated the relationships between teachers' academic background and children's experience and behavioral outcomes in center-based childcare (Howes, 1997). The study concluded that teachers with the most advanced education were most effective. Teachers' years of experience also contribute to student outcomes (Goldhaber & Brewer, 2000; Greenwald et al., 1996; NICHD, 2002; Rivkin, Hanushek, & Kain, 2005). Like children's learning outcomes, teachers' motivation to teach also depends on many different factors — e. g. personal/social factors, socio-economic status, student's behavior, stress, rewards/incentives, salary, self-confidence and personality of the teacher (Alam & Farid, 2011).

2.3.3.3 Learning Environmental Factors

The ECERS-R (Early Childhood Environment Rating Scale – Revised Edition (Harms et al., 2005) provided a comprehensive way to look into learning environmental factors that may influence behavioral outcomes and performance in a preschool classroom environment. Numerous research projects in the United States and abroad have used the ECERS-R to assess global quality and have discovered significant relationships between ECERS-R scores and child and teacher outcome measures (Harms et al., 2005). The ECERS-R rates the following characteristic features of the learning environment – the quality of space and furnishing, personal care routines, materials for language-reasoning, availability, quality and quantity of different classroom activities such as art, science, music, dramatic play, quality of interactions, program structure and provisions for parents and staff (Harms et al., 2005). According to the data derived from one study (Ayvacı & Devecioğlu, 2010), most of the teachers believed that place arrangement in science and nature corners were fruitful to motivate and challenge students to attend science and nature activities. These different dimensions of a learning environment should be addressed in the current study.

2.4 Summary of Literature Review

1. There is a substantial body of literature of existing research that emphasizes the importance of investigating influences of indoor-outdoor spatial relationships in children and teachers' behaviors in preschool classroom environment; however, previous research either lacks empirical findings or is not generalizable/applicable for preschool children.
2. Doors, windows, view, and daylight conditions are the main factors of indoor-outdoor relationships, which are researched extensively. In addition, the transitional space linking indoor and outdoor is often described as a desirable characteristic of indoor-outdoor relationships.
3. The common trend of research on built-environments and learning behavior applies correlation research design and inferential statistics to clarify patterns of relationship. In rare cases, natural experimental design or qualitative approaches are used as research designs.
4. For preschool children, observation is a more reliable way to collect behavioral data than surveys.
5. Other factors influencing learning behavior need to be controlled for if using a correlational approach such as socio-demographic characteristics of children, children-per-teacher ratio, teachers' educational qualification, teacher demographics, salary, income level, education, etc. These considerations play an important role in determining children's learning and teachers' teaching motivation and practices. Among built-environment factors, size-shape, density of classrooms, learning facilities, outdoor environments, etc., are important predictors of children's engagement to learn.

Chapter 3 : Conceptual Framework

This chapter describes the philosophical background and the conceptual framework of the study used to help guide development of the research questions and methodology described later. The broad theoretical background is based on environmental psychology, which claims that human behavior is a construct of the environment. At the conceptual level, the study has claimed to establish relationships between physical environment factors and behavior of children and teachers. At the operational level, the focus is on a particular aspect of the built environment and specific behavioral outcomes of children and their teachers.

3.1 Theoretical Perspective

To develop its conceptual base, this study revisits two important concepts in the field of environment and behavior: 1) Kurt Lewin's Equation and 2) the concept of affordance developed by the perceptual psychologist James J. Gibson. The two concepts are summarized below.

3.1.1 Environment-Behavior Theory

The study chooses Kurt Lewin's Equation (Lewin, Heider, & Heider, 1936) as its base theoretical perspective. Lewin's Equation claims that behavior is a function of person and environment or B = *f* (PE) (Figure 3-1), where B = Behavior, P = Person, and E = Environment. When first presented in Lewin's book *Principles of Topological Psychology* (1936), the theory contradicted most popular theories in that it gave importance to a person's momentary situation in understanding his or her behavior, rather than relying entirely on the past. This theory is of utmost significance for the current research because it emphasizes the role of environment as a determinant of human behavior.

$$B_{\text{ehavior}} = f(P_{\text{erson}}, E_{\text{nvironment}})$$

Figure 3-1: Kurt Lewin's Equation

The equation justifies the basis of this investigation – searching for influences of indoor-outdoor spatial relations in children's learning behavior (engagement) and teachers' teaching behavior (motivation). This relationship is considered to be mono-directional for children. For teachers, the relationship is assumed to work both ways. The teacher, as much as the children, has to accommodate and adapt to the environment, but the teacher's role requires that he/she manipulates the environment for others (Martin, 2002). The teacher has to somehow create conditions under which certain stimulation becomes salient to the pupils. The teacher receives the same stimulation from the environment, changes it for the use of pupils, and receives feedback from pupil's behavior. The teacher has then to process that information in relation to the educational purposes and make sure that the behavior will bring about desirable pupil responses (Adams & Hiddle, 1970). Following the above discussion, we may describe the environment-behavior relations in a preschool classroom as the three-way relationship described schematically in Figure 3-2 below.

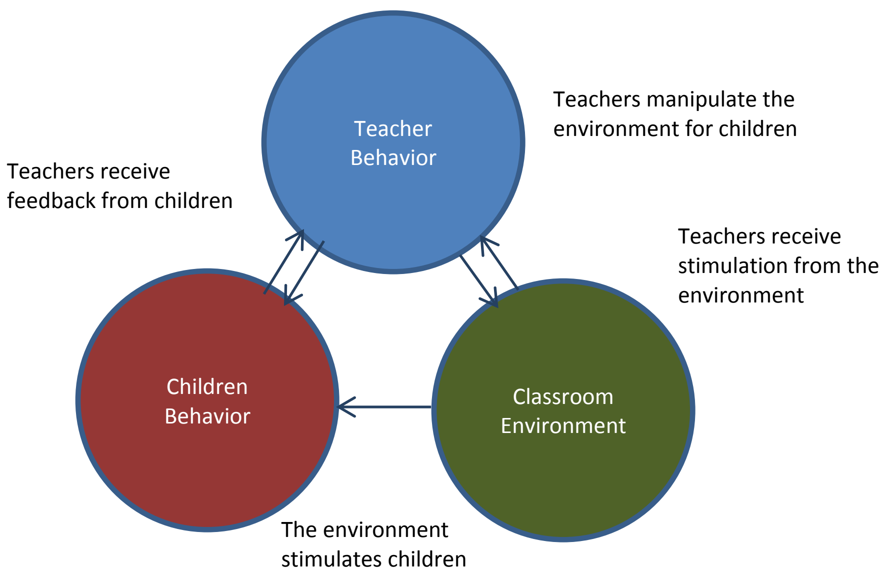


Figure 3-2: Three-way environment behavior relations in a preschool classroom environment

3.1.2 Gibson's Concept of Affordance

The research reported here investigates the relationship between specific architectural elements and human learning behavior in a preschool classroom setting. As elaborated in the literature review, indoor-outdoor spatial relations were highlighted as a design aspect (i.e., able to be manipulated by design practitioners), for a learning environment for young children. This study is also interested in discovering *how* indoor-outdoor spatial relations may influence behavioral outcomes related to learning. The concept of *affordance* is appropriate as it is guided by a conceptual framework that includes *properties* of the environment. In this case, architectural indoor-outdoor relations afford positive outcomes in child engagement and teacher motivation.

An *affordance* refers to the fit between an animal's capabilities and the environmental supports and opportunities that make possible a given activity. Affordances are properties of the environment as far as they relate to an animal's capabilities for using them (Gibson & Pick, 2000). Realization of an affordance means that an animal must take into account the environmental resources presented in relation to the capabilities and dimensions of its own body. Affordance stresses the relationship between perception and action. According to Gibson and Pick (2000), children learn both about the functional properties of the environment (layout, objects, and events), and about themselves by picking up information through the process of identifying and using the environment in relation to their abilities. As affordances are learned, they guide behavioral responses to specific environments (Gibson & Pick, 2000).

This study is an exploration of the relationship of indoor and outdoor spaces to find out what is being offered by particular environmental attributes to guide learning behavior in children and teaching behavior in teachers. A typical type of question asked by the concept of affordance is what is being afforded (functionalities) by the environment for human behavior/activity? This research assumes that higher quality indoor-outdoor relationships in preschool settings can offer (afford) to promote child engagement and teachers' teaching motivation and teaching style. The tentative research questions of this study overlap the concept of affordances.

3.1.3 Relevant Learning Theories

As the present study investigates learning (and teaching) behavior, it revisits some prominent learning theories to understand how they may relate to the conceptual framework. One source (Smith, 2003) was discussed to understand different theories of learning and their relevance to the inquiry of indoor-outdoor spaces and learning in a preschool classroom environment. The author provided a wide range of historic theories behind learning in his article. Learning can be looked at as a product or a process. As a product, it might be defined as an outcome or a change in behavior. As a process, Roger (2003) noted that learning might happen as acquisition learning or as formalized learning. In acquisition learning (or task-conscious learning), the learner may not be conscious of learning, but conscious of the task at hand, while in formalized learning (or conscious learning), it is obvious that the intent of the activity is to learn. Both kinds of learning are crucial for preschool children. Preschool classroom programs are usually divided into teacher-assisted (formalized) and free-activity (acquisition) periods to emphasize both learning processes.

According to Piaget's theory of cognitive development in children (Piaget, 1965), preschool children are in the *preoperational* stage – a phase in which they begin to represent the world with words and images, which reflects increased symbolic thinking and goes beyond the connection of sensory information and physical action. The learning processes in the classroom should accommodate and enhance this new ability of children to think symbolically. The cognitivist views the learning process as information processing and according to their views classroom learning would not be an event but rather a mental process. An example would be learning by discovery. Could a view of a bird feeder and live birds from a window stimulate learning by discovery or perhaps cause a distraction to classroom activities? In social and situational theory, Merriam and Caffarella (2012) noted that the locus of learning is in the relationship between people and the environment. This concept talks about learning in adulthood but pointed out helpful directions for this research. Could indoor-outdoor spatial relations open up the classroom to embrace a more inclusive exterior environment to encourage learning?

3.2 Learning from the Pilot Survey

A connection between the concept of affordances and the tentative operational variables of this study was explored during the researcher's visit to the Children's Montessori School in Jacksonville, NC, to conduct a pilot survey on March 8, 2013. This school was selected for the pilot for its elaborately designed transitional space (Figure 3-3), which provided a rich indoor-outdoor physical relationship between the classrooms and the outdoors. The idea was to investigate behavioral variation in play and learning among children between indoor, outdoor and transitional space of the school. Open-ended observations made in the outdoor classroom revealed findings suggesting influence of indoor-outdoor relationship of space on both students' learning and teachers' teaching strategies and motivations.

The researcher observed that the teacher at the outdoor classroom was showing live birds, which came at a birds' house (Figure 3-4) just outside one of the windows of the classroom and taught children to identify their species by a catalogue with images of those birds. This wonderful learning affordance was created by the indoor-outdoor relationship of space of the classroom. This view provided learning affordance for children and an innovative teaching strategy for the teacher.

Figure 3-3: Jacksonville Montessori School offered rich indoor-outdoor spatial relations

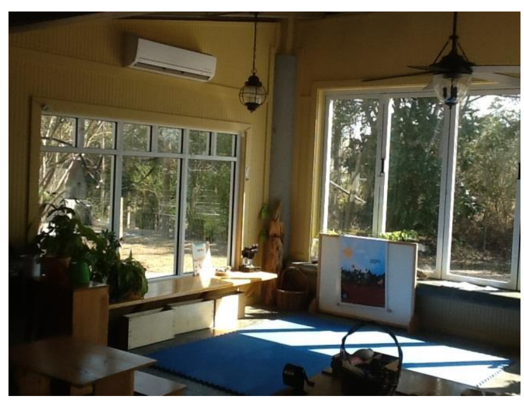


Figure 3-4: A view of the birds' nest, Jacksonville Montessori School

3.3 Conceptual Level to Operational Level

At the conceptual level, the study assumes that certain architectural indoor-outdoor relationships would predict more learning engagement in children and more motivation among teachers in preschool classroom environments. However, at its operational level, the study tries to define all its predictors and outcomes. Indoor-outdoor relationships of space are defined by four architectural components of a classroom – doors (only exterior doors connecting to outdoors), windows (only exterior windows connecting to outdoors), views (views toward outdoors) and transitional space. The study is interested to know what learning opportunities these elements *afford* to influence behavior. Therefore, at its operational level, the study proposes a systematic way to measure the learning affordances of doors, windows, views, and transitional spaces of preschool classroom. The study also defines child engagement and teacher motivation in terms of specific behavioral outcomes. Four indicators are described to *operationalize* the measure of child engagement and three indicators are defined to measure teacher motivation. At its operational level, the study also admits that there are ranges of other predictors, which are needed to be *controlled* to objectively estimate the relationships between the key predictors and outcomes. These control variables are described under three primary sets — physical environmental attributes, human factors, and learning environment attributes.

3.4 Determining Variables of the Research

Guided by the *concept of affordance* and relevant *learning theories*, this study defines its predictors (independent variables) and outcome (dependent variables) measures. The selection processes of these variables were guided by the literature review and discussion presented in 2.3.2 and 2.3.3.

3.4.1 Dependent Variables: Children

According to its definition of child engagement (see 2.1.2), the study measured both the positive and negative indicators of child engagement so that the predictive validity of the proposed measures could be tested.

Children's Collective Engagement: This measure will examine the *collective* engagement of children during classroom activities.

Percentage of Engaged Children: This measure quantifies the number of engaged children (in different activities) by looking into individual behavior.

Distracted Children: This measure qualifies the number of distracted children by observing individual behavior. It provides a negative measure for learning engagement of children.

Number of Behavioral Guidance Directives by Teachers: The study hypothesized that more engagement of children would result in fewer behavioral guidance directives by the teachers and counting the number of behavioral guidance directives would provide the researcher a negative measure of child engagement in the classrooms.

3.4.2 Dependent Variables: Teachers

Based on its definition of teacher motivation (see 2.1.2), the study decided to measure the following outcomes among teachers.

Hands-On Lessons: The researcher would count the number of hands-on lessons the teachers applied in a certain time period (a week).

Creative Lessons: The researcher would also count the number of lessons that were created entirely by the teachers as a measure of their enthusiasm and innovation.

Nature-Based Lessons: Since it was hypothesized that increased indoor-outdoor relations predict stronger bonds with nature, the research was also interested to see whether it contributed to teachers' teaching styles in using natural elements to teach. The number of times teachers use a natural element to teach children will be counted for this purpose.

3.4.3 Independent Variables Relating to Indoor-Outdoor Relationships of Space

Based on the information provided in Table 2-2 this research has defined indoor-outdoor spatial relations in terms of four architectural elements — doors, windows, views, and transitional spaces. Based on its relevance to Gibson's concept of affordance, the indoor-outdoor predictors are defined as door affordance, window affordance, view affordance and transitional space affordance respectively. The literature review guided the measurement criteria of these predictors, which are presented in Table 2-2. Following characteristics of these four indicators will be measured.

Door Affordance: Number and availability of doors which connect the classroom directly to the outdoor environment and the visual transparency of such doorways.

Window Affordance: Number of windows, window scale, window operability, visual transparency of windows, window depth, window orientation, and window amount.

View Affordance: View of vegetation, activity, distance, and greenness.

Transitional Space Affordance: Availability of transitional space, depth and usability of transitional space, activity zones and vegetation in transitional space.

3.4.4 Independent Control Variables

Following the lead of previous studies presented in section 2.3.3, three ranges of control variables will also be measured as below.

Physical Environmental Factors: Weather data; childcare characteristics such as size, star rating, total number of children and teachers, building design, building age and function; classroom characteristics such as size, shape, height, furnishings and density of classrooms, etc.

Human factors: Children's age, gender, family background, social-economic status, number; teachers' age, gender, number, academic qualifications, years of experience, income, salary, self-confidence, personality, etc.

Learning Environmental Variables: Quality and quantity of various learning materials, availability of different activity zones for children, classroom curriculum and program structure, etc.

3.5 Hypotheses and Research Questions

The following paragraphs describe the two primary hypotheses of the research.

Hypothesis 1: Variance in indoor-outdoor relationship of space in preschool classroom environments predicts variance in learning behavior of children. To explain further, this research assumes that children are likely to exhibit more learning engagement in classrooms that have higher quality indoor-outdoor relationship of space.

Hypothesis 2: Indoor-outdoor spatial relations in preschool classroom environments predict teacher motivation. Teachers would likely be more motivated in classrooms that have higher quality indoor-outdoor spatial relations. To be more specific, increased affordance scores of indoor-outdoor spatial relations predict the likelihood of more hands-on and innovative lessons by the teachers and also increase teachers' tendencies to teach children with natural elements.

The two primary hypotheses lead the study to its primary research questions.

Primary Research Question 1: How are indoor-outdoor spatial relationships associated with child engagement in a preschool classroom environment?

Based on the four indicators of child engagement as described in section 3.4.1, the four secondary research questions to follow would be:

- Research Question 1A: How are indoor-outdoor spatial relationships associated with children's collective learning engagement levels in a preschool classroom environment?
- Research Question 1B: How are indoor-outdoor spatial relationships associated with the quantity (percentage) of engaged children in a preschool classroom environment?
- Research Question 1C: How are indoor-outdoor spatial relationships associated with the number of distracted children in a preschool classroom environment?
- Research Question 1D: How are indoor-outdoor spatial relationships associated with the number of behavioral guidance directives by the teachers in a preschool classroom environment?

The second primary research question of the study is stated below.

Primary Research Question 2: How are indoor-outdoor spatial relationships associated with teacher motivation in a preschool classroom environment?

Based on the three indicators of teachers' teaching motivation, as described in section 3.4.1, the three secondary research questions to follow would be:

- Research Question 2A: How are indoor-outdoor spatial relationships associated with teachers' motivation to engage children with hands-on lessons in a preschool classroom environment?

- Research Question 2B: How are indoor-outdoor spatial relationships associated with teachers' enthusiasm and innovation to create new lessons to teach children in a preschool classroom environment?
- Research Question 2C: How are indoor-outdoor spatial relationships associated with teachers' tendencies to teach children with natural elements in a preschool classroom environment?

Chapter 4 : Methodology

The study reported here is by nature *exploratory*. According to Stebbins (2001), exploration, with its open character and emphasis on flexibility and pragmatism, is arguably a more inviting and, indeed, accurate way of representing social-behavioral research than treating it as a narrowing, discipline-based process that settles and confirms rather than unsettles and questions what one knows. This study admits the complexity of the relationships between architectural characteristics and learning related behaviors of children and teachers. It understands that it is beyond the scope of this research to *fully* explain the mechanism of this relationship. Rather, the study relies on the potentials of *exploration* of real world events in naturally occurring patterns and attempts to question and add to what is already known about the environment-behavior relationship in the realm of learning environments of young children.

This research investigates architectural characteristics of childcare centers and it is interested to know how such design attributes may influence learning and teaching outcomes in preschool classrooms in childcare centers. In the previous chapter, a conceptual framework was developed for the study, with direction from reviewed literature in the relevant fields. The conceptual framework has defined the independent (both experimental and control) and dependent variables and stated the research questions of the study. This chapter draws on the conceptual framework and envisions a research model that provides a logical, systematic method of data collection and analyses that would attempt to answer the research questions. The first part of the chapter talks about the broad research design and justifies the aptness of the chosen design. This part also defines the geographical context of the study and explains sample qualifications and sample selection procedure for collecting data. The second part gives a holistic view of the research model and looks closely to the step-by-step procedure that was followed for collecting data. The third part focuses on the methods of collecting data and describes the instruments and detailed data collection mechanisms for each of the variables of the study.

The research model for this study is inspired by the *Cycle of Empirical Research* (Figure 4-1) proposed by Runkel and McGrath (1972). In this cycle research is regarded as a series of logically ordered – though chronologically chaotic – choices. The choices run from formulation of a problem, through design and execution of a study, and, ultimately, analysis of results and their interpretation (McGrath, 1981).

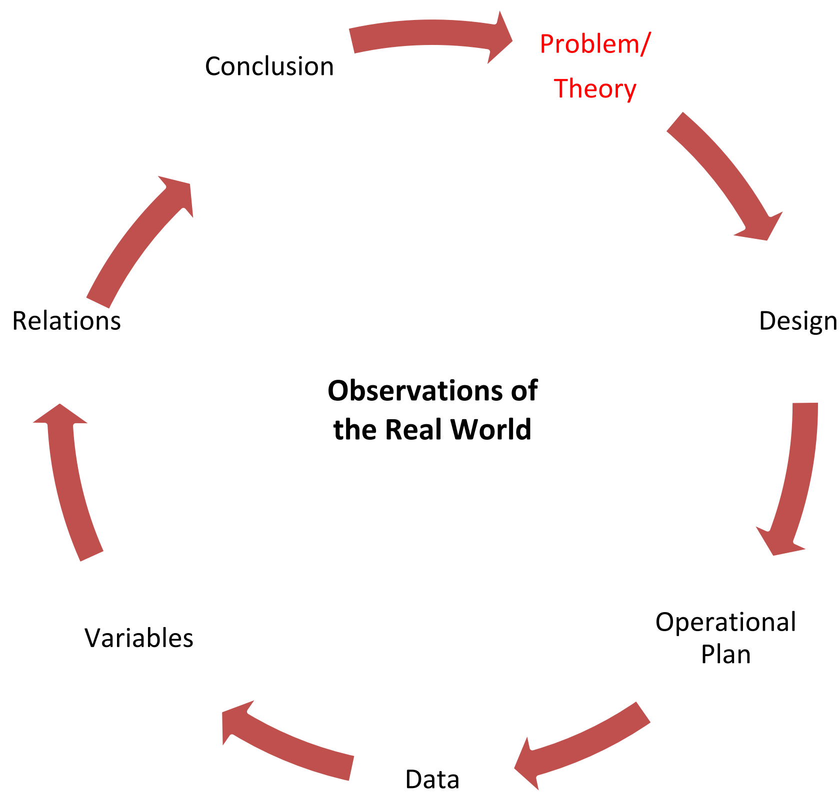


Figure 4-1: Cycle of empirical research

4.1 Research Design Overview

The study's correlation approach was guided by the three general characteristics of correlational research: a focus on naturally occurring patterns, the measurement of specific variables, and use of statistics to clarify patterns of relationships (Groat & Wang, 2001). The study explores what actually happens inside a preschool classroom on regular days and in their naturally occurring patterns without any manipulation of the settings. Specific built environmental variables and behavioral outcomes of children and teachers were measured systematically. Specific control variables were also measured. Finally, inferential statistics were used to determine the likelihood that results were a consequence of a chance occurrence. To be more specific, this research is a relationship study (Groat & Wang, 2001), which seeks to describe relationships among key variables by focusing more specifically on the nature and predictive power of such relationships.

4.1.1 Why Correlation Research?

The correlation strategy is well-suited for exploring the relationship among two or more variables of interest. Unlike experimental research, in which a variable is purposefully manipulated by the researcher, correlation research seeks to document the naturally occurring relationship among variables. This characteristic means that it is particularly appropriate in circumstances when variables either cannot be manipulated for practical reasons or should not be manipulated for ethical reasons (Groat & Wang, 2001). This study attempts to explore relationships among naturally occurring variables like child engagement/ teacher motivation and indoor-outdoor spatial characteristics of a classroom. Manipulation is difficult, if not impossible, both for practical and ethical reasons. Rather, chances of success are higher by studying children and their teachers in their natural settings (regular classroom activities).

4.1.2 Why North Carolina?

Compared to the national average, North Carolina has one of the highest rates of working mothers with young children, thus making the need for childcare one of the state's top priorities (NC-DHHS, 2014c). Approximately 250,000 children in North Carolina spend part or all of their day in regulated childcare arrangements (NC-DHHS, 2014a). As of July, 2014, there were a total of 7,140 regulated facilities, including 4,763 regulated childcare centers and 2,407 family childcare homes (NC-DHHS, 2014b). The need and availability of childcare is essential for the State of North Carolina's economic development and stability. This is why the State of North Carolina was considered to be an appropriate geographic location for research that aims to develop environmental learning potential in preschool classrooms of childcare centers.

4.1.3 Sample Qualification and Sample Selection Process

The study investigated whether variation in indoor-outdoor spatial relationships in preschool classrooms could explain variation in learning outcomes. Therefore, the chosen sample unit was an individual classroom. Random selection of classrooms was judged unfeasible because no listing exists that includes all classrooms in childcare centers in the state of North Carolina. A list of all childcare centers of North Carolina was available on the website of the North Carolina Department of Health and Human Services (NC-DHHS, 2014b), which listed a total of 7,140 regulated childcare facilities (childcare centers and family childcare homes). However, a simple random sampling process from this list of all North Carolina centers was considered to be impractical and unrealistic given time and budgetary constraints. Collecting data was a time-consuming process that took almost four hours for the researcher for each classroom, making proximity an important criterion for sample selection. Except for geographic distance, getting access to centers was also a major concern for the researcher.

Samples were selected randomly from a list of centers that have been affiliated with the Natural Learning Initiative (NLI). Founded in 2000 with the purpose of promoting the importance of the natural environment in the daily experience of all children, through environmental design, action research, education, and dissemination of information, NLI is a research and professional development unit at the College of Design, NC State University, Raleigh, NC, USA (NLI, 2014). Being a research assistant at the time of sample selection, the researcher had access to centers who were working closely with NLI. The list contained names of 55 centers, that been associated with three recent projects with NLI. Additionally, the following three qualifying criteria were imposed for selecting centers.

1. Only childcare centers, not family childcare homes, were considered for the study. The study is concerned with the architectural characteristics of childcare centers as a distinct functional building type. Residences providing care facilities were completely a different genre in an architectural perspective and considered to be beyond the scope of this aim of the study. Besides, the number of children is limited in family childcare homes, which would restrict opportunities to observe collective behavior of children.

2. Centers only in Wake County, NC were selected. Geographic proximity, as mentioned earlier, was an important criterion and it ensured reasonable travel distance for data collection from the researcher's present location.
3. Centers with a minimum of 3-star ratings in the NC Childcare Rating Scale (Bryant, 2000) were only considered to be selected as samples. Selected centers for the study needed to be comparable in their ratings so that the controlling factors were comparable as well.

4.2 Research Model and Step by Step Procedure

Figure 4-2 illustrates the research design and basic steps of the research. Once the classrooms were selected and visits were arranged, the researcher employed three primary methods of collecting variable data – systematic observation, questionnaire survey, and environmental data collection methods. For collecting behavioral data related to child engagement and teacher motivation, both systematic observation and questionnaire surveys were employed. A separate questionnaire was used to collect center data from directors. Environmental rating scales were used to collect built environmental data, including architectural indoor-outdoor relationship of space and indoor learning environmental qualities of preschool classrooms. In addition to those three primary methods, detail photographic data were collected as well. The researcher took high resolution photographs of classroom features. Photographs were also taken for specific teacher and children activities, which were relevant to the research questions of the study. Photographic data were also used for some specific built-environmental measurements. How different methods were adopted for different variables is explained diagrammatically in Figure 4-2. Collected data were then analyzed in appropriate statistical models to predict relationships. The relationships were discussed and explained in light of previous studies, observed phenomena and methodological perspectives. Conclusion was drawn upon both statistical findings and additional observational findings, which provided valuable insights regarding the importance of spatial indoor-outdoor relationships for learning activities in preschool classrooms.

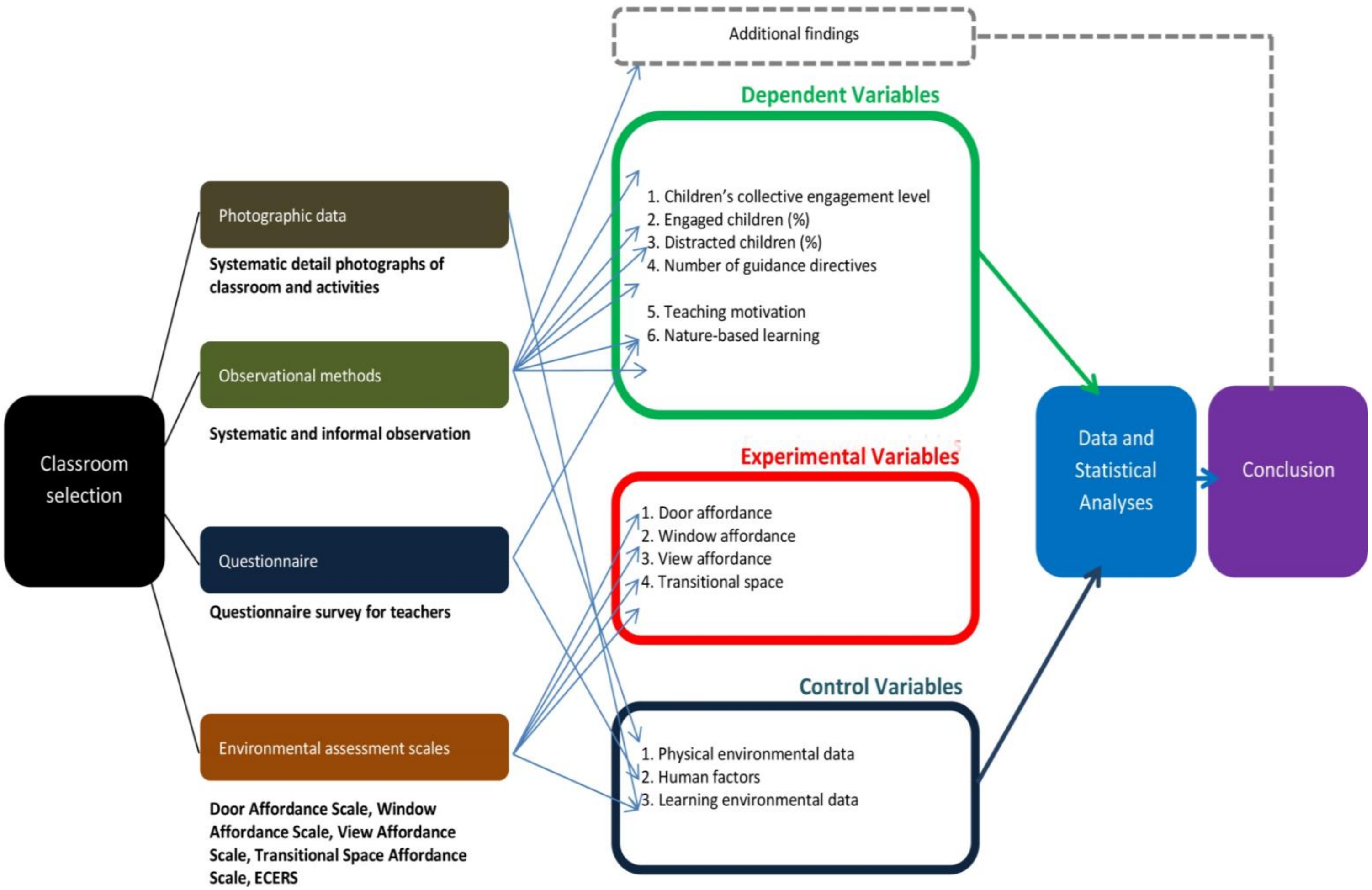


Figure 4-2: Methodology diagram

4.2.1 Pre-Data Collection

1. The researcher prepared a list of 55 centers, which have previously participated in three recent NLI affiliated projects.
2. Ten centers were selected randomly (by assigning random numbers) from that list.
3. After random selection, the researcher contacted the directors/resource persons of the selected centers by telephone calls and/or emails.
4. The centers that responded positively and agreed to participate were visited by the researcher on agreed dates (and times).
5. On these preliminary visits, the researcher met the center directors and explained the objective of the research with the help of a PowerPoint presentation (sample slides in Appendix 1.1) prepared by the researcher.
6. The researcher was introduced by the center director to teachers/caregivers in classrooms with children 3-5 years of age.
7. The researcher explained the main objectives and data collection methods to the teachers.
8. Upon teachers' approval to participate in the research, the researcher asked teachers to sign two copies of the IRB-approved *Teacher's Consent Form* (Appendix 1.2). The researcher himself then signed those forms and left one copy of the signed document with the teachers.
9. The researcher then handed one copy of an IRB-approved *Invitation to Participate* letter (Appendix 1.3) and one copy of an IRB-approved *Consent Form for Parents* (Appendix 1.4) to the teachers and asked them to distribute copies to parents at their convenience.
10. The researcher exchanged contact details (phone and email) with the teachers and asked them to contact the researcher once the consent forms were signed and returned by the parents of the children of a selected classroom.

4.2.2 Data Collection Procedure

1. Once the consent forms were signed by the parents, the researcher visited the center for collecting data on agreed dates. Usually one full day was assigned for collecting data. The researcher reached the centers at 8:30 a.m. and received the signed consent forms from

respective teachers. The researcher then signed back those forms and left copies with the teacher to distribute parents' copies of the signed forms and kept the originals with himself.

2. Before starting data collection, the researcher asked the teacher(s) to identify children whose parents did not agree to the participation of their children or did not give their consent to *photo release*. The researcher took note of that and remained careful not to collect individual observational data or take photos of those children in the classrooms.
3. The researcher then asked the teacher to spot a place in the classroom for the researcher. The researcher was also careful to change his spots during data collection to keep classroom activities uninterrupted and undisturbed by his presence.
4. The researcher used the systematic observation tool (pen and paper) which was designated for collecting behavioral data regarding child engagement and teacher's teaching motivation (Appendix 1.5). The behavioral measurements are elaborated in section 4.3.1.
5. During observation, the researcher also took photographs of activities which were relevant to the area of interest. However, the researcher was careful to avoid taking photographs of children whose parents did not give consents for the study and/or photo release.
6. The researcher made sure that he collected minimum 20 minutes of observational data for each of the teacher's assisted and free activity sessions during his stays in the classrooms.
7. The environmental data were collected when children and teachers went outside for their daily outdoor activity sessions. If bad weather (or other reasons) restricted outdoor activities of the classroom, environmental data were collected in the presence of children and teachers. The indoor-outdoor spatial relationships of classrooms were measured by four tools (door affordance, window affordance, view affordance and transitional space affordance tools), which are elaborated in section 4.3.2. When the classrooms were empty, the researcher also systematically took detailed photographs of the entire classroom for using in specific measurements. The daylight measurements usually were also taken in empty classrooms (elaborated in section 4.3.3.1).
8. During children's nap time, the research took the questionnaire (Appendix 1.6) surveys with teachers.
9. Once all classroom data collection was completed, the researcher met the center director and took a small survey (Appendix 1.7) for childcare center specific information.

4.3 Variable Definitions and Data Collection Methods

The selection of variables of this research is guided by the direction from the literature review. The variables are described under three main categories – a) dependent variables, b) independent experimental variables and c) independent control variables.

4.3.1 Dependent Variables

The six dependent (outcome) variables (Figure 4-3) of the study attempted to measure the teaching and learning activities and behaviors inside a preschool classroom during regular activities. Four variables were employed to collect learning engagement behavioral data of children and two variables were measured to rate teacher motivation. These variables, their definitions and detail measurement criteria are described below.

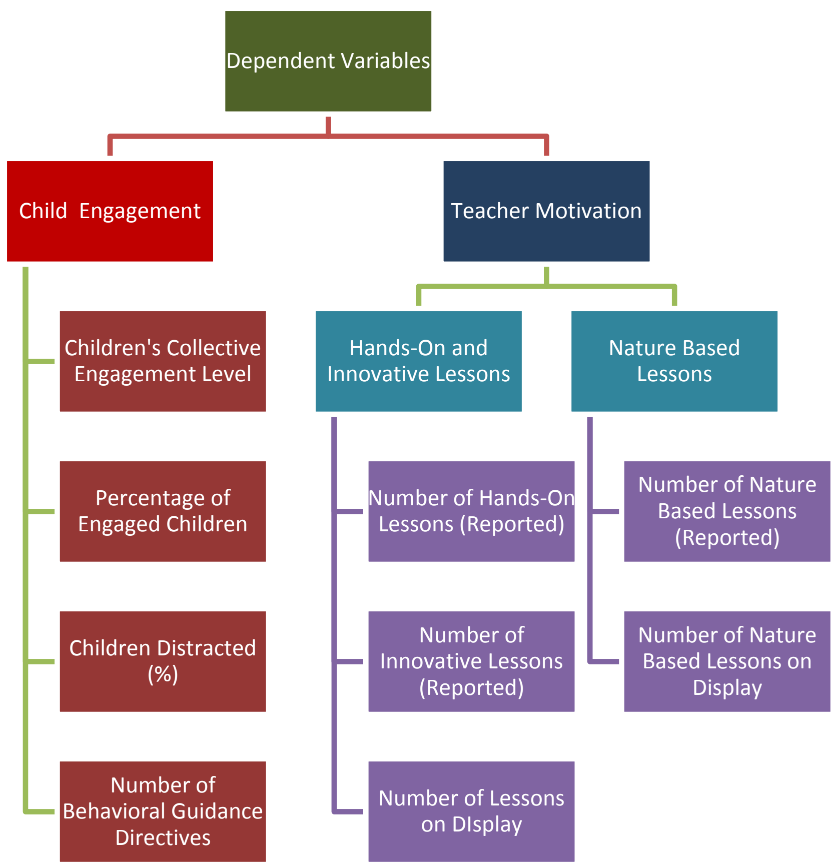


Figure 4-3: Branching of dependent variables

4.3.1.1 Child Engagement

A core assumption of this study argues that, more valid results are possible by observing the spontaneous activities of the children rather than using self-assessment tools or teacher/researcher administered tests. Increased use of observational methods has the potential to make a clear contribution, particularly with young children (Whitebread et al., 2008). Numerous assessment systems are available to assess school-going children's academic performance; however, assessment systems for measuring learning behavioral outcome of preschool children are rare. It was important to acknowledge the different engagement periods in a preschool classroom during observation. In terms of child engagement, preschool classroom activities can be divided into two basic phases — teacher-directed activity time and free activity time. It was expected that children's learning behavior would differ substantially when they were controlled by teachers from the time when they were free to choose activities and engage all by them. This difference in activity sessions was acknowledged in the four indicator measurements of child engagement. Two indicators were used to assess learning engagement during teacher-assisted activity time – *1) children's collective engagement level* and *2) percentage of distracted children*. One indicator, *percentage of engaged children,* was measured to assess engagement during free activity session. The fourth indicator, *number of behavioral guidance directives,* was measured over both sessions of teacher driven and free activities. Among the four indicators, *children's collective engagement level* and *percentage of engaged children* were positive measures while *percentage of distracted children* and *number of behavioral guidance directives* were negative indicators of child engagement. Because some of these measures were newly developed to serve the distinct objectives of the study, positive and negative measures provided opportunities for the researcher to test predictive validity of the indicators by checking the direction and amount of interrelationship between these outcome variables (see 5.1.3) A data collection template (see Appendix 1.5) was used to collect these four data during observation in a classroom. The four indicators of child engagement are described below.

Children's Collective Engagement Level

Children's collective engagement level was a collective measure of all children during teacher-assisted activities such as story times, group times, group music or dance, etc. Based on one study (Walsh & Gardner, 2005) discussed in the literature review chapter (see section 2.3.2.2), the following scale (Table 4-1) was used to assess the collective engagement level of children during teacher-assisted periods.

Table 4-1: Children's collective engagement level scale (based on Walsh and Gardner, 2005)

1 = Most of the children in the class appear apathetic and unenthusiastic, e.g., lying over the tables, wandering around the room, yawning, etc.	2 = Most of the children in the class seem to complete the activity offered by the teacher out of obligation rather than interest.	3 = Most of the children in the class are eager to participate in the activities offered by the teacher.

Children are observed during teacher-driven activities and are rated in the scale for a total 20 minutes time. To increase the accuracy of this measure, the 20-minute timeframe was divided into two 10-minute episodes. The mean value of the two episodes was taken as the measure of children's collective engagement level of a classroom.

Percentage of Engaged Children

One validated assessment system known as the Active Learning Inventory Tool (Van Amburgh et al., 2007) was consulted to develop an assessment for engagement in children during free activity sessions in the classrooms. This tool emphasized calculating the number of active-learning episodes and the duration per active learning episodes per lecture. Although developed and validated for college students, it helped the researcher find a way of systematically measuring the amount of engagement in a classroom among children during free activity times. During the free activity session, the teacher usually asked the children to choose their own activities and let them freely engage. At this session, usually the teachers did not interfere with the children unless required. When the free activity sessions started, the researcher calculated the number of children in engagement. Children were observed for four episodes, each with duration of five minutes (for a total of 20 minutes). During each episode, the same child was never counted more than once. Only the number of different children in engagement was recorded. The mean count of these four episodes was expressed as a percentage of the total number of children present in the classroom. For example, if an average of five children were observed *engaged* during the four observation periods in a classroom containing a total of 20 children, then the percentage of engaged children for that classroom was calculated as average/total children in class. (For example, 5/20 = 0.25 —25%.) The list of activities which were considered to be *engagement* were art, blocks, sand/water play, nature/science activities, fine motor activities, math/number, and reading/writing. Use of TV, video and/or computer was not counted as *engagement*. There is ambiguity in research related to the *learning curve* of screen time for preschool children. Research showed that the more time preschool children spent with screens, the less time they stay engaged in creative play (Vandewater, Bickham, & Lee, 2006) and constructive problem-solving (Wyver & Spence, 1999). One study (Christakis & Garrison, 2009) expressed concern that the screen time in home-based childcare programs for preschool age children may double their total amount of screen time. But opposite findings showed that as many as four areas of learning can be supported by technology for preschool age children (Plowman, Stevenson, Stephen, & McPake, 2012). It was assumed that considering use of TV, video and/or computer as an *engagement* may contradict the focus of the study. Dramatic play was also excluded from the list. Although the study admits the significance of dramatic play in preschool age children's learning (Frost, Wortham, & Reifel, 2008; Rowe, 2007), it was difficult for the researcher to identify and code dramatic play behavior accurately. Dramatic play behavior among children was extended beyond the dedicated activity zones for dramatic play in the classrooms. Children were also observed to be engaged in dramatic play with other learning materials like blocks, books, papers, etc. Sometimes, social dramatic play involved only a group of children (no material or activity zone) and it was not possible to code dramatic play systematically without closely following their activities and conversations.

Percentage of Distracted Children

Children who were not attentive during teacher-assisted activities (wondering around, looking outside the window, not paying attention to what the teacher was saying or doing etc.) were counted for a total of 20 minutes. During that course of 20 minutes of observation, the same child was never counted more than once. The measure was expressed as a percentage of the total number of children present in a classroom.

Number of Behavioral Guidance Directives

Number of behavioral guidance directives was the fourth indicator measurement for child engagement in the classrooms. The number of times the teacher(s) gave instructions to control the children in a classroom was counted during both teacher-assisted and free activity sessions. This did not include instructional guidance directives by the teachers. Although it was a behavioral outcome of the teacher, it reflected an overall engagement scenario of children in the classrooms. More behavioral guidance directives were assumed to be associated with poorer learning engagement condition of children and vice versa. Table 4-2 summarizes the calculation and data collection methods of the four measurement indicators of child engagement in the classrooms.

Table 4-2: Dependent variables related to child engagement

	Child Engagement Indicators	Activity Session	Calculation	Data Collection Method	Reference
1	Children's Collective Engagement Level	Teacher-assisted	Scalar (1-3)	Systematic observation	Walsh and Gardner, 2005
2	Percentage of Engaged Children	Free activity	Number of engaged children as a percentage of total number of children	Systematic observation	Proposed new measurement
3	Percentage of Distracted Children	Teacher-assisted	Number of distracted children as a percentage of total number of children	Systematic observation	Proposed new measurement
4	Number of Behavioral Guidance Directives	Teacher-assisted + free activity	Count	Systematic observation	Proposed new measurement

4.3.1.2 Teacher Motivation

Teacher motivation was expressed by two composite measures – teaching motivation and nature-based learning. Data from questionnaire surveys added to the information gathered from systematic observation. Observational methods were suitable for children of 3 to 5 years of age, but in-depth understanding of the phenomena, especially teachers' perspectives regarding the issue, could not be fully understood by observations only. The questionnaire (Appendix 1.6) interview of the teachers provided a standard way of collecting in-depth information. A questionnaire is defined as a series of written questions on a topic about which the respondents' opinions are sought (Sommer & Sommer, 1991). The main purpose of the questionnaire survey was to know about teachers' tendencies to teach children with hands-on lessons and natural elements. Five values were counted with the help of both observational and questionnaire data. The first three measures — *number of hands-on lessons per week (teacher reported)*, *number of innovative lessons per week (teacher-reported*), and *number of hands-on lessons on display (observed)* were added to calculate teaching motivation value. The other two values — *number of lessons per week involving a natural element (teacher-reported)* and *number of nature-based lessons on display (observed)* were added to calculate nature-based lessons.

Number of Hands-On Lessons per Week (Teacher-Reported)

Teachers were asked how many hands-on lessons they used in a typical week. The examples of hands-on lessons included task-based learning techniques that involved the children's effort to prepare the learning materials (Figure 4-4). To make sure that the teachers were reporting a valid count, they were given sufficient time to remember that week's activities. The researcher always asked for examples of that week's hands-on lessons to make sure that the counts were valid.

Number of Innovative Lessons per Week (Teacher-Reported)

Teachers were also asked how many lessons were completely their own ideas. It was expected that more motivated teachers would be more innovative and enthusiastic in trying new things while teaching children.

Number of Hands-On Lessons on Display

The researcher used the systematic observation sheet (Appendix 1.5) to record the number of hands-on lessons in classroom displays (Figure 4-4). Later, this count was verified by matching the numbers from detailed photographs taken inside the classrooms by the researcher.

Number of Lessons per Week Involving a Natural Element (Teacher-Reported)

Teachers were also asked how many times they used a natural element to teach children in a typical week. Examples of such lessons ranged from teaching leaf structures with real leaves to teaching diurnal or seasonal variations by showing the view of the sky through a window. The researcher always asked for examples of that week's nature-based lessons to make sure that the counts were valid and teachers understood the question properly.

Number of Nature-based Lessons on Display

The researcher used the systematic observation sheet (Appendix 1.5) to record the number of nature-based lessons in classroom displays (Figure 4-5). Detailed photographs taken inside the classroom allowed the researcher to verify these counts taken during data collection phase.

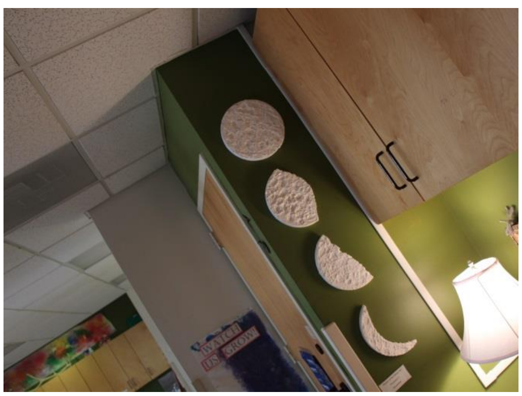


Figure 4-4: Example of hands-on lesson on display

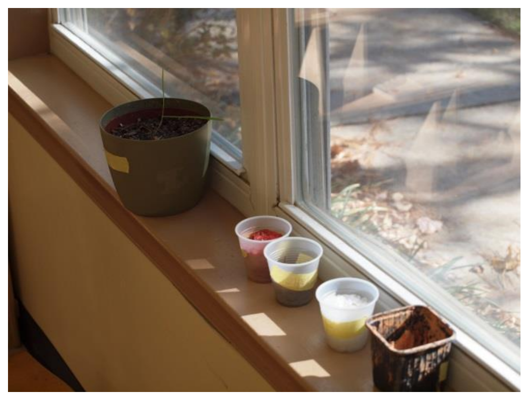


Figure 4-5: Example of nature based lesson on display

Table 4-3 summarizes the different indicators of teaching motivation and their measurements in data collection methods.

Table 4-3: Data collection methods of teacher motivation

	Indicators	Measurement	Data Collection Method	Calculation
Teacher Motivation	Teaching Motivation (in terms of hands-on lessons and teaching innovation)	Number of hands-on lessons per week	Questionnaire survey	Three values were added
		Number of innovative lessons per week	Questionnaire survey	
		Number of hands-on lessons on display	Systematic observation	
	Nature Based Learning	Number of lessons per week with natural elements	Questionnaire survey	Two values were added
		Number of nature based lessons on display	Systematic observation	

4.3.1.3 Tools for Collecting Behavioral Data

The following two tools were used by the researcher for collecting behavioral outcome data (dependent variables).

Systematic Observation Tool

The observation tool (Appendix 1.5) allowed the researcher to systematically collect data related to the four measurements of child engagement. It allowed the researcher to take count of behavioral guidance directives by the teachers in both sessions of teacher-assisted activities and free activities. The researcher used this observational tool also to record the counted number of hands-on lessons and nature-based lessons in the classroom displays. Additionally, this same observation sheet was also used to take notes on date, time, number of children, number of boys and girls, number of teachers and specific weather data as well. The researcher had to work with multiple devices, including pen, paper, notebook, camera, and cell phone (for daylight measurement). The *one-page* observation sheet (Appendix 1.5) increased the efficiency of data collection.

Teacher Questionnaire

The *Teacher Questionnaire* (Appendix 2.6) was also an important tool for collecting behavioral outcomes related to teaching motivation. It contained a total of 28 questions. Numerous other control variable data, including teachers' experiences, their academic qualifications, etc., were also collected by this questionnaire tool. Additionally, the questionnaire contained some open-ended questions to understand how teachers valued indoor-outdoor spatial relationships of space in their everyday teaching and learning activities inside the classrooms.

4.3.2 Independent Experimental Variables

No previous tool/scale was found which measured the indoor-outdoor spatial relationships of a space comprehensively. Therefore, the researcher had to consult several previous studies (see section 2.3.2) for a feasible solution of measuring indoor-outdoor spatial relations in the classrooms. Based on findings presented in Table 2.2 (page 27), four measurement scales were proposed for collecting data regarding architectural indoor-outdoor relationships of space. The four scales, namely *Door Affordance Scale*, *Window Affordance Scale*, *View Affordance Scale* and *Transitional Space Affordance Scale* measured both the quantities and learning affordances of doors, windows, views and transitional spaces, respectively, in the selected preschool classrooms. To be consistent in their measurement, all the four tools used three-point Likert scales (1-3). The researcher used a spreadsheet to collect data (see sample page in Appendix 1.8) with these four scales.

The most significant advantage of these four proposed scales was that they looked into each architectural element (a door, a window, a view and a transitional space) separately and coded their individual learning affordances. The total value of a particular architectural indoor-outdoor characteristic was the sum of its individual items' scores. For example, if a classroom had three windows, which scored 5, 10 and 15 in the *Window Affordance Scale,* respectively, then the total window affordance score of that room would be 5+10+15 = 30. This individual measurement technique gave the scales depth and accuracy for measuring indoor-outdoor spatial relations in the classrooms.

4.3.2.1 Door Affordance Scale

The scale rated only *exterior* doors, which opened directly to the outdoor. Internal doors connecting lobbies, hallways or other classrooms were not considered *exterior* doors, and, hence, were not rated. The two items of this scale (Table 4.4) rated the visibility and the orientation of an exterior door. It was hypothesized that more visibility and transparency in door material would allow more daylight and outdoor views, both of which were considered advantageous for learning and teaching behavioral outcomes. In orientation, south-facing doors got the highest ratings because they allowed diffused daylight (GSA, 2003). East or west-facing was scored lowest because they could cause potential glare.

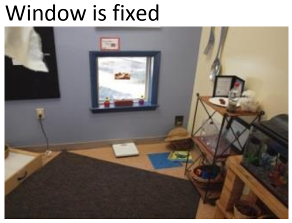
Table 4-4: Door affordance scale

		Door Affordance Scale		
		1	**2**	**3**
1	**Door Visibility**	Door is made of opaque material and has no visibility	Door has partial visibility	Door has full visibility
2	**Door Orientation**	East/west	North	South

4.3.2.2 Window Affordance Scale

Two different studies were discussed (DeBord et al., 2005; Heschong, 2003) to determine the measurement characteristics of window affordance score (see Table 2.2 in page 27). Five characteristic features of a window (Table 4.5) were rated by the *Window Affordance Scale*. The *Window Design* rated the depth of the window sill. Wider depth was assumed to be associated with higher learning affordances because it allowed extra shelving spaces for learning display and activities. *Window Scale* rated the appropriateness of the scale of a window in terms of children's ergonomics. *Window Operability* rated whether the window was fixed or operable to allow fresh air. *Window Visibility* rated the transparency of a window. Finally, *Window Orientation* rated the direction of the window-wall where south-facing windows were rated the best because they allowed desirable diffused daylight in the classrooms.

Table 4-5: Window affordance scale

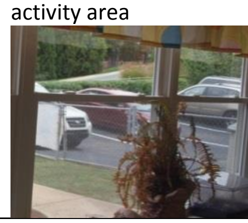
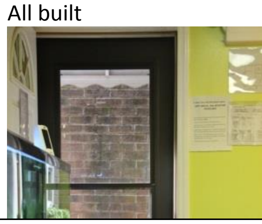
		Window Affordance Scale		
		1	**2**	**3**
1	**Window Sill Depth**	Flat, sill depth is not usable 	Sill depth is sufficient to put small objects 	Sill depth is sufficient to accommodate activities 
2	**Window Scale**	Window scale is not appropriate for children 	Window scale is regular, not designed in child scale 	Window scale is appropriate for children 
3	**Window Operability**	Window is fixed 	Window is partially operable 	Window is fully operable 
4	**Window Visibility**	Window has no visibility	Window has partial visibility 	Window has full visibility with/without operable screens 
5	**Window Orientation**	East/west 	North 	South 

4.3.2.3 View Affordance Scale

The researcher discussed three previous studies (Heschong, 2003; Matsuoka, 2010; Tanner, 2009), as mentioned in section 2.3.2.1, to develop the *View Affordance Scale* (Table 4-7). There were two indicators in this scale. As the mentioned studies have argued that a stimulating view contributed to learning affordances, the first indicator rated a view according to what can be seen in that view. An active area with other children playing, a view of a bird feeder with live birds — these were some examples of highest-rated *view activity*. The other indicator rated the amount of nature in a view. View of nature was found to be associated with positive outcomes for children and teachers in many different studies for other student age groups (Benfield et al., 2013; Matsuoka, 2010). A fully natural view was rated the highest by this scale, while a view without any natural object was rated the lowest.

The researcher used a spreadsheet template (sample page shown in Appendix 1.8) to collect data related to architectural indoor-outdoor relationships of the classrooms. These indoor-outdoor spatial relationship data were usually collected when the classroom was empty or children were in their nap time.

Table 4-6: View affordance scale

		View Affordance Scale		
		1	**2**	**3**
1	**View Activity**	View does not contain any activity area 	View contains monotonous activity area 	View contains interesting area (play area, bird feeder) 
2	**View Naturalness**	All built 	Mostly built 	Mostly/all natural 

4.3.2.4 *Transitional Space Affordance Scale*

Following the clues provided in two previous studies (DeBord et al., 2005; Olds, 2001), this researcher developed the following scale (Table 4-7). The *depth* was considered an important aspect, which determined the usability of the transitional space. One of the most significant aspects of the transitional space was the opportunity to grow plants in it. The second indicator attempted to rate the level of vegetation in a transitional space. The third indicator rated the appropriateness of the surface material for children's usage. The fourth indicator rated seating opportunities in the transitional space. It was assumed that dedicated activity zones in the transitional space would enhance indoor-outdoor interactions of children and their teachers in a classroom. Therefore, the fifth and final indicator rated the number of activity zones present in the transitional spaces observed.

Table 4-7: Transitional space affordance scale

		Transitional Space Affordance Scale		
		1	**2**	**3**
1	**Usability of the transitional space**	Transitional space is narrow and not usable (depth is less than 6 feet)	Transitional space has minimum depth for child usage (depth is 6 – 8 feet)	Elaborate transitional space (depth is 15 feet or more)
2	**Vegetation**	No trees, shrubs, planters or soft surface in transitional space	Few trees or shrubs or planters or soft surface.	Transitional space is well designed to accommodate planting
3	**Material**	Surface material is hard and dangerous for free play	Surface material is soft but the transitional space is not fully safe for free child activities	Surface of the transitional space is made with child friendly material.
4	**Seating Provisions**	No seating provision in transitional space	Transitional space is designed with child scale seating provision	
5	**Activity Zones**	No activity zones in the transitional space	One activity zone in the transitional space	More than one activity zone in the transitional space

4.3.3 Independent Control Variables

As discussed earlier in literature review and conceptual framework, three sets of control variable data were collected for this study. They are: 1) physical environmental attributes, 2) human factors and 3) learning environmental attributes. The following discussion summarizes the data collection methods for the control variables of the study.

4.3.3.1 Physical Environmental Data

Three sub-sets of physical environmental data were collected: a) weather data, b) center-specific data and c) classroom characteristics.

Mean Temperature data of the day of observation was recorded from the official weather website provided by the National Weather Services (http://www.weather.gov/).

Weather Condition was measured by the proposed scale in Table 4-8. This data tried to capture the momentary condition of the weather during the data collection period.

Table 4-8: Weather condition and sky condition scales

	Extreme	Moderate	Good
Weather Condition Scale	1 = snow/storm/heavy rain/tornado warning/below 40 ^{o}F/over 90 ^{o}F	2 = cold — 40 ^{o}F to 60 ^{o}F/moderate rain/hot 80 ^{o}F to 90 ^{o}F	3 = sunny/overcast good weather — 60 ^{o}F to 80 ^{o}F
Sky Condition Scale	1 = Cloudy/snowy/foggy	2 = Overcast	3 = Sunny

Sky Condition tried to capture another parameter of the weather during the time of observation. Again, a proposed scale was used, in which a sunny condition was rated the highest (Table 4-8).

The daylight factor (DF) is a metric used to quantify the amount of diffused daylight in a space. (Diffused daylight is light that has been scattered in the atmosphere before reaching the Earth's surface). It is usually measured at the height of the work plane (e.g., a desktop), under a standardized overcast sky. It is defined as the ratio of the luminance of a point in a building and the luminance at an unshaded outside point facing upward (Otis & Reinhart, 2009)

$DF = (E_{in} / E_{ext}) \times 100$

E_{in} : Interior luminance at a fixed point on the work plane.

E_{ext} : Exterior luminance under an overcast sky.

The researcher used a smart phone app called LuxMeter and used his mobile phone device to collect daylight luminance data. Usually, when the classroom was empty, the researcher turned off all electric lights in the room and measured luminance with the tool in three different points of the room. The average value of the three measurements was used for the measurement of DF for that location. The DF data was not used as a variable in the research; rather, it was used to validate the proposed indoor-outdoor spatial relationship measurement scales.

Daylight Code data of each classroom was assigned based on the observation of the researcher (Table 4-9). This scale was retrieved from the Heschong study (Heschong, 2003).

Table 4-9: Daylight code scale (source Heschong, 2003)

Daylight Code	Description
Daylight Code 0	No daylight in classroom.
Daylight Code 1	Minimal daylight.
Daylight Code 2	Some daylight in classroom, but insufficient for normal operation without electric lights.
Daylight Code 3	Daylight in part of the classroom, which would allow occasional turning off of part of the electric lights. This might translate to approximately 5-15% potential electric lighting savings.
Daylight Code 4	More asymmetrical daylight allowing operation of classroom without electric lights occasionally in all or frequently in parts of the classroom. This might translate to approximately 20- 40% potential electric lighting savings.
Daylight Code 5	Even and balanced daylight allowing operation of classroom without electric lights for a large portion of the school year. This might translate to approximately 45-75% potential electric lighting savings during daylight hours.

However, this variable was later dropped because of its subjectivity and the researcher's limitations in not being able to assess the percentage usage of electric lights.

License Star Rating data of each of the centers was available in their respective websites.

A small questionnaire (Appendix 1.7) was used to collect center-level data regarding *Total Number of Children*, *Total Number of Teachers*, *Building Age (years), Building Function, Building Type,* and *Years of Operation*. *In addition, Building Footprint* of the center was measured by a web tool know as Free Map Tools (http://www.freemaptools.com/).

Size of Classrooms was measured by the researcher with the help of a measuring tape. *Area per Child* was a simple composite measure derived by dividing the size of the classroom by the observed number of children present in the classroom. *Open Floor Area (%)* was measured as the percentage open floor space in the total classroom area. The researcher, with a measuring tape, measured the approximate furniture area of the classroom and later subtracted the value from the measured total *classroom size* to get the value of open floor space in the classroom.

4.3.3.2 Human Factors (Children and Teacher Characteristics)

Following child and teacher characteristics data were collected by the researcher.

Number of Children and *Number of Teachers* were directly observed data. *Children per Teacher* was a composite measure from the observed number of children and teachers. Gender of children was measured as *Percentage of Girls* and *Percentage of Boys*.

Teachers' Academic Qualification data and *Teachers' Years of Experience* were collected from the questionnaire survey. Teachers' educational qualification was rated in a scale of 1 to 5 (1=high school, 2=high school and some college, 3=college degree, 4=master's degree, 5=master's and childcare/child development master's degree or PhD).

4.3.3.3 Learning Environment Data

The ECERS-R (Early Childhood Environment Rating Scale – Revised Edition) as described earlier in section 2.3.3.3, provided a comprehensive way to look into learning environmental factors that may influence behavioral outcomes and performance (Harms et al., 2005). The ECERS-R has seven subscales (Harms et al., 2005). This study considered four subscales to be relevant for the current research. They are *space and furnishing*, *language-reasoning, activities* and *program structure*. The researcher is interested to know more about the physical features of the learning environment. This is why those four subscales of ECERS-R were used to collect learning environmental data. In addition to ECERS-R, the researcher also counted the total number of different activity zones in the classroom as an additional measure of the learning environment quality of the classroom.

Table 4-10 summarizes the independent control variables and their individual measurement techniques.

Table 4-10: List of control variables and their measurement techniques

Variable groups	Variable sub-groups	Variable names	Too/Scale	Data collection methods
Physical Environmental Data	1. Weather variables	1. Mean temperature (^{o}F)	Web data	Collected from http://www.weather.gov/
		2. Weather condition	Scalar (1-3)	Observational
		3. Sky condition	Scalar (1-3)	Observational
		4. Day Light Factor (DF)	DF = (E_{in} / E_{ext}) × 100	By LuxMeter app in cell phone device
		5. Daylight Code	Scalar (0-5)	Observational
	2. Center data	6. Center star rating	Scalar (1-5)	From center website
		7. Number of children	Count	Director questionnaire
		8. Number of teachers	count	Director questionnaire
		9. Years of operation	Year	Director questionnaire
		10. Building type	Redesigned/renovated/new design	Director questionnaire
		11. Building foot print (ft^2)	ft^2	Web tool
	3. Classroom characteristics	12. Classroom size	ft^2	Direct measurement
		13. Area per child (ft^2/child)	Area divided by observed number of children	Composite measure
		14. Open space (%)	Open space x 100/ classroom size	Direct measurement
Human Factors	4. Number of observation	15. Number of children	Count	Observational
		16. Number of teachers	Count	Observational
		17. Children per teacher	Number of children/number of teachers	Composite measure
	5. Children demography	18. Percentage of girls	%	Observational
		19. Percentage of boys	%	Observational
		20. Average age of children	year	Questionnaire teacher
	6. Teacher data	21. Teacher qualification	Scalar (1-5)	Questionnaire teacher
		22. Teacher experience	years	Questionnaire teacher
Learning Environmental Data	7. Indoor learning environment quality	23. ECERS-R Space & Furnishing	ECERS-R subscale	Observational
		24. ECERS-R Book & Picture	ECERS-R subscale	Observational
		25. ECERS-R Activities	ECERS-R subscale	Observational
		26. ECERS-R Program Structure	ECERS-R subscale	Observational
		27. Number of activity zones	Count	Observational

4.4 Data Analyses Methods

For data analysis, statistical regression will be employed. A research study that tries to understand and predict relationships among several variables, multiple regression is frequently employed as an analytical tool. It is one of several devices that can be used to describe the strength and direction of relationships among two or more variables (Groat & Wang, 2001). This study aims to explore the nature of the relationship between numerous built environment variables and a number of outcome variables related to child engagement and teacher motivation in preschool classrooms. Regression can provide a mathematical equation that indicates the amount of variance contributed to the differences in the dependent variables by each of the independent variables (indicators of indoor-outdoor relationship of space). Regression equations also tell how much the dependent variable changes or are associated with changes in the independent variable(s). For these reasons, regression analysis is chosen for this research. The statistical methods for this research are elaborately discussed in sections 5.2 and 5.3.

Chapter 5 : Statistical Analyses

The research investigates the relationship between specific architectural elements and learning behavior in a preschool classroom setting. As elaborated in the literature review, indoor-outdoor spatial relations were highlighted as an important design aspect for a learning environment for young children. But does rich indoor-outdoor spatial relation really help learning and teaching activities? Are doors, windows, views and transitional spaces significant predictors of learning and teaching behaviors of children and their teachers in a preschool classroom? No previous study was found that attempted to answer these questions with empirical evidences. In this chapter, the researcher attempts to investigate whether indoor-outdoor relations truly facilitate learning and teaching behavior by statistical analyses of the data collected from the 22 sample classrooms of the study.

The main research questions of this study concern the relationship of indoor-outdoor space with child engagement and teacher motivation. This study has employed different measures to represent child engagement in learning and teachers' motivation to promote hands-on lessons in their classrooms. Child engagement was defined by four different variables. Two positive indicators, namely *children's collective engagement level* and *percentage of engaged children,* measured how positively children were engaged in learning activities during teacher-assisted and free activity sessions respectively. Two negative indicators were also employed, namely *percentage of distracted children* and *number of behavioral guidance directives*. It was assumed that teachers need to use fewer behavioral guidance directives when the level of engagement of children is higher and vice versa. Using both positive and negative measures as dependent variables for child engagement provided opportunities to test predictive validity of these measures (see section 5.1.3). Teaching motivation is defined as teachers' enthusiasm to prepare the learning environment. How many lessons they create and how much they involve the children in the process by hands-on lessons were considered two important aspects of teaching motivation. How much the teachers used natural elements to teach was also measured as an indicator of teaching motivation. Since indoor-outdoor relation affords ways to bring the outdoors inside a classroom environment, it was hypothesized that stronger indoor-outdoor spatial relations would predict higher usage of natural elements in teaching and learning. The researcher has the concern that other variables, such as children's demography, teachers' experience or qualification, learning environment qualities of classrooms, etc. might be associated with both children's engagement in learning and teachers' motivation to teach. To make sure that these variables do not explain away the entire association between indoor-outdoor spatial relations and child engagement or teaching motivation, a total of 19 control variables were adopted. These control variables are discussed (see section 5.1.5) in three groups: a) physical environmental attributes, b) human factors, and c) learning environmental attributes. These control variables were selected and defined by previous studies. Adopting these control variables made sure that any observed effect of the *indoor-outdoor* predictors can be said to be *independent of* the effects of those control variables. The experimental *indoor-outdoor* spatial characteristics are defined by four predictors: door affordance, window affordance, view affordance and transitional space affordance (elaborated in section 5.1.4). The scales used to measure these 4 predictors were based on previous literature and captured not only the quantities of doors, windows, views and transitional spaces; but also attempted to evaluate their learning affordances. The chapter is divided into two sections. The first section (5.1) presents the summary statistics for dependent and independent variable measures of the research. The second section (5.2) discusses the predictive power of independent variables for each of the six dependent variables of the study.

5.1 Descriptive Statistics

The unit of analysis is classroom. Data were collected from 22 different preschool classrooms in eight childcare settings. The average number of children in the classrooms was 13.4. A total of 295 children were observed in those classrooms for data collection on children's engagement in learning. Twenty-six teachers/caregivers were also observed. Questionnaire survey data were collected from the 26 teachers during face-to-face interviews. Out of the eight centers, six were rated as having five stars by the Division of Children Development and Early Education (Bryant, 2000). The remaining three centers had four-star ratings during the time of data collection. The rating system is specifically designed to measure quality based on program standards and staff education every three years. The low variance in the scores and uncertain importance of the difference between four and five stars resulted in exclusion of this variable from the main analyses. Six buildings of the eight centers were newly designed as care facilities and one was renovated from a residence. One center operated inside a church building. By law, any newly designed building for a childcare center is required to have a total windows area of at least 8% to 20% (based on the facing of the classroom) of the floor area (GSA, 2003). These centers, being more newly designed, were likely to have more designed features such as doors, windows, transitional spaces, etc. Other relevant center data is listed in Table 5-1. Average number of children in the centers was 118. The smallest center had only 20 children and four teachers while the biggest one had 280 children and 47 teachers. Size of the buildings ranged from 1000 square feet to 32000 square feet

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Table 5-1: Data of sample childcare centers (n = 8)

	Minimum	Maximum	Mean	Std. Deviation
Number of children	20	280	117.50	99.93
Number of teachers	4	47	19.00	14.95
Years of operation	5	20	13.25	4.77
Building foot print (ft^2)	1000	32000	13249.00	11451.37

Center data were not listed as independent variables of the study mainly for two reasons. First, all behavioral (both observational and survey) data were collected inside classrooms and built environmental variations of the centers were considered distal and redundant for statistical analyses of the study. Second, and more importantly, lack of variability occurred among center data (n = 8). Too few centers were involved for meaningful analysis with center-level measures, so none were used in the regression analyses.

5.1.1 Dependent Variables of Child Engagement

Table 5-2 describes the four characteristic measurements of child engagement. They are a) children's collective engagement level, b) percentage of engaged children, c) percentage of distracted children, and d) number of behavioral guidance directives.

Table 5-2: Data on child engagement (n = 22)

Variables	Minimum	Maximum	Mean	Std. Deviation
children's collective engagement level	1	3	2.32	0.78
percentage of engaged children	0	33	15.50	4.77
percentage of distracted children	0	50	16.64	13.86
number of behavioral guidance directives	1	18	6.09	5.43

Children's collective engagement level was measured in a scale of 1 to 3, with 1 being the lowest and 3 the highest level of collective engagement during teacher-assisted activities. The mean value of children's collective engagement level in the 22 classrooms is as high as 2.32, meaning children were overall well-engaged during teacher-directed activity periods in the classroom. The average value of percentage of engaged children and percentage of distracted children was 15.5% and 16.64%, respectively. The percentage of distracted children ranged from 0 to 50% and the percentage of engaged children ranged from 0 to 33%. The mean value of behavioral guidance directives was 6.09. The lowest number of observed behavioral guidance directives by teachers to control children was one in a classroom. On the other hand, as many as 18 occurrences were observed in the classrooms in which teachers struggled the most to control children. The frequency distribution of the number of behavioral guidance directives by teachers in the 22 classrooms is illustrated in Figure 5-1.

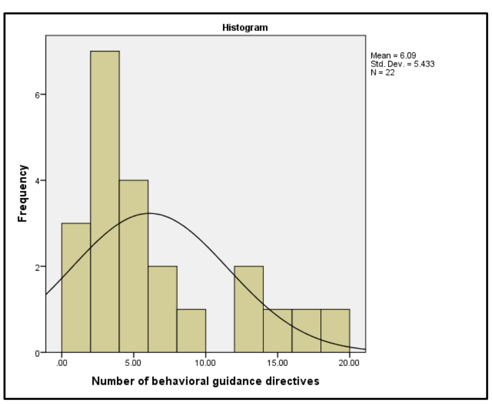


Figure 5-1: Histogram of number of behavioral guidance directives (n = 22)

The distribution is skewed to the right (positive skew), meaning sample classrooms were concentrated to fewer numbers of behavioral guidance directives in the distribution and high occurrences of such directives by the teachers were rare.

5.1.2 Dependent Variables of Teaching Motivations

The teaching motivation was a composite measure. It was the sum of three different indicators – a) number of hands-on lessons in a week (teacher-reported), b) number of innovative lessons in a week (teacher-reported), and c) number of hands-on lesson displays. A separate indicator was also employed to understand the impact of indoor-outdoor space on teachers' tendencies to teach with natural elements. This second dependent variable indicator for teaching motivation is measured by the sum of observed and teacher-reported number of lessons involving natural elements. The descriptive statistics of these datasets are given in Table 5-3.

Table 5-3: Descriptive statistics of teaching motivation variables (n = 22)

Variables	Minimum	Maximum	Mean	Std. Deviation
Number of hands-on lessons in a week	1	12	5.55	3.26
Number of innovative lessons in a week	2	8	3.59	1.84
Number of hands-on lesson displays	1	11	5.27	2.51
Teaching Motivation	5	29	14.45	6.87
Nature based lessons	1	21	7.18	4.78

Cronbach's Alpha (coefficient of internal consistency) among the three indicators of teaching motivation was calculated as 0.835, indicating high internal consistency (Bland & Altman, 1997). These three values were added to constitute the *teacher motivation* score. The mean value of teaching motivation was 14.45. The range of teaching motivation score was 5 to 29, with a standard deviation of 6.87. The mean value of nature based lessons was 7.18. The lowest number of nature-based lessons in a classroom was 1 and the highest was 21. Figure 5-2 and Figure 5-3 portray the frequency distributions of teaching motivation and nature-based lessons. Teaching motivation scores appear to have a normal distribution while the number of nature based lessons was skewed to the right (positive skew).

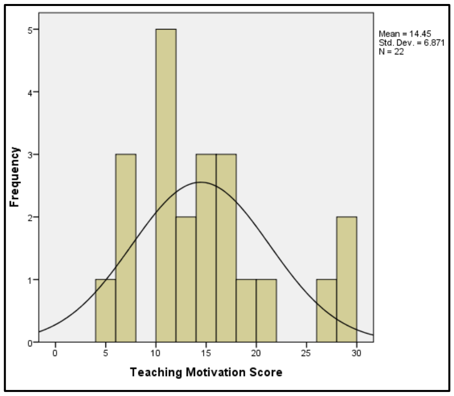


Figure 5-2: Histogram of teaching motivation score (n = 22)

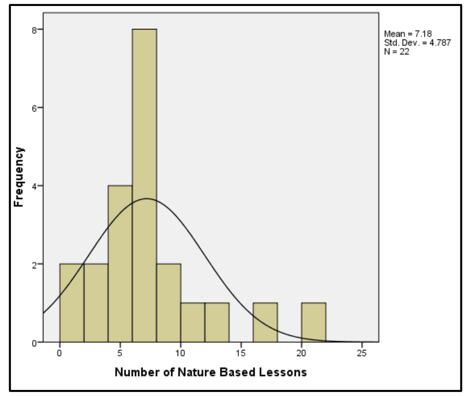


Figure 5-3: Histogram of nature based lessons (n = 22)

5.1.3 Interrelation among the Dependent Variables

Two-tailed Pearson correlations were investigated for all of the six dependent variables of the study (Table 5-4). It was important to understand the interrelations among the dependent variables to examine whether the relationships are meaningful and meet expectations.

Table 5-4: Interrelation between dependent variables of the study (n = 22)

	Children's collective engagement level	Percentage of engaged children	Percentage of distracted children	Number of behavioral guidance directives	Teaching motivation	Number of nature based lessons
Children's collective engagement level	1	0.301	-0.130	-0.423**	0.264	0.443**
Percentage of engaged children		1	-0.101	0.394*	0.641***	0.695***
Percentage of distracted children			1	0.519**	0.008	-0.111
Number of behavioral guidance directives				1	-0.396*	-0.392*
Teacher motivation					1	0.888***
Number of nature based lessons						1

***Correlation is significant at the 0.01 level (two-tailed)
**Correlation is significant at the 0.05 level (two-tailed)
*Correlation is significant at the 0.10 level (two-tailed)

Four significant correlations were found at the p < .01 level (highlighted in orange), three significant correlations were found at the p < .05 level (highlighted in yellow), and five significant correlations were found at the p < .10 level (highlighted in green). Children's collective engagement level was negatively correlated at p < .05 level with the number of behavioral guidance directives. It met general expectations that fewer directives by teachers were needed when children's engagement level was high. Children's collective engagement level was also significantly (p < .05 level) correlated with the number of nature-based lessons – meaning children's collective engagement level was likely to be higher with teachers' tendencies to use natural elements to teach. The percentage of engaged children, as expected, had a significant (p < .01 level) correlation with both teaching motivation and nature-based lessons — meaning children were more likely to engage in activities when teaching motivation and nature-based learning were high in a classroom. The percentage of distracted children was significantly (p < .05 level) correlated with the number of behavioral guidance directives. It was understandable that teachers were likely to use more directives when the percentage of distracted children was higher. The number of behavioral guidance directives was negatively correlated with both variables of teaching motivation at p < .10 level – assuming more motivated teachers tend to use fewer directives to control children. Teaching motivation score was significant (p < 0.01 level) with teachers' tendencies to teach with natural elements. Overall, the directions and significances of the relationships among the dependent variables were mostly consistent with expectations.

5.1.4 Independent Experimental Indoor-Outdoor Variables

The four independent experimental *indoor-outdoor* variables of the study are door affordance, window affordance, view affordance and transitional space affordance. Descriptive statistics for these four indicators of indoor-outdoor spatial relations are given in Table 5-5.

Table 5-5: Descriptive statistics of indoor-outdoor variables (n =22)

Variable	Minimum	Maximum	Mean	Std. Deviation
Door affordance	3.00	10.00	5.36	1.94
Window affordance	0.00	107.00	47.50	34.01
View affordance	0.00	34.00	18.13	11.13
Transitional space affordance	0.00	20.00	7.00	8.15

The average scores for door affordance, window affordance, view affordance and transitional space affordance were 5.36, 47.50, 18.13 and 7.00, respectively. A minimum score of zero for window, view and transitional space score represented extreme cases were classrooms were found without window, view or transitional space. However, the lowest door score found was 3, meaning every room had minimum of one door that opened directly to the outside. The door score had a relatively small standard deviation of 1.94, which met expectations, because the number of doors opening directly to the outside was usually limited to 2 or 3. On the other hand, the window score ranged from 0 to 107, with a high standard deviation of 34.01.

Frequency distributions for window scores and transitional scores are shown in Figure 5-4 and Figure 5-5, respectively. Figure 5-4 shows that as many as four classrooms were observed to have no window. Out of the 22 classrooms, 12 did not have any transitional space (Figure 5-5).

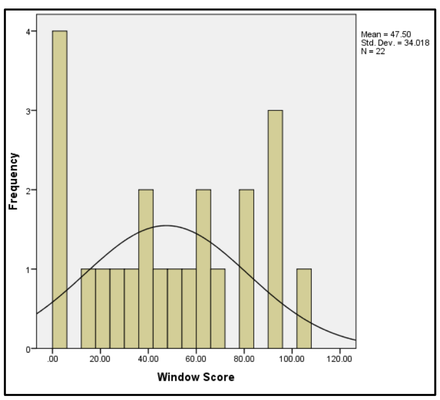


Figure 5-4: Histogram of window affordance score (n = 22)

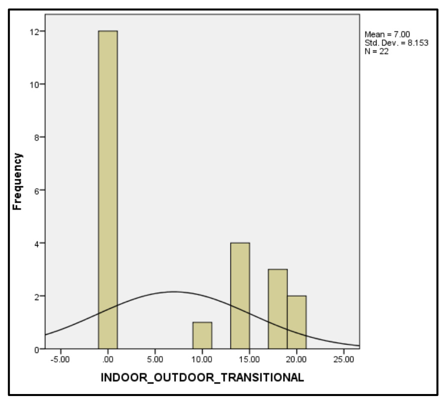


Figure 5-5: Histogram of transitional space affordance score (n = 22)

5.1.5 Independent Control Variables

As mentioned earlier, descriptive statistics of independent control variables are discussed under four groups. They are : a) physical environmental attributes, b) human factors, and c) learning environmental attributes.

5.1.5.1 Physical Environmental Attributes

The physical environmental attributes had two sub-groups – weather variables and attributes of classroom size/space. Weather indicators such as thermal comfort, amount of daylight, etc. were found to have associations with human behavior and performance in many previous literatures (discussed in Chapter 2). Since this study is measuring human behavioral data (child engagement and teacher motivation) as dependent variables, it was important to control for primary weather data of the time of observation. Data were collected from mid-October to the end of November in 2013. The mean recorded temperature of the observation days was 50.11^{o} F. The lowest and highest temperatures recorded in the dates of observations were 29.20 ^{o}F and 72.40 ^{o}F, respectively (Table 5-6).

Table 5-6: Descriptive statistics of weather variables (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
Mean temperature (^{o}F)	29.20	72.40	50.21	11.88
Weather condition	1	3	2.14	0.640
Sky condition	1	3	2.64	0.790

Temperature alone was considered insufficient to portray the overall weather and two additional measurements were recorded during the times of observation. Weather condition ranged from a value of 1 to 3, with 1 being the poorest (snow/storm/heavy rain/tornado warning/below 40 ^{o}F/over 90 ^{o}F), 2 being moderate (cold 40 ^{o}F to 60 ^{o}F/moderate rain/hot 80 ^{o}F to 90 ^{o}F) and 3 being good (sunny/overcast good weather 60 ^{o}F to 80 ^{o}F) based on human comfort criteria (Höppe, 2002). Similarly, sky condition also ranged from a value of 1 to 3, with sunny clear sky rated as the best sky condition.

Table 5-7 describes data related to classroom size and space. It was assumed that less dense classrooms would perform better in terms of child engagement and teachers' performance because they offer more flexibility. The average size of the 22 sample classrooms was 1065.45 square feet. The smallest and largest classrooms observed were 720 square feet and 1450 square feet, respectively.

Table 5-7: Descriptive statistics of variables related to classroom size (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
Classroom size (ft^2)	720	1450	1065.45	200.75
Area per child (ft^2/child)	40.00	140.00	81.33	32.62
Open floor space in classroom	29.23	78.77	56.15	13.38

The most congested classroom had 40 square feet of floor area per child. It is noticeable that the mean value (81.33 square feet) of area per child in the 22 classrooms is almost three times the minimum required value (25 square feet) as stated by the North Carolina General Statutes on mandatory standards for a license (NCGA, 2012). Since all the centers had high license ratings (four and five stars), it was expected that they would provide large classrooms with spatial flexibility.

Figure 5-6 and 5-7 shows the frequency distributions of classroom size and open floor space (%) inside the classrooms. Classroom size had a normal distribution while open floor (no furniture) space was skewed to the left (negative skew) – meaning sample classrooms were concentrated with more openness, and congested rooms with more furniture and less open floor areas were rare.

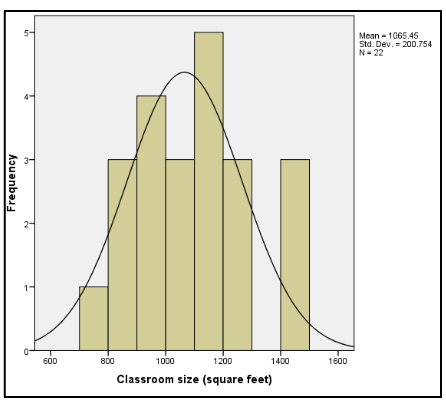


Figure 5-6: Histogram of classroom size (n = 22)

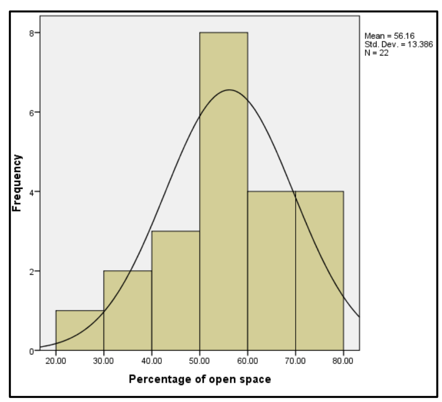


Figure 5-7: Histogram open space percentage (n = 22)

5.1.5.2 *Human Factors – Child and Teacher Data*

Children-teacher ratio is an important indicator of the overall learning environment of a classroom. It is expected that lower numbers of children per teacher would ensure higher quality of care and teaching, resulting in higher child engagement and teaching motivations. Table 5-8 describes data related to the number of observed children and teachers. The average number of observed children in the 22 sample classrooms was 13, with the lowest at 6 and the highest at 22.

Table 5-8: Descriptive statistics of children and teacher number (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
Number of children	6	22	13.41	5.22
Number of teachers	1	2	1.18	0.39
Children per teacher	6.00	22.00	11.79	4.91

In most cases, there were one to two teachers present in the classroom during observations. The average number of children per teacher was close to 12, which was more than the allowable ratio of 1:10 for that particular age range of children (NCGA, 2012). This may be caused by outliers in the small sample size of 22 classrooms. Also, children (and teachers) were counted during the time of observations. The high mean value of child:teacher ratio may also be attributed to an unusual event on the specific days of observation (such as an absent teacher or two merged classrooms, etc.).

The children's demographic data were considered to be important factors, especially when dealing with their collective behavior. Among the 295 children observed in the 22 classrooms, 52.3% were boys and 47.7% were girls. Average age of the children was 3.75. Table 5-9 shows the descriptive statistics of children's demographic data in the 22 classrooms.

Table 5-9: Descriptive statistics of observed children's demography (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
Percentage of boys	36.36	66.67	52.30	8.74
Percentage of girls	33.33	63.64	47.70	8.89
Average age of children in classroom	3.00	5.00	3.75	0.75

It was expected that teachers' qualification and experience would influence child engagement. They were also expected to be strong predictors of teaching motivation. The teachers' educational qualification was rated in a scale of 1 to 5 (1=high school, 2=high school and some college, 3=college degree, 4=master's degree, 5=master's and childcare/child development degree or PhD). For experience, the number of years in childcare services was recorded. In cases when two (or more) teachers were present in a classroom, the mean value of their qualification and experience was calculated for that particular classroom. Teachers' data are reported in table 5-10. The mean value of their academic qualification was 2.95 in a scale of 5, and the mean experience time was 5.45 years.

Table 5-10: Descriptive statistics of teacher data of qualification and experience (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
Teacher's qualification	1	5	2.95	1.25
Teacher's experience (years)	1.00	22.00	5.45	5.86

Figure 5-8 and Figure 5-9 shows the frequency distribution of teacher qualification and experience in those 22 classrooms. Teacher qualification has a normal distribution while teachers' experience (years) is skewed to the right (positive skew) – meaning teachers were more concentrated in fewer years of experience in the sample classrooms (n = 22).

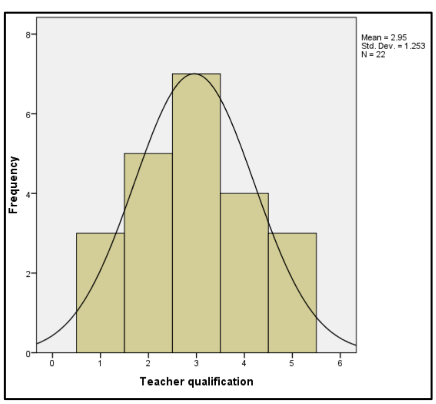


Figure 5-8: Histogram of teacher qualification

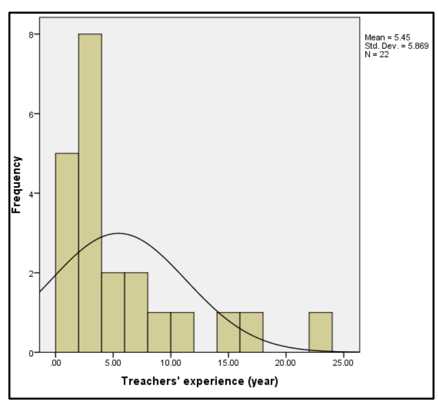


Figure 5-9: Histogram open space percentage

5.1.5.3 Learning Environmental Attributes

Indoor-outdoor spatial relation is not the only built-environment factor which is assumed to have predictive power in explaining variances in child engagement and teacher motivations. In a preschool classroom, the learning environment qualities are strong determinants of children's learning and teachers' teaching behavior. An established, validated and reliable scale known as The Early Childhood Environment Rating Scale –Revised (ECERS-R; (Harms et al., 2005) was used to measure four different aspects of the indoor learning environment qualities of the 22 sample classrooms. Table 5-11 contains descriptive statistical data regarding the indoor environment qualities. Four ECERS-R variables were measured in the specified scale ranging from 1 to 7 (Harms et al., 2005).

Table 5-11: Descriptive statistics of indoor environment qualities (n = 22)

	Minimum	Maximum	Mean	Std. Deviation
ECERS-R: space and furnishing	1.75	7.00	4.26	1.56
ECERS-R: books and pictures	2.00	6.00	4.59	1.33
ECERS-R: activities	2.20	6.20	4.13	1.26
ECERS-R: program structure	2.67	6.67	4.75	1.40
Number of activity zones in classroom	4.00	11.00	8.90	2.48

Besides ECERS-R, the number of different learning activity zones was also counted for the 22 classrooms. Total number of different activity zones in a classroom had a mean value of 8.9, which was close to the maximum (11). It was almost equal to the number of activities enlisted in the ECERS-R. Since all the centers had high license ratings, this finding was consistent with expectations as well.

5.2 Looking for a Relationship: Hierarchical Multiple Regression

Multiple regression is a powerful set of methods used as a data-analytic strategy to explain or predict a criterion (dependent) variable with a set of predictor (independent) variables (Petrocelli, 2003). Hierarchical Multiple Regression was chosen for the statistical analyses of the study. It is a variant of the basic multiple regression procedure that allows a research design to specify a fixed order of entry for variables in order to control for the effects of covariates or to test the effects of certain predictors independent of the influence of others.

5.3 Why Hierarchical Multiple Regression?

Hierarchical regression involves theoretically based decisions for how predictors are entered into the analysis. Simultaneous and stepwise regression are typically used to explore and maximize prediction, whereas hierarchical regression is typically used to examine specific theoretically based hypotheses (Aron, 2012; B. H. Cohen, 2008). This research explores how indoor-outdoor variables stand out as predictors of teacher motivation and child engagement in comparison with other important predictors. Hierarchical multiple regression is particularly suitable for testing theoretical assumptions and examining the influence of several predictor variables in a sequential way, so that the relative importance of a predictor may be judged on the basis of how much it adds to the prediction of a criterion, over and above which can be accounted for by other important predictors. Also the models tell us how strongly a variable is related to a dependent variable net the effects of another variable (s) and as new variables are added to the equation.

5.4 Precautions for Collinearity

When two or more predictors are linearly related, they are said to be *collinear* and the general problem of predictors with close (but perhaps not perfect) linear relationships is called the problem of *collinearity* (De Veaux, Velleman, & Bock, 2005). Collinearity in a multiple regression is considered to be a common phenomenon, which can create a number of problems in the analysis. Collinearity can increase estimates of parameter variance; yield models in which no variable is statistically significant even though R^2 (coefficient of determination) is large, produce parameter estimates of the *incorrect sign* and of implausible magnitude, create situations in which small changes in the data produce wide swings in parameter estimates, and, in truly extreme cases, prevent the numerical solution of a model (Belsley, Kuh, & Welsch, 2005; Greene, 2003). These problems can be severe and mislead the analysis. It is important to take appropriate precautions to restrict the negative effects of collinearity. The following 2 sections discuss strategies for assessing and controlling the effects of collinearity in the regression models.

5.4.1 Assess Collinearity by Calculating Tolerance

One easy way to measure how much one predictor is linearly related to the others is to find the regression of that predictor on the others and look at the R^2 (De Veaux et al., 2005). The R^2 gives the fraction of the variability of the predictor in question that is accounted for by the other predictors. Therefore, $(1 - R^2)$ is the amount of the predictor's variance that is left after the effects of the other predictors. This measure is what the predictor has left to bring to the regression model and is known as the *tolerance*. The *tolerance* thus represents the proportion of variance in the independent variable that is not related to the other independent variables in the model.

A tolerance level of 0.10 or even as high as 0.25 have been used as rules of thumb to indicate excessive or serious multi-collinearity (O'Brien, 2007). For this study, any tolerance smaller than or equal to 0.10 was considered severe for a regression model and alternative models were proposed to control its effects. Since the threshold value for $(1 - R^2)$ is 0.10, the study can calculate the respective threshold value for correlation coefficient R to be 0.949. If there is any correlation between any two independent variables with a coefficient close to this value, the research has to take precautions for controlling collinearity effects.

5.4.2 Strategies for Controlling Collinearity Effects

Three strategies are commonly proposed to prevent collinearity effects (Figure 5-10). They are:

1. Increasing sample size
2. Eliminating redundant variables
3. Combining highly correlated variables

Increasing the sample size was not a viable option for this research due to limitations of time and resources. A more reasonable approach for this study is to eliminate or combine highly correlated independent variables. However, doing so should be theoretically motivated (O'Brien, 2007). Yet, examining the bivariate correlations among all the independent variables will find only associations among pairs of predictors. Collinearity can – and does – occur among several predictors working together (De Veaux et al., 2005) and investigating pairwise relationships may not suffice for identifying and controlling collinearity. In each of the individual regression models (Table 5-15 to

Table 5-20), *tolerance* was measured separately. Alternative regression models were suggested (dropping variables) for instances where tolerance was smaller than or equal to 0.10.

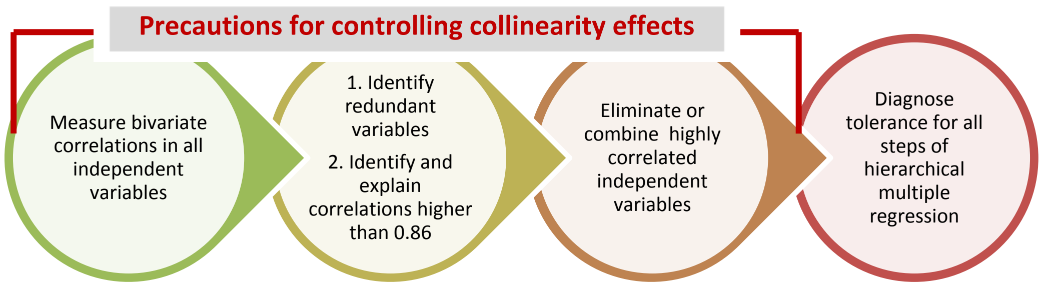


Figure 5-10: Strategy for controlling collinearity effects

5.5 Identifying Collinearity Risks: Bivariate Correlations of Independent Variables

The first precautionary step for controlling the effect of collinearity was to investigate pairwise correlations among all independent variables of the study and identify highly correlated independent variables. Since the study has already defined the threshold to be a tolerance level of 0.10, the estimate threshold of correlation coefficient was calculated to be 0.949. A tolerance lower than 0.10 was identified as collinearity threat in all stages of regression analyses. However, to minimize collinearity threat, any bivariate correlation equal to or greater than 0.85 was treated with caution. A two-tail Pearson correlation was conducted in SPSS among all 23 independent variables (19 control variables and 4 experimental variables) of the study to identify highly correlated pairs (equal to or greater than 0.85).

5.5.1 Elimination of Redundant Variables

All bivariate correlations with a coefficient equal to or greater than 0.85 were identified at the beginning. Among the weather variables, *mean temperature* was highly correlated (R = .916) with *weather condition* (Table 5-12). As discussed in section 5.1.6.1, weather condition was a customized scale to describe the overall weather of the day from a value of 1 to 3, with 1 being the poorest (snow/storm/heavy rain/tornado warning/below 40 ^{o}F/over 90 ^{o}F), 2 being moderate (cold 40 ^{o}F to 60 ^{o}F /moderate rain/hot 80 ^{o}F to 90 ^{o}F) and 3 being good (sunny/overcast good weather 60 ^{o}F to 80 ^{o}F). However, because this measure was so highly correlated with mean temperature, it was considered to be a redundant one. Mean temperature was kept in the analysis because it was an objective measure and expected to be free of subjective biases.

Table 5-12: Correlation matrix of weather variables

	Mean Temperature	Weather Condition	Sky Condition
Mean Temperature	1	0.916**	0.364*
Weather Condition		1	0.480**
Sky Condition			1

**Correlation is significant at the 0.05 level (2-tailed).
*Correlation is significant at the 0.10 level (2-tailed).

Similarly, *number of children* and *number of teachers* were dropped because *children per teacher* served as a composite variable for both predictors. *Percentage of boys* (%) was dropped because *percentage of girls (%)* alone should suffice to provide the *gender* data of children in a classroom.

5.5.2 Combining Highly Correlated Variables

Results suggest that much smaller subgroups of items provide information that is similar to the information generated by administering the full ECERS-R. One study examined the psychometric properties of the Early Childhood Environment Rating Scale - Revised (ECERS-R) using 202 Colorado childcare centers (Perlman, Zellman, & Le, 2004). A factor analysis revealed that the ECERS-R does not measure seven distinct aspects of quality, as asserted by the developers of the ECERS-R, but instead measures one global aspect of quality. One other study (Cassidy, Hestenes, Hegde, Hestenes, & Mims, 2005) showed a two-factor solution for the ECERS-R – one factor for activities/materials and one for interactions. Based on that study, the subscales used in this research are likely to fall more into the activities/materials factor. As expected, the four ECERS-R variables were all highly correlated ($R \geq .85$) with each other (Table 5-13). Although they represented separate learning environmental characteristics of a classroom, it was obvious that a classroom that scored really high in one ECERS-R aspect should also score high in the other three ECERS-R aspects as well.

Table 5-13: Correlation Matrix of Indoor Learning Environment Variables

	Number of activity zones	ECERS: space/ furnishing	ECERS-R: books/pictures	ECERS-R: activities	ECERS-R: program
Number of activity zones	1	0.742***	0.822***	0.801***	0.814***
ECERS-R: space/ furnishing		1	0.826***	0.916***	0.813***
ECERS-R: books/pictures			1	0.919***	0.850***
ECERS-R: activities				1	0.889***
ECERS-R: program					1

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

The ECERS-R scoring system is closely associated with the license rating scale and centers with high license rating is expected to have high scores in all ECERS-R aspects. It is unlikely to find a classroom which scored high in *space and furnishing* but obtained a low score in *books/pictures* or *activities* in the ECERS-R measure. Therefore, a high correlation among the four 4 ECERS-R predictors was obvious and the only way to minimize the collinearity threat was to make a composite ECERS-R variable from these four predictors. No ECERS-R variables were dropped because they represented different dimensions of the indoor learning environment. Rather a composite ECERS-R score was generated to capture those different notions of the indoor environment. All four ECERS-R variables were measured in a scale of 1 to 7 which predicted high internal consistency among those measures. The Cronbach's Alpha (coefficient of internal consistency) was calculated as 0.94, indicating that internal consistency of the four measures was high and the standard score was not required for the composite score. Similarly, a composite score was created with window and view affordance as well. In the correlation matrix (Appendix 1), the *window* and *view affordance* showed a bivariate correlation with a coefficient as high as 0.938. It posed a collinearity threat for the regression analyses. However, both *window* and *view* were two important predictors of the indoor-outdoor spatial relations and they represented separate design characteristics. The reason behind the high correlation between these two predictors was that the number of views were directly associated with the number of windows in a classroom. Since they represented different aspects of the indoor-outdoor spatial relations of a classroom, none of the predictors were dropped from the analysis. A standardized composite score was created by combining the standard Z-score for windows and views. The new composite measure was titled as *window-view affordance*.

5.5.3 Final List of Independent Variables

After eliminating four variables and merging six variables into two new composite ones, a final list of 15 independent variables is presented (Table 5-14). Once again, a two-tail Pearson correlation was conducted in SPSS among these 15 independent variables (Appendix 1.9). Only one collinearity threat was assessed from the new correlation matrix of the independent variables. The two new composite scores – *ECERS-R composite* and *windows and views composite* were highly correlated (R = .938) with each other. Since both predictors are important indicators of the classroom environment, none was dropped from the analyses. However, in instances where both these composite predictors were entered simultaneously in a regression model, the *tolerance* values were carefully examined. In cases were *tolerance* values were lower than or equal to 0.10, alternative regression models were proposed to deal with the collinearity threats.

Table 5-14: Eliminated, merged and finalized list of independent variables

List of Eliminated Variables
1. Weather condition
2. Number of children
3. Number of teachers
4. Percentage of boys

List of Merged Variables	New Merged Variable
1. ECERS-R: space and furnishing	ECERS=R composite
2. ECERS-R: books and pictures	
3. ECERS-R: activities	
4. ECERS-R: program structure	
5. Window affordance	Window-view affordance
6. View affordance	

Final List of Independent Variables		
Variable groups	Variable sub-groups	Variable names
Physical Environmental Data	1. Weather variables	1. Mean temperature (^{o}F)
		2. Sky condition
	2. Variables of classroom size/space	3. Classroom size (ft^2)
		4. Area per child (ft^2/child)
		5. Open space (%)
Human Factors	3. Number of observation	6. Children per teacher
	4. Children demography	7. Percentage of girls
		8. Average age of children
	5. Teacher data	9. Teacher qualification
		10. Teacher experience
Learning Environmenta l Data	6. Indoor learning environment quality	11.ECERS-R composite
		12. Number of activity zones
Experimental Data	7. Indoor-outdoor spatial characteristics	13.Door affordance
		14.Window-view affordance
		15. Transitional space affordance

5.6 Hierarchical Multiple Regression (HMR)

In hierarchical multiple regression (HMR), a set of predictor variables are entered into the model *first* – generally the ones the researcher wants to *control for* when testing the variables that he/she is theoretically interested in. For instance, in this analysis, this study wants to find out whether indoor-outdoor spatial relation predicts child engagement and teacher motivation. But the study has concern that other variables, such as children's demography, teachers' experience or qualification, classroom indoor learning environment qualities, etc., might be associated with both child engagement and teacher motivation. To make sure that these variables do not explain away the entire association between indoor-outdoor spatial relations and child engagement/ teacher motivation, the researcher puts them into the model first. This ensures that they will get *credit* for any shared variability that they may have with the predictor that this study is really interested in: indoor-outdoor spatial relationship indicators (door affordance, window-view affordance and transitional space affordance). Thus, any observed effect of the *indoor-outdoor* predictors can then be said to be *independent of* the effects of the control variables.

There are three sets of control variables: a) physical environmental attributes, b) human factors, and c) learning environmental attributes. Each of these three sets of variables was entered chronologically in the hierarchical regression model keeping the experimental set (indoor-outdoor spatial characteristics) at the end. Significant variable/s (significant at $p \leq .10$ level) from each set were entered with the next set of variables and the process was repeated for all three sets of control variables. Due to the small sample size ($n = 22$) and consequent weak statistical power, it was justified that statistically insignificant variables were dropped as the HMR moved from one model to another. The small sample size was also responsible for using $p \leq .10$ level for significance, rather than the conventional $p \leq .05$ level. Finally, the significant variables from this hierarchical process were put together with the three experimental variables – door affordance, window-view affordance and transitional space affordance. An HMR analysis for a particular dependent variable consisted of four models. The first model enters only the five physical environmental attributes (mean temperature, sky condition, class size, area per child and percentage of indoor open space) in a linear regression to assess their predictive power in explaining the variability of one dependent variable. Variables were entered into the equation in one step by the default *Enter* method in SPSS, which is also called the *forced entry* (IBM-SPSS, 2012). The next model keeps only the significant predictor/s (significant at $p \leq .10$ level) from the first model and *enters* them, together with the five human factor variables of second model (*child per teacher*, *children average age, percentage of girls*, *teachers' academic qualification and teacher experience*). This hierarchical process is repeated for the third model of learning environmental attributes (ECERS-R and number of activity zones). Finally, the significant variables from subsequent three previous models were put together with the set of experimental (indoor-outdoor) predictors. The next section discusses the theoretical perspectives of the order of the hierarchy of the four sets of independent variables.

5.7 Arranging the Hierarchy: Theoretical Justification of the Chronology of Variable Sets

It is already defined why the experimental set of predictors (indoor-outdoor spatial characteristics) was kept at the end of an HMR model. The ordering of the variable sets should reflect their presumed causal priority. The HMR usually begins with the more distal causes and gradually adds the more proximal causes that may mediate those distal causes. In this research, the researcher adopted *functional sets* – the independent variables were grouped into sets for reasons of their substantive content and the function they play in the logic of the research (J. Cohen, Cohen, West, & Aiken, 2013). The physical environmental set was considered to be the most distal one. The five variables in this set — *mean temperature*, *sky condition*, *class size*, *area per child* and *percentage of indoor open space* — seemingly do not have any direct association with learning or teaching behavioral outcomes of children and their teachers. The next set – human factors — was considered to be more proximal than the physical environmental set. It contained five independent variables - *child per teacher*, *children average age*, *percentage of girls*, *teachers' academic qualification* and *teacher experience*. These variables were theoretically more established as predictors of learning behavioral outcomes of children and teachers. The next set – learning environmental attributes – contained variables which were more directly related to learning activities in a classroom. The two variables in this set – *ECERS-R* and *number of activity zones* directly measure the quality and quantity of various aspects of the learning environment, which were expected to have strong predictive power in determining child engagement and teacher motivation.

Due to the small *N* of cases, it is not possible to test for the effects of all the variables simultaneously. So instead of keeping the variables in the models, variables are omitted if they are not statistically significant in the earlier model. This allows for a test of the variables entering the model, but does not allow the researcher to claim that all of the variables have been tested simultaneously. So the model four variables added might not be statistically significant if all the variables were entered, but that could be due to the sharing of a variable's effect with too many other variables relative to the sample size. Nevertheless, the HMR procedures do allow for the ruling out of variables (dropping the statistically insignificant ones) and the testing of the newly included variables, sometimes with variables included from the earlier models.

5.7.1 HMR Analysis for Children's Collective Engagement Level

Table 5-15 contains HMR analyses results for children's collective engagement level (during teachers' assisted activities). Four models (Model 1, 2, 3, and 4) describe the results related to engagement levels in four hierarchical layers – physical environment, human factors, learning environment and the experimental indoor-outdoor spatial characteristics.

Table 5-15: Children's collective engagement level across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS- R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor characteristics)
1. Mean Temp	.024 (.369) [.475]	-	-	-
2. Sky Condition	.040 (.040) [.666]	-	-	-
3. Classroom Size	.001 (.301) [.298]	-	-	-
4. Area per child	.012* (.507) [.635]	.001 (.025) [.219]	-	-
5. Open Floor Area (%)	-.004 (-.063) [.259]	-	-	-
6. Child per Teacher		-.015 (-.095) [.286]	-	-
7. Percent Girls		.010 (.118) [.917]	-	-
8. Child Average Age		.025 (.024) [.711]	-	-
9. Teacher Qualif.		.189 (.304) [.653]	-	-
10. Teacher Experience		-.072** (-.545)[.575]	-.077*** (.581) [.953]	-.088*** (-.659) [.730]
11. ECERS-R Composite			.288 (.488) [.288]	-
12. N of Activity Zones			-.030 (-.097)[.294]	-
13. Door				-.187** (-.465) [.520]
14. Window-view				.018** (.523) [.550]
15. Transitional Space				.014 (.144) [.532]
Adj. R-SQ	R-SQ = 0	R-SQ = .226	R-SQ =.329	R-SQ = .345

"-"=not statistically significant; *=.10; **=.05; ***=.01

As discussed in section 5.7, in the first model — Model 1 — all five physical environmental variables were entered into the equation in one step by the default *Enter* method in SPSS which is also called *forced entry* (IBM-SPSS, 2012). The variables which were significant in this test were entered into the next one — Model 2 (Human Factors) — with the five human factors (children and teacher characteristics). The criterion for significance was $p \leq 0.10$. The process is repeated hierarchically in Model 3 (Learning Environmental Attributes) and finally in Model 4 (Experimental Indoor-Outdoor Attributes) to identify the significant predictors of children's collective engagement level in teacher-assisted activities in the classrooms.

In Model 1 (Physical Environmental Attributes), only *area per child* was positively significant ($p < .10$) among the five physical environmental attributes, predicting more likelihood of child engagement in less congested classrooms. This variable was entered with the next set of variables (human factors) in Model 2. Only *teachers' experience* was significantly ($p < .05$) but negatively related to the dependent variable. The result suggested that more experienced teachers were likely to be less effective in engaging children. Model 2 explained 22.6% of variance in children's collective engagement levels in the classrooms. In Model 3 (Learning Environmental Attributes), neither of the two learning environmental attributes (ECERS-R and number of activity zones) was significant. Teacher experience, which was forwarded from the previous model, was again significant ($p < .01$ level) and this model explained 32.9% variance of the outcome variable. The final model — Model 4 (Experimental Indoor-Outdoor Attributes) — had three significant predictors: teachers' experience ($p < .01$), door affordance ($p < .05$) and window-view affordance ($p < .05$). Teachers' experience had a negative coefficient. Window-view affordance was positively associated, meaning children were more likely to be engaged in classrooms with higher window-view scores. However, door affordance predicted a negative relationship. More doors connecting to the outdoor environment in the classrooms was likely to be associated with less engagement level by the children. These three significant predictors along with other non-significant ones in the final model explained 34.5% variance in children's collective engagement levels in the classrooms.

5.7.2 HMR Analysis for Percentage of Engaged Children

Table 5-16 contains HMR analyses results for percentage of engaged children, and Models 1, 2, 3 and 4 delineate the results of the analyses. In Model 1, three physical environmental variables were significant – classroom size ($p < .10$), area per child ($p < .05$), and open floor area ($p < .10$). Both classroom size and area per child were positively associated, but open floor area had a negative relationship. More children were likely to be engaged when the classrooms were bigger and there was more space per child in the classroom. But more open floor space (less furniture) predicted fewer engaged children. Model 1 with these three significant predictors explained an 18.5% variance in child engagement.

Table 5-16: Percentage of engaged children across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS-R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor Spatial Characteristics)
1. Mean Temp	.-.197 (-.169) [.475]	-	-	-
2. Sky Condition	.4.669 (.266) [.666]	-	-	-
3. Classroom Size	.051* (.743) [.298]	.050* (.729) [.126]	.006 (.092) [.384]	-
4. Area per child	.230** (.541) [.635]	.377** (.886) [.165]	.007 (.017) [.471]	-
5. Open Floor Area (%)	-.786* (-.759) [.259]	-.497 (-.480) [.097]	-	-
6. Child per Teacher		1.33 (.471) [.245]	-	-
7. Percent Girls		.466 (.299) [.779]	-	-
8. Child Average Age		-9.453** (-.513) [.521]	-5.616* (-.305) [.795]	-5.412 (-.294) [.717]
9. Teacher Qualif.		1.782 (.161) [.331]	-	-
10. Teacher Experience		1.396*** (.591) [.482]	.557 (.236) [.686]	-
11. ECERS-R Composite			8.451** (.805) [.230]	Dropped for collinearity
12. N of Activity Zones			-.565 (-.101) [.141]	-
13. Door				-.325 (-.045) [.531]
14. Window-view				.505*** (.812) [.619]
15. Transitional Space				-.181 (-.106) [.463]
Adj. R-SQ	R-SQ = .185	R-SQ =.586	R-SQ =.569	R-SQ = .474

“-“=not statistically significant; *=.10; **=.05; ***=.01

These three significant variables were entered in the next regression model - Model 2 with the five human factors. Classroom size and area per child were still significant but open floor area (%) was no longer significant. From the human factors (children and teacher characteristics), teacher experience was significant ($p < .01$ level) with positive direction and children's average age was significant ($p < .05$) with a negative association. Chances of engagement were higher when children were younger and they were in classrooms with more experienced teachers. Model 2 explained 58.6% variance in the percentage of engaged children. When all of these four significant predictors (classroom size, area per child, child average age and teacher experience) were entered with the two learning environmental attributes in Model 3, only two variables were significant – children's average age and ECERS-R composite. The adjusted R^2 value was lower (.569) for this model, explaining the 56.9% variance in children's engagement. ECERS-R, as expected, was positively associated with engagement.

Children's average age and ECERS-R were forwarded as significant predictors to the final model (Model 4) with the three experimental *indoor-outdoor* variables. But, in Model 4, a collinearity problem arose as the study tried to run the regression with both ECERS-R and window-view entered simultaneously. As reported in 5.5.3, ECERS-R and window-view are highly correlated with each other ($R = .938$). Only ECERS-R was significant ($p < .10$) in this model but window-view affordance had a tolerance value of 0.10. Since this tolerance value is equal to the threshold value (0.10), this collinearity problem was acknowledged and the model was rejected. Instead, an alternative final model (Model 4 in Table 5-16) was proposed where ECERS-R was dropped. In this alternative model, only window-view was significant ($p < .01$ level) with a positive relationship, and no collinearity problem was evident. Both Model 3 and Model 4 are acceptable. . Results in Model 4 suggested that when ECERS-R is omitted, more children are likely to engage in activities in classrooms with better window-view affordances. Model 4 explained the 47.4% variance of the outcome variables and Model 3 explained 56.9%, so Model 3 is a stronger model. Either Model 3 or Model 4 can account for the variation in the percent of children engaged. While it is plausible that windows make a difference to children's engagement, so would the ECERS-R factors.

5.7.3 HMR Analysis for Percentage of Distracted Children

Table 5-17 contains HMR analysis results for percentage of distracted children. As expected, *child per teacher* was persistently significant in Model 2, 3 and 4. It was significant ($p < .01$) at all levels with a positive relationship. It was likely that the percentage of distracted children would rise when the child-teacher ratio was higher in the classrooms. No other variable was significant in Models 2, 3, and 4, which had adjusted R^2 values of .451, .411, and .447, respectively.

Table 5-17: Percentage of distracted children across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS-R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor Spatial Characteristics)
1. Mean Temp	.215 (.253) [.475]	-	-	-
2. Sky Condition	-.438 (-.034) [.666]	-	-	-
3. Classroom Size	.035* (.705) [.298]	.012 (.248) [.738]	-	-
4. Area per child	-.103 (-.333) [.635]	-	-	-
5. Open Floor Area (%)	-.312 (-.415) [.259]	-	-	-
6. Child per Teacher		1.545*** (.754) [.907]	1.585*** (.773) [.742]	1.611*** (.786) [.717]
7. Percent Girls		-.133 (-.117) [.801]	-	-
8. Child Average Age		-.537 (-.040) [.866]	-	-
9. Teacher Qualif.		1.294 (.161) [.814]	-	-
10. Teacher Experience		-.061 (-.035) [.726]	-	-
11. ECERS-R Composite			-.338 (-.044) [.302]	-
12. N of Activity Zones			.825 (.204) [.274]	-
13. Door				-.289 (-.056) [.461]
14. Window-view				.050 (.111) [.523]
15. Transitional Space				.329 (.266) [.586]
Adj. R-SQ	R-SQ = .285	R-SQ = .451	R-SQ =.411	R-SQ = .447

"-"=not statistically significant; *=.10; **=.05; ***=.01

5.7.4 HMR Analysis for Number of Behavioral Guidance Directives

Table 5-18 contains HMR analysis results for the number of behavioral guidance directives by the teachers to control children. In Model 1, both sky condition and area per child were significant, but both these physical environmental variables were subsequently dropped in the next model (Model 2). Like HMR analysis of children's distraction, child-teacher ratio was also persistently significant in predicting the number of behavioral guidance directives by the teachers. As expected, it was significant (p < .01) throughout the hierarchical models and had positive relationships. Results predicted the likelihood of more behavioral guidance directives by teachers when the child-teacher ratio was higher in the classrooms. Among the other variables, teacher academic qualification was also significant in Models 2 (p < .01), 3 (p < .05), and 4 (p < .05) with negative relations. This finding indicated that academically more qualified teachers were less likely to use behavioral guidance directives. Teacher experience was also consistently significant in Models 2 (p < .10), 3 (p < .05), and 4 (p < .10).

Table 5-18: Number of behavioral guidance directives across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS-R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor Spatial Characteristics)
1. Mean Temp	-.030 (-.065) [.475]	-	-	-
2. Sky Condition	2.259** (.328) [.666]	-.087 (-.013) [.547]	-	-
3. Classroom Size	-.005 (-.180) [.298]	-	-	-
4. Area per child	-.103*** (-.619)[.635]	.005 (.030) [.179]	-	-
5. Open Floor Area (%)	-.102 (-.250) [.259]	-	-	-
6. Child per Teacher		.907*** (.820) [.211]	.832*** (.753) [.724]	.844*** (.763) [.715]
7. Percent Girls		.012 (.020) [.882]	-	-
8. Child Average Age		1.004 (.139) [.604]	-	-
9. Teacher Qualif.		-1.484*** (-.342) [.501]	-1.280** (-.295) [.387]	-1.425** (-.329) [.309]
10. Teacher Experience		.188* (.203) .571]	.202** (.219) [.937]	.186* (.201) [.712]
11. ECERS-R Composite			.503 .122 [.205]	-
12. N of Activity Zones			-.447 (-.204) [.264]	-
13. Door				.360 (.129) [.428]
14. Window-view				.003 (.011) [.279]
15. Transitional Space				-.115 (-.172) [.500]
Adj. R-SQ	R-SQ = .657	R-SQ = .846	R-SQ = .854	R-SQ = .852

"-"=not statistically significant; *=.10; **=.05; ***=.01

Surprisingly, teachers' experience was positively associated with the outcome variable. More experienced teachers were more likely to use behavioral guidance directives to control children. The final model — Model 4 — explained an 85.2% variance in the dependent variable.

5.7.5 HMR Analysis for Teaching Motivation

Table 5-19 contains HMR analysis results for teaching motivation.

Table 5-19: Teacher motivation across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS-R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor Spatial Characteristics)
1. Mean Temp	.018 (.031) [.475]	-	-	-
2. Sky Condition	-.292 (-.034) [.666]	-	-	-
3. Classroom Size	.021 (.612) [.298]	-	-	-
4. Area per child	.113* (.536) [.635]	.030 (.143) [.219]		
5. Open Floor Area (%)	-.359 (-.700) [.259]	-		
6. Child per Teacher		.181 (.130) [.286]		
7. Percent Girls		.044 (.057) [.917]		
8. Child Average Age		-.941 (-.103) [.711]		
9. Teacher Qualif.		3.764*** (.686) [.653]	2.453* (.447) [.396]	.662 (.121) [.316]
10. Teacher Experience		.099 (.085) [.575]		
11. ECERS-R Composite			2.801 (.539) [.210]	
12. N of Activity Zones			-.584 (-.211) [.302]	
13. Door				.657 (.186) [.506]
14. Window-view				.162** (.525) [.600]
15. Transitional Space				
Adj. R-SQ	R-SQ = .026	R-SQ = .357	R-SQ =.527	R-SQ = .636

"-"=not statistically significant; *=.10; **=.05; ***=.01

In Model 1 of physical environmental attributes, only *area per child* was positively significant ($p < .10$). Findings implied that teachers were likely to be more motivated in less congested classrooms. Subsequently, *area per child* was not significant in Model 2 of children and teacher characteristics.

Teachers' academic qualification was consistently significant in Model 2 ($p < .01$) and in Model 3 ($p < .10$). The positive relationship indicated that teachers with more academic qualifications were likely to be more motivated. The adjusted R^2 values of Model 2 and Model 3 were .357 and .527, respectively. No other variables were significant in Models 2 and 3. The learning environmental indicators or other human factors were not significant in predicting variance in teaching motivation. However, teacher qualification was no longer significant in the final Model 4 (in Table 5-19), where the only significant predictor was the window-view affordance ($p < .05$). The relationship was positive and the model explained 63.6% variance in teaching motivation. Teachers were likely to be more motivated when the qualities and quantities of windows and views were higher in the classrooms. No cases of collinearity were detected.

5.7.6 HMR Analysis for Nature Based Learning

Model 5-20 reports HMR analysis results for nature based learning in classrooms. At the beginning, in Model 1 of physical environmental attributes both *area per child* and *open floor area (%)* were significant. Area per child was positively associated ($p < .05$), predicting higher probability of nature-based learning in classrooms which had more space per child. The relationship was negative ($p < .10$) for open floor area. Less furniture and more open floor space were associated with fewer evidences of nature based lessons by the teachers. In the second model (Model 2), these two physical environmental attributes were not significant and subsequently dropped in the next model. In Model 2, only teacher academic qualification was positively associated with teacher tendency to use natural elements to teach children. More qualified teachers were more likely to use natural elements to teach children. However, the adjusted R^2 value of Model 2 was low (0.07). In the next hierarchical model (Model 3), ECERS-R was the only significant ($p < .05$) predictor of nature-based learning. The model explained a 45.7% variance in nature-based learning. A positive relationship posited that the probability for teachers' tendencies to use natural elements to teach was higher in classrooms with better ECERS-R scores. When ECERS-R was entered in the experimental Model 4 (Table 5-20), collinearity problems were evident.

Table 5-20: Nature based learning across four models, hierarchical regression models, unstandardized coefficient, (standardized coefficient), [tolerance].

Variables	Model 1: Physical Environmental Attributes	Model 2: Human Factors (Children and Teacher Characteristics)	Model 3: Learning Environmental Attributes (ECERS-R and # Activity Zones)	Model 4: Experimental Attributes (Indoor-Outdoor Spatial Characteristics)
1. Mean Temp	-.047 (-.117) [.475]	-	-	-
2. Sky Condition	1.901 (.314) [.666]	-	-	-
3. Classroom Size	.014 (.581) [.298]	-	-	-
4. Area per child	.085** (.577) [.635]	.012 (.079) [.218]	-	-
5. Open Floor Area (%)	-.295* (-.825) [.259]	-.079 (-.221) [.530]	-	-
6. Child per Teacher		-.095 (-.098) [.250]	-	-
7. Percent Girls		.000 (-.001) [.837]	-	-
8. Child Average Age		-.769 (-.121) [.656]	-	-
9. Teacher Qualif.		2.118* (.554) [.653]	.242 (.063) [.396]	-
10. Teacher Experience		-.104 (-.127) [.489]	-	-
11. ECERS-R Composite			3.167** (.874) [.210]	Dropped for collinearity
12. N of Activity Zones			-.474 (-.246) [.302]	-
13. Door				.170 (.069) [.532]
14. Window-view				.132*** (.614) [.683]
15. Transitional Space				.122 (.207) [.610]
Adj. R-SQ	R-SQ = .113	R-SQ = .07	R-SQ = .457	R-SQ = .534

"-"=not statistically significant; *=.10; **=.05; ***=.01

As reported in section 5.5.3, ECERS-R and window-view are highly correlated with each other (R = .938). The tolerance for ECERS-R and window-view affordance was reported to be .119 and .109, respectively. The researcher rejected this model as tolerance reached threshold value (0.10) and dropped ECERS-R from the final experimental model (Model 4). After dropping ECERS-R, window-view affordance was the only significant predictor of nature-based learning. It was significant ($p < .01$ level) and positively associated with the outcome. Higher window-view score predicted more practices of teaching with nature. This model had the higher adjusted R^2 value, explaining 53.4% of variance in nature-based learning.

5.8 Summary of Findings

The most significant findings from the six HMR models are summarized below

1. Doors, windows and views were significant predictors of children's collective engagement levels during teacher-assisted activities. Door affordance and window-view affordance were both significant at $p < .05$ level in the final experimental model (Model 4 in Table 5-15) but they showed opposite relationships with the outcome variable. While window-view affordance predicted higher engagement levels, door affordance had a negative coefficient value – meaning a group of children were likely to be less engaged in teacher-assisted activities if the classroom had more doors connecting to the outdoor environment.
2. Window-view affordances promoted engagement in children. When ECERS-R was constant, window-view affordance was the only variable which had predictive power of explaining variation in the percentage of engaged children in a model which explained a 47.4% variance in the outcome. It was significant at $p < .01$ level.
3. Among the three indoor-outdoor spatial characteristics, window-view affordance was the most significant predictor in determining teaching behavioral outcomes. Window-view affordance was the only significant predictor of teaching motivation with a significance of $p < .05$ level and an unstandardized coefficient value of 0.162. The model predicted a 63.6% variance ($R^2 = .636$) of the teaching motivation value.
4. Window-view affordance was also a significant ($p < .01$ level) predictor in a model, explaining a 51.4% variance in nature-based learning practices in a classroom. It was also the only significant variable in that model (Model 4 in Table 5-20) which had predictive power for explaining teachers' tendencies to teach with natural elements.
5. Transitional space affordance was not significant for any of the six dependent variables of the study.
6. Among the human factors, teacher-child ratio was the strongest predictor for both the percentage of distracted children ($p < .01$ level) and the number of behavioral guidance directives ($p < .01$ level). It was the only significant variable for explaining percentage of distracted children, and the respective model predicted 44.7% of variance in this outcome.

7. Among the other human factors, teachers' academic qualification was significantly ($p < .05$) and negatively related in predicting the number of behavioral guidance directives (Model 3 in Table 5-18). This predictor, along with two other significant variables — children-per-teacher and teachers' years of experience — in a model explained 85.4% of the variances of this outcome variable.
8. Surprisingly, teachers' years of experience was negatively related with children's collective engagement level. It was the most significant predictor ($p < .01$ level) in a model with two other significant variables (door and window-view affordance) which explained a 34.5% variance in children's collective engagement level during teacher-assisted activities in the classrooms (Model 4 in Table 5-15).
9. ECERS-R was the most significant variable ($p < .05$) for predicting the percentage of engaged children (Model 3 in Table 5-16). ECERS-R and children's average age were significant in a model which explained 56.9% of the variance in engaged children during free activity session.

5.9 Quality Considerations

This subsection describes the measures taken for reliability and validity of variable measurements. The study used validated and reliable scales for some of the measurements. For example, ECERS-R used to collect data related to learning environmental attributes is an established scale with satisfactory predictive validity and reliability (Harms et al., 2005). Children's collective engagement level was also measured by a validated tool (Walsh & Gardner, 2005). The study also used some new and innovative approaches to measure other behavioral outcomes of child engagement and teacher motivation. The proposed new subscales for measuring indoor-outdoor spatial relations (Door Affordance Scale, Window Affordance Scale, View Affordance Scale and Transitional Space Affordance Scale) were also developed based on previous studies (Table 2.2). Although full scale tests for validity and reliability was not possible due to time and budgetary concerns, the study attempted to validate its new measurements by looking into the interrelationships and their directions of these measurements to check whether these correlations and their directions meet expectations. Overall, the directions and significances of the relationships among the behavioral outcome variables were mostly consistent with expectations (described already in Table 5-4 in section 5.1.3), which justified their predictive validity.

The study used Daylight Factor (DF) data to validate the indoor-outdoor spatial relation measurements. DF data were collected for all 22 classrooms with a reliable and validated instrument (cell phone device). It was hypothesized that window and view affordance score would be highly correlated with the DF values because the amount of windows and other openings are primarily responsible for the amount of daylight in the room. Window affordance scores were highly correlated ($R = 0.93$) with DF, as expected. View Affordance Score was also highly correlated with DF ($R = 0.91$). For Door Affordance and Transitional Space Affordance Score, the correlation amounts were 0.54 and 0.31, respectively. It was expected that these two predictors would not correlate with DF values as highly as windows and views. The correlations with the DF values provided the basis of predictive validity of the proposed four subscales of indoor-outdoor spatial relations.

All data were single-handedly collected by the researcher himself – which facilitated the *reliability* of the measurements of the study. The study has concerns for *external validity,* which is elaborately discussed in section 6.7.3.

Chapter 6 : Discussion and Conclusion (Statistical Study)

The study investigates effects of indoor-outdoor spatial relations on children and teachers' behavioral outcomes in preschool classrooms. Four observational indicators were measured to define child engagement: a) children's collective engagement level, b) percentage of engaged children, c) percentage of distracted children, and d) number of behavioral guidance directives by teachers to control children in the classroom. The first two indicators were positive measures and the latter ones were used as negative indicators of child engagement during classroom activities. Teacher motivation was measured as a sum of hands-on lesson, innovative lessons (lessons created by the teachers), and number of lessons (children's work) on display. Both teacher reports and observational data were used for the measurements. A second indicator of teaching motivation looked into teachers' tendencies to teach children using natural elements. This variable created an opportunity to see whether indoor-outdoor relations influenced teaching styles in a classroom as well. Besides the three indicators of indoor-outdoor spatial relations (door, window-view and transitional space), 12 control variables were analyzed in the hierarchical multiple regression models to ensure that other plausible predictors of child engagement and teacher motivation gets *credit* for any shared variability that they may have along with the three experimental *indoor-outdoor* variables. The primary hypotheses of the study assumed that both child engagement and teacher motivation would positively relate with different architectural measures of indoor-outdoor spatial relations. The analyses in this dissertation found statistically significant relationships between different indicators of child engagement and specific architectural *indoor-outdoor* variables. Relationships were also found between teacher motivation and window-view affordances of a classroom. Moreover, regression models supported that windows and views were likely to afford more opportunities for teachers to teach children with natural elements. Other significant relationships were found between different control variables and specific indicators of child engagement and teacher motivation – which demand further explorations. These relationships are also discussed more elaborately in this chapter.

The aim of the study is to learn *how* architectural characteristics may predict learning and teaching behavior. While the statistical analyses (Chapter 5) identify relationships, it is essential to uncover the mechanisms behind in light of previous studies, methodological explanations and observed phenomena. Major findings in statistical analyses are discussed separately in the previous chapter. A common strategy (Figure 6-1) is replicated to discuss significant findings – identify the possible *mediator* between a predictor and a dependent variable. Mediators provide additional information about how or why two variables are strongly associated (Bennett, 2000). Previous findings, methodological explanations and observed phenomena during data collections are discussed to understand the mechanism behind significant statistical findings.

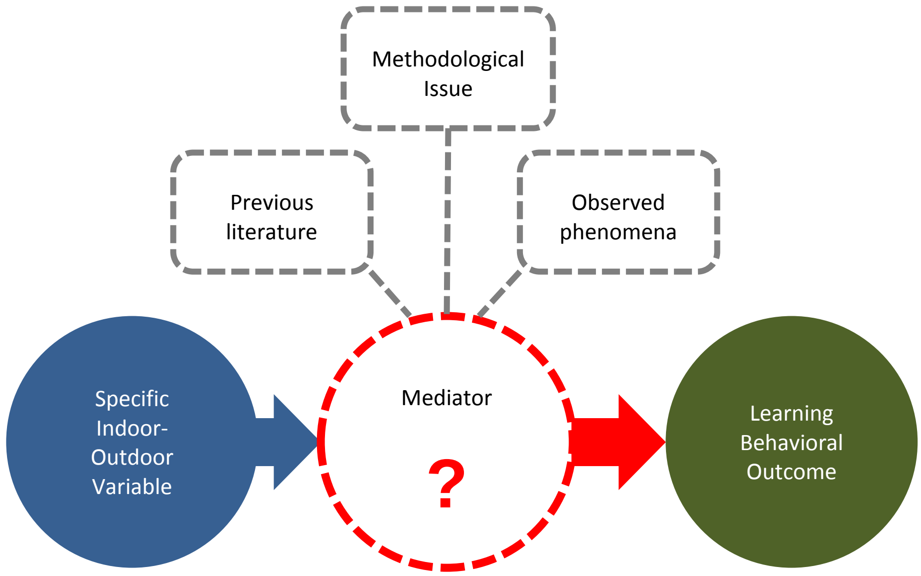


Figure 6-1: Understanding 'how' the relationships work

Like any other research, this study also contains limitations ranging from data collection methods to generalization of the findings. Four limitations were prominent: a) sample size and selection processes, b) limitations of instrument validity, c) lack of qualitative attributes, and d) lack of generalizability of findings. The second part of this chapter discusses the significances and implications of the findings in light of these four limitations of the study. The overall objective of the discussion chapter is to avoid the pitfalls of statistical overstatement and look into things objectively so that findings of the research can contribute to the larger body of knowledge effectively.

6.1 Windows Engage Children while Doors Distract

During teacher assisted periods, children's collective engagement level had significant relationships with three predictors – teacher experience, door affordance, and window-view affordance (Model 4 in Table 5-15). It should be kept in mind that the study used $p \leq .10$ level due to the small sample size ($n = 22$) and consequent relative weaker statistical power. Door affordance and window-view affordance were both significant at $p < .05$ level but they showed opposite relationships with children's collective engagement level. While window-view affordance predicted higher engagement level, door affordance had a negative coefficient value – meaning a group of children were likely to be less engaged in teacher-assisted activities if the classroom had more doors connecting to the outdoor environment. The positive effects of window-view affordance can be explained by daylight and Attention Restoration Theory (ART) discussed in section 2.2.2; however, it is difficult to explain the negative relationship with doors. It can be simply a consequence of small sample size (22 classrooms) or low standard deviation of door affordance score of 1.94 (minimum of 3 and maximum of 10). Alternatively, it can be that preschool children perceive doors and windows differently. While windows provide only visual access and perhaps means of attention restoration, doors are the ways to go to the outdoors. Children greatly value going outdoors and their daily activities in outside environments. Doors and windows may possibly have different meanings when it comes to children's classroom engagement. A similar study with a larger sample size or a qualitative approach could help explain this phenomenon.

6.2 Windows and Views Promote Engagement in Children

Window-view affordance was also a significant predictor ($p < .01$ level) of engaged children (Model 4 in Table 5-16) when ECERS-R (Early Childhood Environment Rating Scale) score was dropped in the hierarchical multiple regression model. ECERS-R and window-view affordance were highly correlated with a correlation coefficient of 0.938. Due to severe collinearity, it was not possible to test these two variables simultaneously in a regression model. The model with window-view affordance, being statistically significant (Model 4 in Table 5-16) explained 47.4% variance in the percentage of engaged children. In the alternative model, ECERS-R and children's average age were significant (Model 3 in Table 5-16), and the model predicted the 56.9% variance in engaged children. The findings claim that when ECERS-R is constant, window-view affordance is the only variable which had predictive power in explaining variation in the percentage of engaged children and it is likely that more children will engage in activities during free activity sessions when the window-view score is higher. This phenomenon of children's higher engagement in self-assisted activities with more windows and views can be explained by the both Daylight Theory and Attention Restoration Theory (ART). In two large scale studies (Heschong, 2003; Heschong et al., 1999), elementary school children in classrooms with larger window areas scored higher in mathematics and reading when compared with those in classrooms with smaller windows and less access to light. In a different study (Hathaway, 1992), grade four students in full spectrum lighting, which replicated natural light had better attendance, achievement, and better growth and development than students under conventional light. Although no studies were found which linked child engagement with daylight, it can be assumed that the positive effects of increased daylight (as a consequence of increased windows) would also be applicable for preschool children. Performances of students enhanced with views of natural settings in high school students (Matsuoka, 2010) and also college level students (Benfield et al., 2013). The study by Tanner (2009)reported that when an elementary school student needed to take a break from learning, it was easier to get back on track after taking a quick look outside at a pleasant view. This finding predicts that similar positive results of view of natural settings may also be true for younger children of 3 to 5 years of age. The finding was also consistent with two previous studies (Taylor, 2002; Wells, 2000) which have given evidences that views of nature contributes to self-discipline and cognitive functioning of children.

6.3 More Window-View Affordances = More Teaching Motivations

One of the most significant findings of the research is the effect of window-view affordances on teaching motivations. In the HMR of teaching motivation, Model 4 (see Table 5-19) showed the window-view affordances is the only statistically significant predictor of teaching motivation with a significance of $p < .05$ level and an unstandardized coefficient value of 0.162. Due to the small sample size ($n = 22$), the study used $p \leq .10$ level for significance, instead of the traditional $p \leq .05$ level. Although window-view is the only statistically significant variable in the model, the model also included door affordances, along with teacher qualifications. These three variables were significant in a model, which predicted 63.6% variance ($R^2 = .636$) in the teaching motivation value. Recall that both the independent and the dependent variable here are composite measures. Window-view affordance is comprised of number of windows and views of a classroom and various other window-view design characteristics of a preschool classroom that are directly linked with learning and teaching affordances. Teaching motivation was the sum of teacher-reported number of hands-on and innovative lessons in a typical week and the number of hands-on lessons in classroom display. Hands-on lessons refer to activities that involved children and teachers to create something in order to teach and learn. Innovative lessons were the lessons which the teachers claimed to be entirely their unique ideas. Both innovative and hands-on lessons were counted from teachers' answers to the questionnaire survey, while hands-on lessons on display were calculated by systematic direct observation by the researcher in the selected classrooms. In other words, teaching motivation was the sum of teachers' enthusiasm (to involve children and display their works) and innovations.

The findings are consistent with one previous qualitative study (Slopack, 2011), which showed that windows in a classroom contribute to increased concentration, alertness and motivation for teachers and students at a large urban college. Studies that connect teaching motivation to windows and views in preschool environment are limited; however, this study can think of a number of mediators which may explain this relationship between window-view affordances and teaching motivation (Figure 6-2).

One of the contributing factors of the window-view affordance score was the amount of windows. Number of windows is responsible for the amount of daylight inside a classroom. To validate the proposed indoor-outdoor spatial relations measurement scale, the Daylight Factor (DF) was measured in the 22 classrooms. DF defines the indoor diffused daylight quality of a space as a ratio of indoor and outdoor luminance. The window affordance score, as expected, was highly correlated with the measured DF. The correlation coefficient between the window-score and measured DF in the 22 classrooms was as high as 0.93. The classrooms that scored higher in the window-view affordance index were also rich in daylight quantity. Numerous research studies have found associations between daylight and human behavior. Ample daylight condition has been found to be associated with less stress and discomfort (Cuttle, 1983), productivity and improvement in job performances (Abdou, 1997; Hedge, 1994), and also mood and satisfaction (Dasgupta, 2003) in adults. Most of these studies were conducted in different work environments like office spaces or hospitals, but findings in this study indicate that similar positive effects of daylight are also likely to motivate teachers in preschool classroom environments.

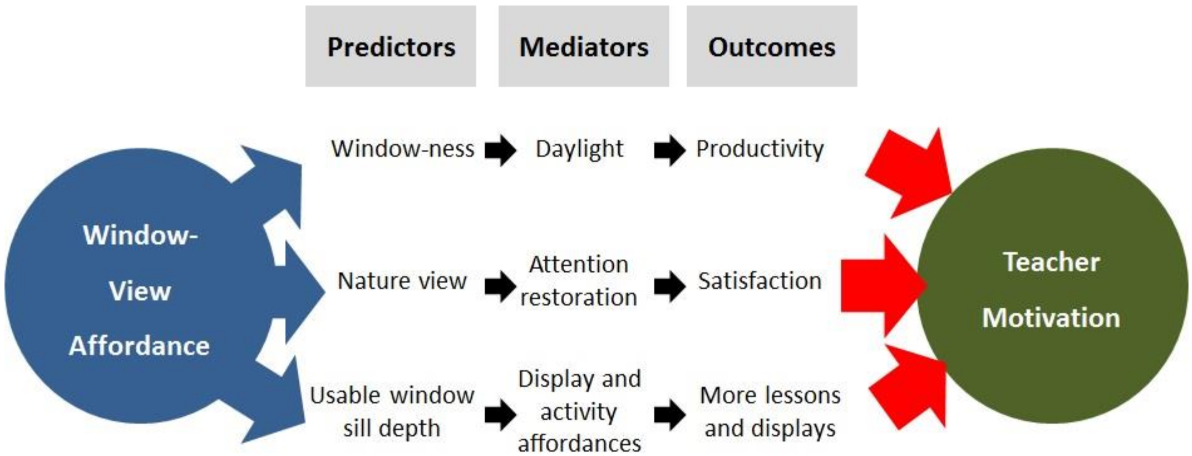


Figure 6-2: Mediators explaining influences of window-view affordance on teaching motivation

The view component of the window-view affordance measure had two indicators: a) view naturalness and b) view activity. View naturalness measured the amount of nature (trees, plants, grassy area, sky, etc.) and the view activity rated how stimulating a view is. The classrooms which scored higher in window-view affordances contained more natural and stimulating views. Having visual access to nature is known to be beneficial across a wide range of contexts. Natural views were associated with increased feelings of privacy, satisfaction, patience, task enthusiasm and lower levels of frustration (R. Kaplan, 1993; Sop Shin, 2007). The findings of this study that window-view affordance significantly predicts teacher motivation is consistent with the findings of these previous studies. Teachers' appreciation of daylight was also evident in certain observations during data collection in classrooms. In many classrooms with rich daylight, teachers tended to use fewer electric/artificial lights. Rather, a combination of table and stand lamps were used, which provided a stimulating lighting environment (Figure 6-3). Many of them told the researcher that they preferred to keep the electric lights low because they believed it kept the children in the classroom calm and engaged. Teachers' options for creating such stimulating lighting environment were limited in classrooms with minimal or no windows (Figure 6-4).

Figure 6-3: Ample daylight afforded stimulating lighting environment

Figure 6-4: Classrooms with minimal/no windows were dependent on electric lighting

Attention Restoration Theory (ART) by Kaplan (1995) claimed "interacting with environments rich with inherently fascinating stimuli invoke involuntary attention modestly, allowing direct-attention mechanisms a chance to replenish." ART is based on past research showing separation of attention into two components: a) involuntary attention, where attention is captured by inherently intriguing stimuli, and b) directed attention, where attention is directed by cognitive-control processes (S. Kaplan, 1995). One study argued that nature, which is filled with intriguing stimuli, modestly grabs attention in a bottom-up fashion (Berman, Jonides, & Kaplan, 2008). The view affordance scale rated fully natural and stimulating views as the highest level. For example, views full of nature or children's play activities scored high in the scale. One of the reasons why window-view affordance was significant in predicting teacher motivations may be because teachers in those classrooms had more opportunities for attention restoration by looking at more natural or stimulating views. Teachers who needed to take a break from classroom activities may have found it easier to get back on track after taking a quick glance outside at a pleasant view of nature or children playing outdoors.

The window affordance scale rated different design characteristics of the windows. One such characteristic was the depth of the window sill. It was assumed that wider depth of window sill affords more learning activities in preschool classrooms. Children's hands-on works displayed by their teachers were counted as an indicator of teaching motivation. Classrooms with sufficient depth of window sills allowed teachers more *shelving* space to display children's hands-on works. Those areas were always busy with learning activities – growing plants, drying art works, conducting science experiments, etc. (Figure 6-5). Classrooms without such design features of window sills may restrict learning activities near the windows (Figure 6-6).

Figure 6-5: Depth of window sills were busy with learning activities

Figure 6-6: No depth in window sills minimized shelving affordances

The three mediators discussed above (daylight, attention restoration, and shelving/display affordances) provide explanations for the significant relationship between teaching motivation and window-view affordance. This primary finding not only supports previous studies but also was supported by observed phenomena in the selected classrooms.

6.4 More Window-View Affordances = More Nature-Based Learning

Teachers were asked how many times in a week they used a natural element to teach children. Such lessons ranged from teaching leaf patterns with real leaves to showing the sky through a window to teach diurnal variations. The researcher also counted nature-based learning activities in the classroom (examples in Figure 6-7 and 6-8). These two values were added to measure *nature-based learning activities* (which was also used as an indicator of teaching motivation). It was hypothesized that more indoor-outdoor relations would predict more nature-based learning in a classroom. Hierarchical multiple regression for nature-based learning (Model 4 in Table 5-20) showed that window-views affordance was the only significant predictor for this dependent variable. Due to the small sample size (n = 22), the study used $p \le .10$ level for significance.

Figure 6-7: Teaching leaf anatomy by using daylight through a window

Figure 6-8: View afforded the teacher to teach children season changes

Window-view was significant ($p < .01$ level) and together with the other variables in the model, explained the 51.4% variance in nature-based learning practices in a classroom. It was likely that teachers used more nature-based lessons to teach when the window-view index had a higher/richer value. Windows were the sources of daylight in classrooms. Daylight was essential for many nature-based experiments. For example, in one classroom, the teacher pasted some dried leaves against a window to teach children about leaf anatomy (Figure 6-7). The daylight through the window afforded the teacher opportunities to show the pattern of leaf veins clearly to children. Similarly, for many other nature based science experiments, window-areas provided the ideal space for activities (Figure 6-8).

In addition to science experiments, indoor-planting activities were also motivated by the presence of window and window-sill depth (Figure 6-9). Indoor planting activities allowed teachers more opportunities to teach children with natural elements (Figure 6-10).

Figure 6-9: Windows afforded indoor planting activities

Figure 6-10: More indoor planting activities predicted more nature-based learning

No previous studies were found that supported relationships between window design and teachers' tendencies to teach with natural element. But this statistical finding is supported by observed classroom activities in the current study. More windows provided more daylight, display shelving and more opportunities for indoor planting activities, which may in turn provided teachers more affordances to teach with natural elements. It can be argued whether or not nature-based learning is a valid indicator of teaching motivation; however, it is a measure of teaching style and designates *good practice* in a preschool classroom. Numerous studies have shown that children learn better when the lessons incorporate nature and the outdoor environment (Lieberman et al., 2000; Malone & Tranter, 2003; Tai et al., 2006). Designing more windows with sufficient sill-depth can be an effective way to promote nature-based learning in a preschool classroom design.

6.5 The Effects of Transitional Spaces

In the hierarchical multiple regression models, no significant relationship was found between transitional space and children's or teachers' behavioral outcomes. This was the only *indoor-outdoor* variable which showed no predictive power over the six dependent variables of children and teacher behavior. However, bivariate correlation analyses showed that transitional space had a statistically significant ($p < .01$ level) relationship with teaching motivation ($R = .558$). This indoor-outdoor variable was also significantly ($p < .05$ level) related with teachers' tendencies to teach children with natural elements ($R = .521$). Out of the 22 classrooms observed, only 10 had transitional spaces. But the mean values of engaged children (expressed in percentages), teaching motivation and nature-based learning varied greatly in those 10 classrooms from the remaining 12 (Figure 6-11). On average, 21.5% of the children were observed to be engaged in activities in classrooms with transitional spaces, which was substantially more than classrooms without transitional spaces (12.6% of the children). The mean score for teaching motivation in classrooms with transitional spaces (18.7) was almost twice the average value in the remaining classrooms (10.9). The average value of nature-based learning in the 10 classrooms with transitional spaces (10) was more than twice the mean value (4.8) of the remaining 12 classrooms. These findings were consistent with the assumptions made by different educators on the value of transitional space in early childhood learning (Frost et al., 2001; Moore & Cosco, 2007).

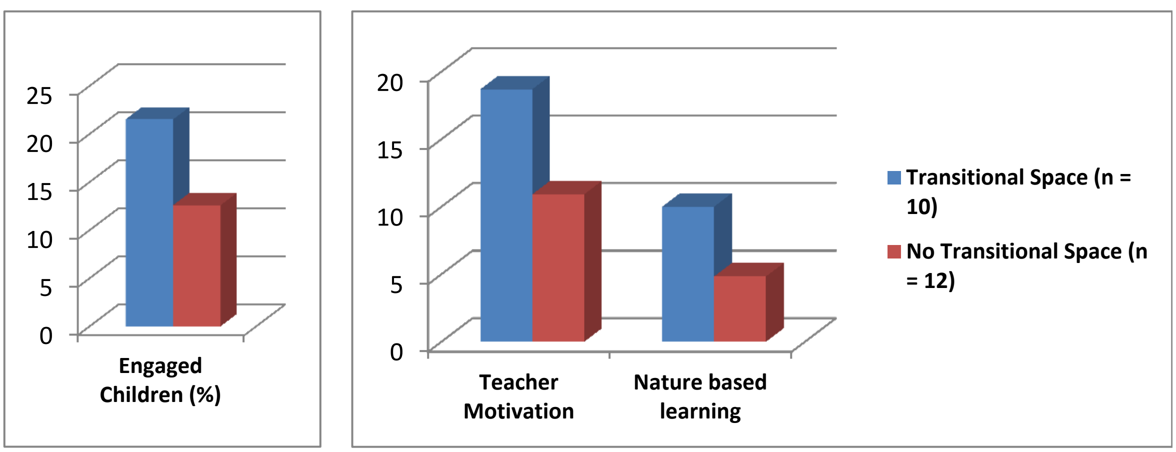


Figure 6-11: Mean value comparison of dependent variables in classrooms with and without transitional spaces

Transitional spaces were busy areas. Teachers in one classroom mentioned that they used the transitional space year-round for various learning activities. For example, indoor plants and seedlings flourished there for later outdoor planting (Figure 6-12). It allowed teachers different learning activities which were too *messy* for indoor classroom environment but not suitable for exposed outdoor environments either (Figure 6-13). In other words, transitional space afforded activities which were not possible in indoor or outdoor environments.

Figure 6-12: Transitional spaces were used yearlong for various activities

Figure 6-13: Transitional spaces afforded activities which were not possible elsewhere

The transitional space and its potential for learning activities are under-researched. This study was also unable to provide any statistically significant finding that may add to the value of having transitional spaces attached to preschool classrooms. Comparison of mean values of different outcome variables and observed phenomena in a few of the classrooms indicate that more investigation is needed to understand the pedagogical value of a transitional space for early childhood learning.

6.6 Other Predictors of Children's and Teachers' Learning Behavior

In addition to indoor-outdoor variables, other significant predictors explained variances in children's learning and teachers' teaching behavioral outcomes in the observed classrooms. This section discusses those explanatory variables and explains their significance in predicting outcome.

6.6.1 Children per Teacher is the Strongest Determinant of Distraction

It was expected that the number of children per teacher would prevail as a strong indicator of children's distractions in a classroom. In addition, the quality of care and education largely depend on the children-to-teacher ratio. Most of the standards and design guides for childcare centers specify this ratio for different age ranges of children (GSA, 2003; NC-DHHS, 2003). Usually the ratio is smaller for younger children. For the state of North Carolina, the child-teacher ratio for children who are 3 years old, 4 years old, and school age are 1:15, 1:20, and 1:25, respectively (NC-DHHS, 2003). One study concluded that classrooms that complied with professional standards of adult-child ratios also had more effective teachers and more positive child outcomes (Howes, 1997). In this study, the teacher-child ratio was the strongest predictor for both the percentage of distracted children ($p < .01$ level) and the number of behavioral guidance directives ($p < .01$ level). It was the only significant variable for explaining child distraction, and the model predicted a 44.7% of variance in this outcome. These findings suggest that children are more likely to be distracted and teachers would use more directives to control them when the child per teacher ratio is high in a preschool classroom. However, no significant association was found here for positive child outcomes (children's collective engagement and percentage of engaged children) or teacher motivation.

6.6.2 Teachers' Academic Qualifications vs. Teachers' Experience

Teachers' academic qualification was negatively related to ($p < .05$) the number of behavioral guidance directives (Model 3 in Table 5-18). Two other variables — children-per-teacher and teachers' years of experience — were also significant in this model. The final model (Model 4 in Table 5-18) explained 85.4% of the variances of this outcome variable. More qualified teachers were likely to use fewer behavioral directives to control children. Numerous research studies have found links between teachers' academic qualifications and students' positive academic outcomes (Bishay, 1996; Darling-Hammond, 1999; Ferguson, 1991; Greenwald et al., 1996; Monk, 1994; Wenglinsky, 2000). Although conducted with different age groups of children, all of these studies concluded that teachers with the most advanced educations were most effective. One research study investigated the relationship between teachers' academic background and children's experience and behavioral outcomes in center-based childcare (Howes, 1997). The study concluded that teachers with the most advanced education were most effective. The findings here regarding the negative relationship between teachers' academic qualifications and number of behavioral directives are consistent with the findings of the mentioned studies.

Surprisingly, teachers' years of experience was negatively related with children's collective engagement level. It was a statistically significant predictor ($p < .01$ level) in a model with two other indoor-outdoor variables (door and window-view affordance), which explained the 34.5% variance in children's collective engagement level during teacher-assisted activities in the classrooms (Model 4 in Table 5-15). Teacher experience was also a significant ($p < .10$ level) variable in the hierarchical multiple regression of number of behavioral guidance directives. Both findings were univocal in claiming that more experienced teachers were less effective in engaging children and they were likely to use more behavioral guidance directives to control classrooms. The evidence from previous studies investigating whether teachers' years of experience contribute to student outcomes is somewhat equivocal (Goldhaber & Brewer, 2000; Greenwald et al., 1996; NICHD, 2002; Rivkin et al., 2005). One study (Greenwald et al., 1996) suggested that teachers' years of experience positively predicted student outcomes, but the effect size was small (.17). Another study (Goldhaber & Brewer, 2000) revealed small positive effects for teacher years of experience that did not reach 95% confidence levels. One study found a significant difference between young and old teachers' motivation and old teachers were motivated more than young teachers (Yemisi, 2013). It contradicted the findings of one previous study which found younger teachers more motivated (Bishay, 1996).

Conversely, this finding may also be attributed to methodological issues of small sample size. The frequency distribution of teaching experience was skewed to the right (Figure 5-3) compared to the normal distribution of teaching motivations (Figure 5-2). Considering the small sample size of 22, the finding that more experienced teachers were less effective in engaging children may simply be the consequence of this skewed data or outliers. Teachers' academic qualification was also positively significant in two consecutive models (Model 2 and Model 3 in Table 5-19) for predicting teachers' motivations. This predictor was not significant in the final hierarchical regression model. However, it met expectations and was consistent with previous studies discussed earlier.

6.6.3 ECERS-R Matters

The ECERS-R (Early Childhood Environment Rating Scale – Revised Edition) composite score rated four aspects of a classroom environment. They are: 1) space and furnishing, 2) books and picture, 3) activities and 4) program structure. The *space and furnishing* part looked into indoor space, furnishing for routine care, relaxation, comfort, privacy, room arrangement for play, space for gross motor play, gross motor equipment and child-related displays in a preschool classroom. *Books and pictures* rated the quantity and quality of books and pictures in the classroom in terms of developmental appropriateness and needs of children. The *activities* category rated the scope, quality and quantity of different activities such as fine motor, art, music, blocks, sand-water, dramatic play, nature-science etc. The *program structure* aspect looked into the quality of the class schedule in terms of free play, group time and provisions for children with disabilities. It was expected that classrooms that scored higher in ECERS-R composite score would perform better in engaging children in self-assisted activities. This expectation was met, as the statistical findings showed that the ECERS-R was the most significant variable ($p < .05$) for predicting the percentage of engaged children (Model 3 in Table 5-16). ECERS-R and children's average age was significant in the model which explained 56.9% of the variance of engaged children during free activity sessions. Numerous research projects in the United States and abroad have used the ECERS-R to assess global quality and have discovered significant relationships between ECERS-R scores and child outcome measures (Harms et al., 2005). This particular finding of this research supported ECERS-R's importance and validity in explaining children's learning behavior.

6.7 Conclusion (Statistical Findings)

Quantitative findings suggest that indoor-outdoor spatial relationships, in terms of window views, may positively influence engagement of children in learning, particularly during free-activity periods. Window views may also support teacher motivation and a propensity to engage children in hands-on learning, particularly through using innovative, nature-based approaches. These exploratory findings suggest consideration of indoor-outdoor spatial relations as an integral part of childcare center classroom design.

6.8 Limitations of the Study

Four limitations of the study are discussed in the following sections.

6.8.1 Statistical Limitations: Sample Size and Sampling Process

The main limitation of the study is the relatively small sample size (N=22). Approximately 250,000 children in North Carolina spend part or all of their day in regulated childcare arrangements (childcare centers and family childcare homes) in approximately 7,140 centers (NC-DHHS, 2014a). Twenty two classrooms is only a small fraction of this huge population. The size of the sample dictates the amount of information the study has and, therefore, in part, determines the precision or level of confidence that is in the sample estimates. The study used a non-probabilistic/purposive sample. The centers were randomly selected from a list of all centers that previously participated in three NLI-governed projects – not from a list of all centers of North Carolina. It was assumed that getting permission for access to and collecting intensive data from random centers would be impractical. Probabilistic sampling is one of the most important criteria for correlation research (Groat & Wang, 2001). The goal of probabilistic sampling is to achieve a sample that is truly representative of the larger population. To address these limitations, a 90% confidence interval was used in all of the regression models instead of 95%.

6.8.2 Limitation Related to Instruments

No existing scale was found to measure the indoor-outdoor spatial relationships of a space. The proposed tool in this study to measure door, window, view and transitional space affordances in preschool classrooms was not properly tested for validity and reliability. Most of the tool indicators were developed from two previous research studies (Heschong, 2003; Tanner, 2009). The lack of reliability and validity existed also in the measurements of the outcome variables of child engagement and teacher motivation. No single study or tested tool/scale was found which could meet the requirements of outcome measurements of this study. Multiple research studies were used as sources to generate the measurement techniques. However, the four measures of child engagement and two measures of teacher motivation were all tested for bivariate correlation (Table 5). The direction and significance of the relationships were meaningful and consistent with expectations (elaborately discussed in section 5.1.4), which can account for the predictive validity of these measures.

6.8.3 Lack of External Validity

The main concern of external validity is whether the result of the study is applicable to the larger world or other places, or at least whether there are defining contextual constraints within which the results are valid (Groat & Wang, 2001). The sample used in the current study is essentially a convenience sample, so generalization was inherently in question. Data were collected from early October to mid-November. This means that the findings cannot be generalized to other times of the year, especially when climatic conditions are drastically different from the fall/autumn period. The primary concern of the study is indoor-outdoor spatial relationship, which is subjected to daylight variations, weather conditions, sky conditions, tree foliage, etc. — all of which vary according to seasonal changes all year round. A recent similar study (Wu et al., 2014) which applied remote-sensing techniques to investigate the link between surrounding greenness and school-based academic performance found consistently positive significant association in the spring and negative relation in October, due to the ”fall effect” in New England, where the study took place. This finding emphasizes the importance of year-round data collection.

The study is also geographically limited to Wake County, North Carolina. It is a matter of concern whether the findings of this research are applicable for other parts of the United States or other parts of the world. The way childcare centers or preschools are designed in the U.S. may vary compared to the ways they are designed in a developing country, or in cities with extreme land crises, where land value predicts design. In such areas where windowless environment are more common, transitional space is only a luxury or where there is no room for *greenness* in the dense concrete jungle – indoor-outdoor spatial relationship measurement calls for a different approach. This lack of generalizability is a prominent limitation of the study. However, the study proposes a systematic way of measuring indoor-outdoor spatial relations by means of its four proposed scales — door affordance scale, window affordance scale, view affordance scale and transitional space affordance scale. Whatever the differences may be in urban environments, or weather or geographic locations, the approach to measure indoor-outdoor spatial relations would bear conceptual similarities. These tools can be modified accordingly to different settings. The findings of this study may not be generalized to every other context, but its approach can guide similar studies in many different settings.

Chapter 7 : Qualitative Findings

Besides collecting variable specific quantitative data, notes and photographs of specific events were recorded, which provide insights about the role of indoor-outdoor spatial relations relative to child engagement and teaching motivation. These qualitative findings add further understanding related to indoor-outdoor spatial relations and classroom management and potential design implications. The four events discussed below were recorded during quantitative data collection.

7.1 Management and Policy Issues May Hinder Design Intentions

One classroom (Figure 7-1) had a large floor-to-ceiling window with a roller shutter. This meant the classroom could be completely opened to the outdoor play environment.

Figure 7-1: The classroom designed to be completely opened to outside

The architect had provided unique affordances with this design with the intention of flexible spatial indoor-outdoor relationships so that learning activities could be linked from inside to outside. But to the researchers’ surprise, the teachers reported that the roller window is never opened during regular classroom activities. If the window is opened, it would require more manpower (teachers/caregivers) to supervise children in the larger indoor-outdoor areas. What was facilitated by the design was never used, due to management issues.

7.2 Design Intentions Can be Supported by Indoor Zoning of Activities

Teachers were asked to rate the most and least popular activity zones for children in their respective classrooms. While the activity of playing with blocks was a clear winner as the most popular activity, the *writing desk* was surely the least popular activity among children in the 22 classrooms. However, things were different in one classroom (Figure 7-2), where the writing desk was integrated with a classroom window and was a popular space.

Figure 7-2: Is a writing desk more functional when integrated with a window?

The researcher observed children using that zone as frequently as the other obvious popular choices like blocks, dramatic play, etc. The teachers confirmed what the researcher observed, and said that the writing desk was popular in that particular classroom. This drew the researcher's attention to the zoning principles of a preschool classroom. While architectural indoor-outdoor spatial relationships are important, it is also equally important to arrange the indoor activity zones in harmony with classroom doors, windows, views and transitional spaces of the classroom. This brings the study back to the observed phenomenon in the pilot survey. A science/nature zone can be placed by a window with a view of a bird feeder close to it, so that the teacher can teach children about bird species by showing them live birds. Some of the activity zones have better chances to function when they are placed close to a window/view or in a transitional space.

7.3 Design of the Outdoor Environment May Increase Indoor-Outdoor Relations

In another classroom, both teachers were asked the following question: "What would you suggest to improve the learning environment of the classroom?" Both replied that they would like to completely open up their classroom to the small courtyard space (Figure 7-3) located immediately outside the class. That classroom, along with three other preschool classrooms, shared this courtyard space, which was rich in vegetation and learning affordances. Surrounded by colonnaded transitional spaces, this outdoor area was small, contained, and manageable.

Interestingly, this center and the previously mentioned center in 7.1 were both operated by the same company, which apparently had not developed a consistent indoor-outdoor architectural policy.

Figure 7-3: A classroom with contained outdoor environment

7.4 Windowless Classrooms Restrict Nature-Based Learning

No writing desk like the one described in 7.2 was found in the windowless classroom (Figure 7-4). This classroom, in fact, was different in many other aspects as well. There was, of course, no indoor plant in the classroom. No nature-based learning or science experiment was evident and a discussion with the teacher revealed that she was unable to teach children simple concepts like diurnal variation or seasonal variations just because of the absence of a window. A windowless classroom environment was found to be associated with decreased academic performance and also severe health consequences for school-age children (Küller & Lindsten, 1992). However, this topic has not been researched for preschool children and their teachers. More research is needed to understand the consequences of a windowless environment on preschool children's learning outcomes and teacher motivation.

Figure 7-4: How do windowless classrooms function?

7.5 Conclusion

Qualitative findings illustrate how well-intentioned design may be thwarted by regulations or management policies, how design intentions can be supported by indoor zoning of activity, how design of outdoor environments may increase indoor-outdoor relations, and how windowless classrooms can restrict nature-based learning.

Although the qualitative findings are sporadic, they add a valuable perspective and suggest that the success of indoor-outdoor spatial relationship for motivating positive outcomes in children and teacher behavior may rely on issues such as policy, management, and indoor zoning of activities. These findings extend understanding the scope of potential future research regarding architectural characteristics of preschool classrooms and their influences on learning and teaching behavior.

Chapter 8 : Implication of Findings for Design and Future Research

Taken together, what are the implications of the quantitative and qualitative/anecdotal findings for childcare center classroom design and future research?

8.1 Design Implications

The concluding parts of this dissertation investigate the future possibilities and directions for research and design. The study revisits Owen's diagram (Figure 8-1) on design research (Owen, 1998) to understand the reciprocity of the two realms of research and practice in the fields of design. In a series of flow diagrams, Owen showed how *Design Research* and *Design Practice* interplay in one continuous process of knowledge-making.

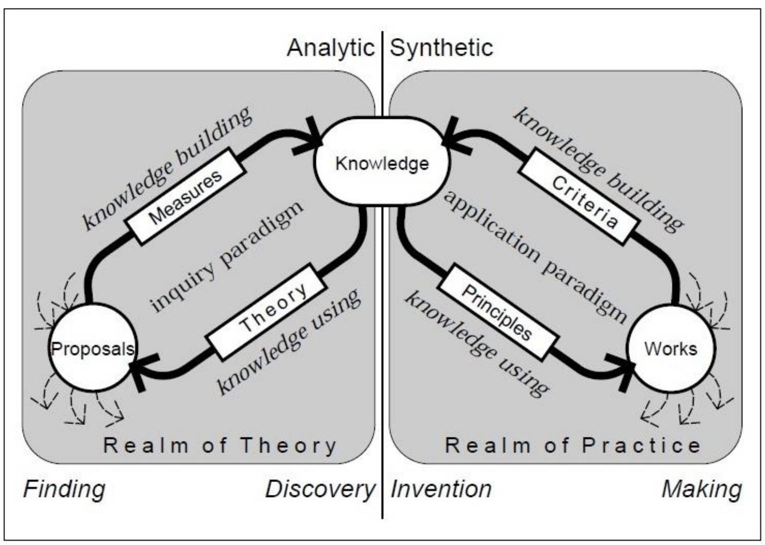


Figure 8-1: The continuous process research and practice in design (Owen, 1998)

Similar to Owen's ideas, this study also expects that its findings can be effectively translated into alternative forms to contribute to practical tasks.

8.2 Implications and Recommendations from Findings

Table 8-1 provides a summary record of the major findings (statistical and qualitative), their implications, and recommendations for design policies and research.

Table 8-1: Summary of findings, implications, and recommendations

	Findings	Implications	Recommendations
Statistical Findings	More window-view affordance = more teaching motivation (hands-on and innovative lessons).	Teacher motivation may be improved in preschool classrooms designed with high affordance scores for windows and views. Existing designs can be improved by developing the immediate surrounding landscape.	Newly designed classrooms should accommodate more windows. Windows should be designed at children's scale, and with wider sill-depth to afford window-zone learning activities. In existing classrooms, where new windows cannot be installed, the immediate surrounding landscape can be improved to afford interactive views emphasizing nature.
	More window-view affordance = more engaged in children.		
	More window-view affordance = more nature based learning in classrooms.		
	Higher ECERS-R score = more engagement in children.	ECERS-R predicts positive outcomes in children in preschool classroom environment.	Items measured by ECERS-R should be integrated with preschool classroom design processes.
Qualitative Findings	The mean values of child engagement, teacher motivation and nature-based learning are considerably higher in classrooms with transitional spaces.	Transitional space can be considered as an 'essential' classroom element rather than just an extension of space.	More research is needed to evaluate the influence of a transitional space on learning outcomes. Design guidelines and official rating systems for childcare centers and preschool classrooms should emphasize the inclusion of transitional spaces as a required design criterion.
	Contained immediate outdoor environment encourages teachers to increase indoor-outdoor spatial accessibility.	Contained immediate outdoor environment may add to the affordances of indoor-outdoor spatial relations of a classroom.	Landscape design should accentuate classroom design intentions regarding indoor-outdoor relations.
	Indoor classroom zoning and arrangement of activities may reinforce the positive effects of indoor-outdoor spatial relations to learning engagement.	Teachers can be encouraged to become aware of the potentials of classroom arrangement/zoning in influencing learning behavior.	Design guidelines/policies and official rating systems should inform teachers/caregivers/directors about zoning principles to emphasize indoor-outdoor spatial relations in preschool classrooms.
	Regulations and management policies may hinder indoor-outdoor classroom accessibility.	Policies and design implications can converge to maximize the influences of indoor-outdoor spatial relations on learning environment.	Design guidelines and childcare policies need to be reviewed to remove conflict and revised to accommodate indoor-outdoor spatial affordances for learning and teaching.

The directions for future research and design are discussed in the following sections in light of the findings, implications and recommendations of this study discussed in Table 8-1.

8.3 Directions for Future Research and Design

Three recommendations are discussed for future research and design, which draw on the findings of this study.

8.3.1 Validated Instrument to Measure Indoor-Outdoor Spatial Relations

One of the most important outcomes of the current study is its approach to systematically measure the spatial indoor-outdoor relationships of preschool classrooms. The study proposed four subscales (door affordance scale, window affordance scale, view affordance scale and transitional space affordance scale) to measure learning affordances of different architectural indoor-outdoor spatial characteristics. These subscales use indicators based on previous literature. However, a full-scale reliability or validity check for these scales was not possible with the time and budgetary constraints of this research. Future research projects should attempt to validate these subscales and continue the development process of these measures.

8.3.2 Design Guidelines for Model Classroom

The findings of this study should be able to contribute to contemporary design guidelines and rating systems. Statistical findings of this research signify the importance of certain architectural indoor-outdoor design characteristics in predicting positive outcomes in child engagement and teacher motivation. These design recommendations should constitute new guidelines and principles or at least contribute to the existing ones, which have not addressed indoor-outdoor spatial relations as an important criterion. For example, ECERS-R (Harms et al., 2005) has several sub-sections to rate the learning environment qualities of a preschool classroom, but it does not rate the indoor-outdoor spatial relationship indicators described in this research. Similarly, the star rating system by the North Carolina Division of Children Development and Early Education lacks a systematic and comprehensive way to rate indoor-outdoor relationships of space. The GSA (2003) contains some fragmented recommendations for window design or addition of a transitional space, but it also lacks an all-inclusive perspective toward indoor-outdoor spatial relationships in preschool classroom design.

Figure 8-2 is an attempt to translate the research findings into a graphical representation of a model classroom design. As suggested by the additional findings, one of the key factors for successful indoor-outdoor spatial design is integration of the indoor activity zones in the classroom with the architectural indoor-outdoor attributes (doors, windows, views and transitional spaces).

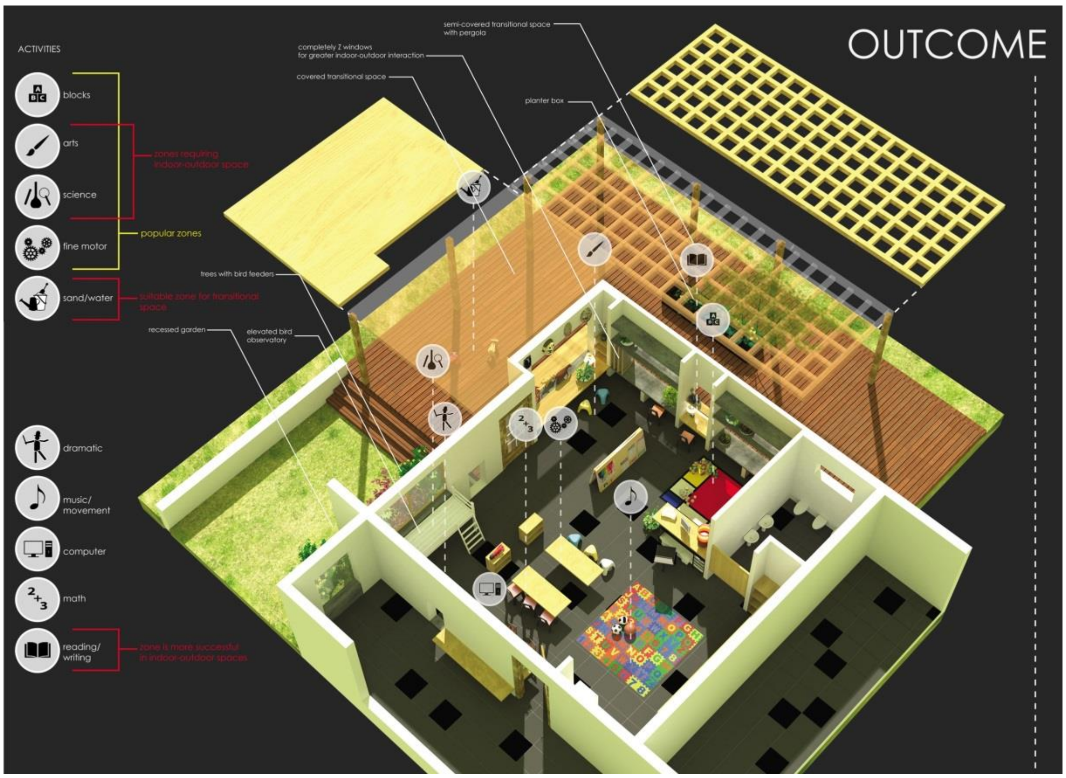


Figure 8-2: Model classroom design to maximize the effects of indoor-outdoor relations

The schematic design in Figure 8-2 suggests such broad zoning principles for indoor layout. For example, a writing desk should be integrated with a window. Arts, science and nature should be integrated with operable window and sufficient sill-depth so that messy activities and experiments can take place on the windows. The surrounding landscape should reflect these design intentions as well. For example, one window can have view of nearby trees with bird feeders so that the teacher can create a mock bird observatory and teach children about bird species by showing real birds (Figure 8-2).

8.3.3 Replication

A relative small sample size (N = 22) is a weakness of the current study. A similar study with a larger sample size may produce stronger results. Experimental or longitudinal designs would allow researchers to investigate the causality of indoor-outdoor spatial relations on learning and teaching.

8.4 Closing Comments

Architecture is a neglected aspect of educational research and information is limited regarding the influence that the built environment has on academic outcomes. Considering the growing demand for childcare facilities in the United States, further investigation of this neglected aspect of early childhood research is timely. The study reported here adds to the limited evidence that architectural design may influence behavioral outcomes in learning environments, even in early childhood institutions. The findings call for reforms and developments in design guidelines and policies regarding childcare center architecture. This study also suggests promising new approaches to built environment research, which can be used to investigate a broader range of related built environment concerns. Improving indoor-outdoor spatial relations and their consequential positive motivational outcomes cannot be entirely achieved by the architect or the landscape architect or the classroom teacher. Rather, achieving such outcomes demands a harmonizing effort of all parties. The results of this study pave the way for improved practices and collaboration among architects, landscape architects, and educators for enhancing indoor-outdoor spatial relations in preschool classrooms in order to enhance the qualities and effectiveness of the learning environment for both children and their teachers.

References

Abdou, O. A. (1997). Effects of luminous environment on worker productivity in building spaces. *Journal of architectural engineering, 3*(3), 124-132.

Adams, R., & Hiddle, B. (1970). Realities of teaching–explorations with video tapeholt, rinehart and winston: Inc.

Alam, M. T., & Farid, S. (2011). Factors affecting teachers motivation. *International journal of Business and social science, 2*(1), 298-304.

Andersen, S. R. (1998). The trouble with testing. *Young Children, 53*(4), 25-29.

Aron, A. (2012). *Statistics for psychology 6th edition*: Pearson.

Ayvacı, H. S., & Devecioğlu, Y. (2010). Place arrangements and motivation methods of preschool teachers use in science and nature activities. *Procedia-Social and Behavioral Sciences, 2*(2), 1977-1981.

Banning, J., & Canard, M. (1986). The physical environment supports student development. *Campus Ecologist, 4*(1), 1-3.

Barnett, W. S. (2003). Better teachers, better preschools: Student achievement linked to teacher qualifications. Nieer preschool policy matters, issue 2.

Belsley, D. A., Kuh, E., & Welsch, R. E. (2005). *Regression diagnostics: Identifying influential data and sources of collinearity* (Vol. 571): John Wiley & Sons.

Benfield, J. a., Rainbolt, G. N., Bell, P. a., & Donovan, G. H. (2013). Classrooms with nature views: Evidence of differing student perceptions and behaviors. *Environment and Behavior*. doi: 10.1177/0013916513499583

Bennett, J. A. (2000). Mediator and moderator variables in nursing research: Conceptual and statistical differences. *Research in Nursing & Health, 23*(5), 415-420.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological science, 19*(12), 1207-1212.

Bishay, A. (1996). Teacher motivation and job satisfaction: A study employing the experience sampling method. *Journal of Undergraduate Sciences, 3*(3), 147-155.

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *Bmj, 314*(7080), 572.

Brandon, R., Stutman, T., & Maroto, M. (2011). The economic value of the US early childhood sector. *Economic analysis: The early childhood sector*, 19-41.

Bredekamp, S. (1987). Developmentally appropriate practice in early childhood programs serving children from birth through age 8.

Bronfenbrenner, U. (2009). *The ecology of human development: Experiments by nature and design*: Harvard university press.

Brophy, J. E. (2013). *Motivating students to learn*: Routledge.

Bryant, D. M. (2000). *Validating North Carolina's 5-star child care licensing system*: University of North Carolina, Frank Porter Graham Child Development Center, UNC-CH Smart Start Evaluation Team.

Burnette, C. (1971). *Introduction.* Paper presented at the Architecture for Human Behavior, Philadelphia.

Cassidy, D. J., Hestenes, L. L., Hegde, A., Hestenes, S., & Mims, S. (2005). Measurement of quality in preschool child care classrooms: An exploratory and confirmatory factor analysis of the early childhood environment rating scale-revised. *Early Childhood Research Quarterly, 20*(3), 345-360.

CCAA. (2012). Child Care in America: 2012 State Fact Sheets. Arlington, VA: Child Care Aware of America

Chiles, P. (2005). The classroom as an evolving landscape. In M. Dudek (Ed.), *Children's Spaces* (pp. 101-113): Architectural Press.

Christakis, D. A., & Garrison, M. M. (2009). Preschool-aged children's television viewing in child care settings. *Pediatrics, 124*(6), 1627-1632.

Cohen, B. H. (2008). *Explaining psychological statistics*: John Wiley & Sons.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*: Routledge.

Cornell, P. (2002). The impact of changes in teaching and learning on furniture and the learning environment. *New directions for teaching and learning, 2002*(92), 33-42.

Cuttle, K. (1983). *People and windows in workplaces.* Paper presented at the Proceedings of the people and physical environment research conference.

Darling-Hammond, L. (1999). *Teacher quality and student achievement: A review of state policy evidence*: Center for the Study of Teaching and Policy, University of Washington Seattle, WA.

Dasgupta, U. (2003). *The impact of windows on mood and the performance of judgmental tasks.*

De Veaux, R. D., Velleman, P. F., & Bock, D. E. (2005). *Stats: data and models*: Pearson/Addison Wesley Boston.

DeBord, K., Hestenes, L., Moore, R., Cosco, N., & McGinnis, J. (2005). *Preschool Outdoor Environment Measurement Scale (POEMS)*: Lewisville, NC: Kaplan Early Learning Company.

Denham, S. A., & Burton, R. (1996). A social-emotional intervention for at-risk 4-year-olds. *Journal of School psychology, 34*(3), 225-245.

Devlin, A. S., & Arneill, A. B. (2003). Health care environments and patient outcomes a review of the literature. *Environment and Behavior, 35*(5), 665-694.

Diana, R. J. (2012). Imagining the Garden: Childhood, Landscape, and Architecture in Early Pedagogy, 1761--1850 *Imagining the Garden: Childhood, Landscape, and Architecture in Early Pedagogy, 1761--1850*: Harvard University.

Dudek, M. (2005). *Children's spaces*: Routledge.

Earthman, G., & Lemasters, L. (1996). Review of research on the relationship between school buildings, student achievement, and student behavior.

Eberhard, J. P. (2009). *Brain landscape the coexistence of neuroscience and architecture*: Oxford University Press.

Edwards, L., & Torcellini, P. A. (2002). *A literature review of the effects of natural light on building occupants*: National Renewable Energy Laboratory Golden, CO.

Ferguson, R. F. (1991). Paying for public education: New evidence on how and why money matters. *Harv. J. on Legis., 28*, 465.

Fernet, C., Senecal, C., Guay, F., Marsh, H., & Dowson, M. (2008). The Work Tasks Motivation Scale for Teachers (WTMST). *Journal of Career Assessment, 16*(2), 256-279. doi: 10.1177/1069072707305764

Frost, J. L., Wortham, S., & Reifel, S. (2001). *Play and child development*. New Jersey: Merrill Prentice Hall.

Frost, J. L., Wortham, S. C., & Reifel, R. S. (2008). *Play and child development*: Pearson/Merrill Prentice Hall Upper Saddle River^ eNJ NJ.

Gibson, E. J., & Pick, A. D. (2000). *An ecological approach to perceptual learning and development*: Oxford University Press.

Goelman, H., & Jacobs, E. V. (1994). *Children's play in child care settings*: SUNY Press.

Goldhaber, D. D., & Brewer, D. J. (2000). Does teacher certification matter? High school teacher certification status and student achievement. *Educational evaluation and policy analysis, 22*(2), 129-145.

Greene, W. H. (2003). *Econometric analysis*: Pearson Education India.

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of educational research, 66*(3), 361-396.

Groat, L., & Wang, D. (2001). *Architectural research methods*: Wiley.

GSA. (2003). Child care center design guide.   Retrieved June 20, 2013, from http://www.gsa.gov/graphics/pbs/designguidesmall.pdf

Gulwadi, G. B. (2006). Seeking restorative experiences elementary school teachers' choices for places that enable coping with stress. *Environment and Behavior, 38*(4), 503-520.

Harms, T., Clifford, R. M., & Cryer, D. (2005). *Early childhood environment rating scale, revised edition*: Teachers College Press New York.

Hathaway, W. E. (1992). *A study into the effects of light on children of elementary school-age--a case of daylight robbery*: ERIC.

Hedge, A. (1994). Reactions of computer users to three different lighting systems in windowed and windowless offices. *Work and Display Units, 94*.

Heschong, L. (2003). [Windows and classrooms: A study of student performance and the indoor environment].

Heschong, L., Mahone, D., Kuttaiah, K., Stone, N., Chappell, C., & McHugh, J. (1999). Daylighting in schools: An investigation into the relationship between daylighting and human performance. *Summary for the Pacific Gas and Electric Company on behalf of the California Board for Energy Efficiency Third Party Program*.

Höppe, P. (2002). Different aspects of assessing indoor and outdoor thermal comfort. *Energy and buildings, 34*(6), 661-665.

Hopwood-Stephens, I. (2013). *Learning on your doorstep: Stimulating writing through creative play outdoors for ages 5-9*. New York, London: Routledge.

Howes, C. (1997). Children's experiences in center-based child care as a function of teacher background and adult: child ratio. *Merrill-Palmer Quarterly (1982-)*, 404-425.

IBM-SPSS. (2012). IBM SPSS Statistics Information Center. Retrieved 4 June 2014, from http://pic.dhe.ibm.com/infocenter/spssstat/v22r0m0/index.jsp

Irwin, A., & Joachim, W. (1978). *Children and the environment*. New York: Plenum Press.

Kamii, C. (1990). *Achievement testing in the early grades: The games grown-ups play*: ERIC.

Kaplan, R. (1993). The role of nature in the context of the workplace. *Landscape and Urban Planning, 26*(1), 193-201.

Kaplan, R. (2001). The nature of the view from home psychological benefits. *Environment and Behavior, 33*(4), 507-542.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169-182.

Karmel, L. J. (1965). Effects of windowless classroom environment on high school students. *Perceptual and motor skills, 20*(1), 277-278.

Küller, R., & Lindsten, C. (1992). Health and behavior of children in classrooms with and without windows. *Journal of Environmental Psychology, 12*(4), 305-317.

Lang, J. (1974). Part one: Emerging issues in architecture. In H. R. Dowden (Ed.), *Designing for human behavior: Architecture and the behavioral sciences* (pp. 3-14). Pennsylvania.

Larson, C. T. (1965). *The effect of windowless classrooms on elementary school children*. Ann Arbor: College of Architecture and Design, University of Michigan.

Laughlin, L. (2010). *Who's minding the kids? Child care arrangements, Spring 2005/Summer 2006*: US Department of Commerce, Bureau of the Census.

Laughlin, L. (2013). *Who's minding the kids? Child care arrangements, Spring 2011*: US Department of Commerce, Bureau of the Census.

Lewin, K., Heider, F. T., & Heider, G. M. (1936). Principles of topological psychology.

Lieberman, G. A., Hoody, L. L., & Lieberman, G. M. (2000). [California Student Assessment Project].

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*: Algonquin Books.

Malone, K., & Tranter, P. (2003). Children's environmental learning and the use, design and management of schoolgrounds. *Children, Youth and Environments, 13*(2).

Martin, S. H. (2002). The classroom environment and its effects on the practice of teachers. *Journal of Environmental Psychology, 22*(1-2), 139-156. doi: 10.1006/jevp.2001.0239

Martin, S. H. (2006). The classroom environment and children's performance - is there a relationship. In C. Spencer & M. Blades (Eds.), (pp. 91-107). New York: Cambridge UP.

Matsuoka, R. H. (2010). Student performance and high school landscapes: Examining the links. *Landscape and Urban Planning, 97*(4), 273-282. doi: 10.1016/j.landurbplan.2010.06.011

McDevitt, T. M., & Ormrod, J. E. (2002). *Child Development and Education*. Merrill: Prentice Hall.

McDonald Connor, C., Son, S.-H., Hindman, A. H., & Morrison, F. J. (2005). Teacher qualifications, classroom practices, family characteristics, and preschool experience: Complex effects on first graders' vocabulary and early reading outcomes. *Journal of School psychology, 43*(4), 343-375.

McGrath, J. E. (1981). Dilemmatics: The study of research choices and dilemmas. *American Behavioral Scientist, 25*(2), 179-210.

McKenzie, T. L. (2010). C. H. McCloy Lecture. Seeing is believing: observing physical activity and its contexts. *Research quarterly for exercise and sport, 81*(2), 113-122.

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2012). *Learning in adulthood: A comprehensive guide*: John Wiley & Sons.

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of education review, 13*(2), 125-145.

Moore, R. C. (1996). Outdoor setting for playing and learning: Designing school grounds to meet the needs of the whole child and whole curriculum. *The Namta Journal, 21*(3), 97-121.

Moore, R. C., & Cosco, N. (2007). Greening Montessori school grounds by design. *NAMTA JOURNAL, 32*(1), 129.

Moore, R. C., & Goltsman, S. M. (1992). *Play for all guidelines: Planning, designing and management of outdoor play settings for all children*: Mig Communications.

NASP. (2003). Motivating learning in young children. Retrieved June 4, 2014, from http://www.nasponline.org/resources/home_school/earlychildmotiv_ho.aspx

NC-DHHS. (2003). Summary: North Carolina Child Care Law and Rules Retrieved June 4, 2014, from http://ncchildcare.dhhs.state.nc.us/pdf_forms/law_summary_11_00.pdf

NC-DHHS. (2014a). Child Care Analysis Detail (pp. 990-990). Raleigh, NC: North Carolina Department of Health and Human Services.

NC-DHHS. (2014b). NC Child Care Snapshot. Retrieved November 10, 2014, from http://ncchildcare.nc.gov/general/mb_snapshot.asp#Child Care Highlights

NC-DHHS. (2014c). North Carolina Child Care Snap Shot. Retrieved June 20, 2014, from http://ncchildcare.nc.gov/general/mb_snapshot.asp

NCGA. (2012). NC General Statutes, Chapter 110, 110-91. Mandatory standards for a license. Retrieved October 11, 2014, from http://www.ncga.state.nc.us/EnactedLegislation/Statutes/HTML/BySection/Chapter_110/GS_110-91.html

NICHD. (2002). Child-care structure→ process→ outcome: Direct and indirect effects of child-care quality on young children's development. *Psychological science, 13*(3), 199-206.

Nilsen, B. A. (2013). *Week by week: Plans for documenting children's development*: Cengage Learning.

NLI. (2014). About us. Retrieved November 10, 2014, from http://naturalearning.org/about-us

NRC. (2008). Early childhood assessment: Why, what, and how. Vol. 1. Washington, DC: National Research Council (NRC).

O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality & Quantity, 41*(5), 673-690.

Olds, A. (2001). *Child care design guide*. Washington D. C.: McGraw-Hill.

Otis, T., & Reinhart, C. (2009). Daylighting rules of thumb. Retrieved June 4, 2014, from http://www.gsd.harvard.edu/research/gsdsquare/Publications/DiffuseDaylightingDesignSequenceTutorial.pdf

Pelletier, L. G., Séguin-Lévesque, C., & Legault, L. (2002). Pressure from above and pressure from below as determinants of teachers' motivation and teaching behaviors. *Journal of Educational Psychology, 94*(1), 186.

Perlman, M., Zellman, G. L., & Le, V.-N. (2004). Examining the psychometric properties of the early childhood environment rating scale-revised (ECERS-R). *Early Childhood Research Quarterly, 19*(3), 398-412.

Perry, N. E., & Winne, P. H. (2006). Learning from learning kits: Study traces of students' self-regulated engagements with computerized content. *Educational Psychology Review, 18*(3), 211-228.

Petrocelli, J. V. (2003). Hierarchical multiple regression in counseling research: Common problems and possible remedies. *Measurement and evaluation in counseling and development, 36*(1), 9-22.

Piaget, J. (1965). The stages of the intellectual development of the child. *Educational psychology in context: Readings for future teachers*, 98-106.

Plowman, L., Stevenson, O., Stephen, C., & McPake, J. (2012). Preschool children's learning with technology at home. *Computers & Education, 59*(1), 30-37.

Rainey, R. M. (1988). Architecture and landscape: Three modes of relationship. *Places, 4*(4), 4-6.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*(2), 417-458.

Rivlin, L. G., & Rothenberg, M. (1976). The use of space in open classrooms. *Environmental Psychology: People and their physical settings, Holt, Rinehart & Winston*.

Rowe, D. (2007). Bringing books to life: the role of book-related dramatic play in young children's literacy learning. *K. Roskos, & J. Christie.(Eds.), Play and literacy in early childhood: research from multiple perspectives*, 37-63.

Runkel, P. J., & McGrath, J. E. (1972). *Research on human behavior: a systematic guide to method*: Holt, Rinehart and Winston.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology, 25*(1), 54-67.

Sanoff, H. (2009). Foreward *Scools for the Future: Design Prposals from Architectural Psychology* (pp. vii-ix): Hogrefe & Huber Publishers.

Shim, S.-Y., Herwig, J. E., & Shelley, M. (2001). Preschoolers' play behaviors with peers in classroom and playground settings. *Journal of Research in Childhood Education, 15*(2), 149-163. doi: 10.1080/02568540109594956

Slopack, M. (2011). *The impact of a window in the classroom on learning as perceived by students and teachers.*

Smith, M. K. (2003). Learning theory. *The encyclopedia of informal education.* Retrieved October 31, 2014, 2014, from http://infed.org/mobi/learning-theory-models-product-and-process/

Sommer, B., & Sommer, R. (1991). *A practical guide to behavioral research: Tools and techniques*: Oxford University Press.

Sop Shin, W. (2007). The influence of forest view through a window on job satisfaction and job stress. *Scandinavian Journal of Forest Research, 22*(3), 248-253.

Standing, E. M., & Havis, L. (1998). *Maria Montessori, her life and work*: Plume New York, NY.

Stebbins, R. A. (2001). *Exploratory research in the social sciences* (Vol. 48): Sage.

Sylvia, R. D., & Hutchison, T. (1985). What makes Ms. Johnson teach? A study of teacher motivation. *Human relations, 38*(9), 841-856.

Tai, L., Haque, M. T., McLellan, G. K., & Erin, K. J. (2006). *Designing outdoor environments for children*: McGraw-Hill.

Tanner, C. K. (2009). Effects of school design on student outcomes. *Journal of Educational Administration, 47*(3), 381-399.

Taylor, A. (2002). Views of nature and self-discipline: Evidence from inner city children. *Journal of Environmental Psychology, 22*(1-2), 49-63. doi: 10.1006/jevp.2001.0241

Ulrich, R. (1984). View through a window may influence recovery. *Science, 224*(4647), 224-225.

Van Amburgh, J. A., Devlin, J. W., Kirwin, J. L., & Qualters, D. M. (2007). A tool for measuring active learning in the classroom. *American journal of pharmaceutical education, 71*(5).

Vandell, D. L., Belsky, J., Burchinal, M., Steinberg, L., & Vandergrift, N. (2010). Do effects of early child care extend to age 15 years? Results from the NICHD study of early child care and youth development. *Child development, 81*(3), 737-756.

Vandewater, E. A., Bickham, D. S., & Lee, J. H. (2006). Time well spent? Relating television use to children's free-time activities. *Pediatrics, 117*(2), e181-e191.

Veltri, S., Banning, J. H., & Davies, T. G. (2006). The community college classroom environment: Student perceptions. *College Student Journal, 40*(3), 517-527.

Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D. (2005). The effect of sunlight on postoperative analgesic medication use: a prospective study of patients undergoing spinal surgery. *Psychosomatic Medicine, 67*(1), 156-163.

Walsh, G., & Gardner, J. (2005). Assessing the quality of early years learning environments measuring the quality of early years learning environments. *Early Childhood Research and Practice, 7*(1).

Wells, N. M. (2000). At home with nature: Effects of "greenness" on children's cognitive functioning. *Environment and Behavior, 32*(6), 775-795. doi: 10.1177/00139160021972793

Wenglinsky, H. (2000). How teaching matters: Bringing the classroom back into discussions of teacher quality.

Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., . . . Demetriou, D. (2008). The development of two observational tools for assessing metacognition and self-regulated learning in young children. *Metacognition and Learning, 4*(1), 63-85. doi: 10.1007/s11409-008-9033-1

Wilson, E. O. (1984). *Biophilia*: Harvard University Press.

Wu, C.-D., McNeely, E., Cedeño-Laurent, J., Pan, W.-C., Adamkiewicz, G., Dominici, F., . . . Spengler, J. D. (2014). Linking Student Performance in Massachusetts Elementary Schools with the “Greenness” of School Surroundings Using Remote Sensing. *PloS one, 9*(10), e108548.

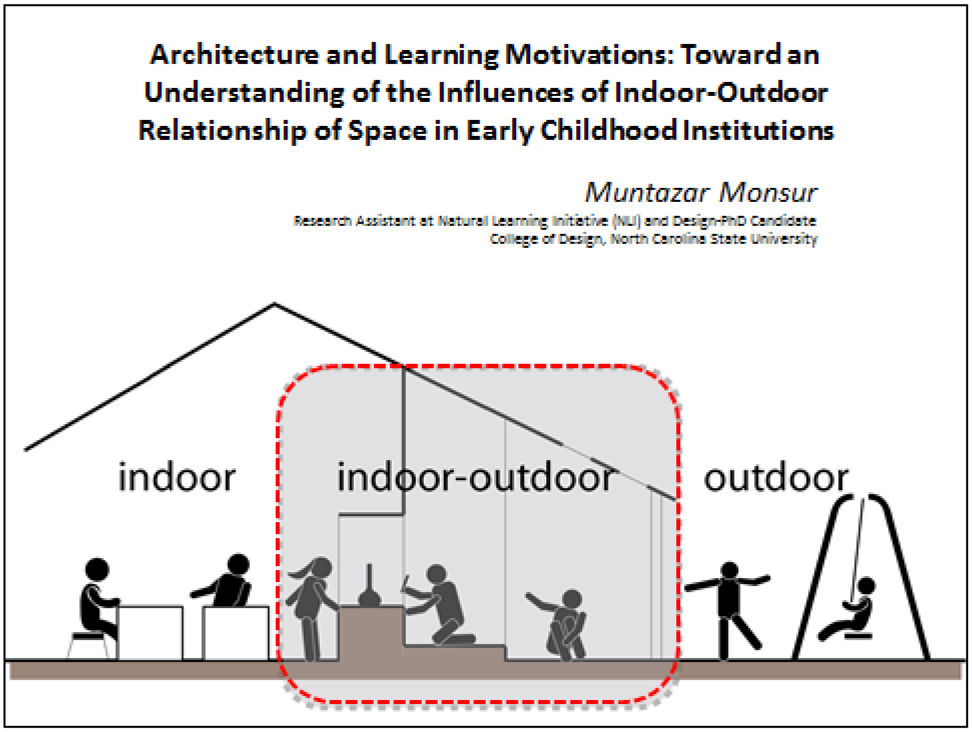
Wyver, S. R., & Spence, S. H. (1999). Play and divergent problem solving: Evidence supporting a reciprocal relationship. *Early Education and Development, 10*(4), 419-444.

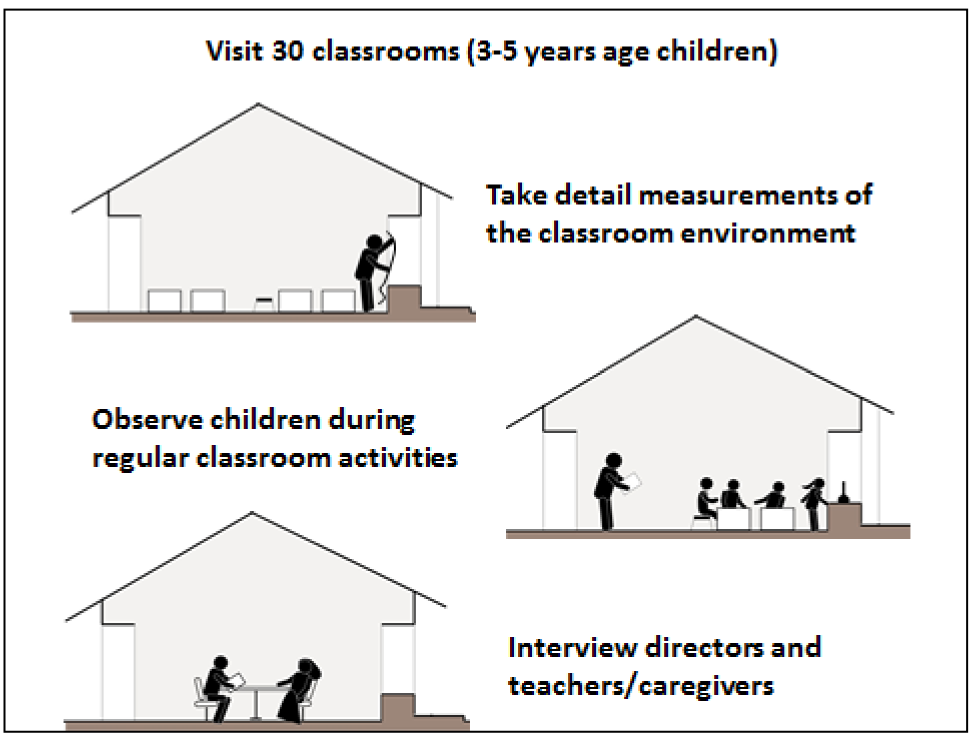
Yemisi, A. C. (2013). The influence of gender, age, training and experience on teachers’ perception in ado and efon local government areas, ekiti state, nigeria. *Greener Journal of Educational Research, 3*(3), 138-143.

Zimring, C. M., Ulrich, R. S., Zhu, X., DuBose, J. R., Seo, H.-B., Choi, Y.-S., . . . Joseph, A. (2008). A review of the research literature on evidence-based healthcare design.

Appendices

Appendix 1.1: Selected Slides from Power Point Presentation to Center Directors





Appendix 1.2: IRB Approved Consent Form for Teachers

North Carolina State University
INFORMED CONSENT FORM FOR CAREGIVERS/TEACHERS
THIS CONSENT INFORMATION IS VALID SEPTEMBER 24, 2013 THROUGH SEPTEMBER 24, 2014
Architecture and Learning Motivations: Toward an Understanding of the Influences of Indoor-Outdoor Relationship of Space in Early Childhood Institutions
Muntazar Monsur

This research is conducted as part of a PhD in Design degree in the College of Design, North Carolina State University, Raleigh, North Carolina
Please initial your understanding of each paragraph below, on the line provided. Do not initial each paragraph until and unless you understand it.

DESCRIPTION
The aim of the study is to understand the influence of indoor-outdoor spatial relationship of a classroom on children's learning motivation. The majority of children's waking hours are spent in childcare centers. Previous studies indicate that both the indoor and outdoor environment motivate activities among children and their teachers. A goal of the research is to learn how strong relationships between the indoors and outdoors in a classroom can contribute to the quality of the learning environment in early childhood.

______

PURPOSE
It is expected that findings of this research will demonstrate the value of indoor-outdoor spatial relationships in preschools and childcare centers and benefit the design and development processes of preschools and childcare centers by influencing the practice of architects, landscape architects, designers, educators, and policy makers. ______

PROCEDURES
During the usual classroom activities children in your classroom will be observed to assess their learning motivation level. Some still photography will be taken during classroom activities (prior consent). Since you will be conducting the class, you will be observed as well. An additional interview with you is anticipated to deepen the understanding of the importance of indoor-outdoor spatial relationship for the learning environment of the classroom.
The sole purpose of the questionnaire interview is to learn from your insights and experiences about the contribution of indoor-outdoor spatial relationship of a classroom to the quality of the learning environment in early childhood. The questionnaire is NOT any kind of assessment of your teaching methods or philosophy

______

RISKS
The goal of this project is to observe children's regular classroom activities and it involves no unusual risks to you or the children at your class.

______

BENEFITS
It is likely that children, teachers, caregivers, center directors and head of schools will benefit indirectly from the information imparted about the influence of indoor-outdoor space relationship of space on learning motivation in school environments. Findings of this study may also inform architects, landscape architects, designers, educators and researchers about design decisions related to childcare centers and preschools for improved learning environment and learning motivation.

______

COMPENSATION
Participants will not receive compensation for their involvement in the study.

______

CONFIDENTIALITY
The information gathered by the researchers will be kept strictly confidential. The data resulting from your participation will be combined with others who take part in the study and used in presentations but your identity will not be revealed.
Your individual responses from the questionnaire survey will be used in research documents or future presentations, but they will always appear in false names or IDs.

_____

The photographs taken during the project will be used to document the research study and may be used in presentations of the research results but your name or identity will not be used. Faces in presented photographs will always be covered or blurred. You may decline to appear in pictures.

CONTACT
If you have any questions at any time regarding the study or the procedures, you may contact the Principal Investigator, Muntazar Monsur, M Arch, PhD in Design, College of Design, NC State University, 2911 Ligon St, A24, Raleigh, NC 27607 or by telephone (919) 699-1986; mmonsur@ncsu.edu or you may also contact his advisor Professor Robin Moore, MCP, Director, The Natural Learning Initiative, College of Design, NC State University, Campus Box 7701, Raleigh, NC 27695-7701 or by telephone (919) 515-8345; robin_moore@ncsu.edu. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Samuel Snyder; Campus Box 7801; Raleigh, NC 27695; (919) 513-4328 – Phone; (919) 515-5901 – Fax; sssnyder@ncsu.edu. _

PARTICIPATION
Your participation in this study is voluntary; you may decline participation.

CONSENT
I have read and understand the above information. I have received a copy of this form.
I agree to participate in this study.

________ Name (please print) ________ Signature ________ Date

PHOTO RELEASE
I agree to permit myself to be photographed as part of the study activity. I understand that my picture may be shown in documents/presentations of the research results but my name will not be used in any way and my face will be blurred or covered in all photographs to make sure that they are not recognized.

________ Name (please print) ________ Signature ________ Date

WITNESS
I witness that the above individual understands the information contained in this form. He or she has received a copy of this form. He or she agrees to participate in this study.

________ Name (please print) ________ Signature ________ Date

________ Project Investigator ________ Signature ________ Date

Appendix 1.3: IRB Approved One Page Invitation to Participate

INVITATION TO PARTICIPATE

Architecture and Learning Motivations: Toward an Understanding of the Influences of Indoor-Outdoor Relationship of Space in Early Childhood Institutions

By

Muntazar Monsur

A research to look into the relationship between **Architecture** and **Children's Learning Motivation**

The majority of children's waking hours are spent in childcare centers and it is very important to understand what kind of architecture would benefit children the most. The design of both indoor classrooms and outdoor play areas are found to be very important for the proper development and wellbeing of children. Previous studies indicate that both the indoor and outdoor environment motivate activities. However, very few, if any studies have investigated how the relationship between the indoor and the outdoor environment of a school may influence behavior of children and their teachers.

The study aims

1. To learn how relationships between the indoors and outdoors can contribute to the quality of the learning environment.
2. To explore the link between school architecture and learning benefits in young children.

Procedure

The researcher will collect detail data of the classroom environment to measure the visual and physical relationship between the indoor and the outdoor. This data will be analyzed with behavioral data of children and their teacher collected by systematic observation and questionnaire survey. During regular classroom activities, children will be observed periodically from a distance to assess their learning motivation levels. Teachers/caregivers will be interviewed to collect data concerning their understanding and teaching motivations related to classroom design.

Your Child's participation is highly appreciated!

For any question or concern, please contact

Muntazar Monsur

Research Assistant at Natural Learning Initiative (NLI) and Design-PhD Candidate at the College of Design, North Carolina State University

919-699-1986 mmonsur@ncsu.edu

About Muntazar

Muntazar Monsur is an architect. He teaches at a most prominent Architecture School (BUET) in Bangladesh and currently pursuing his PhD degree in North Carolina State University. He is also working as a research assistant at the Natural Learning Initiative (NLI) at the College of Design. He has been awarded the Best Paper Award in EDRA43, Seattle for his previous research conducted over school going urban children of Bangladesh. Muntazar's current research area concerns children's learning environment. At present, he lives in Raleigh NC with his wife and 3.5 years old daughter.

Appendix 1.4: IRB Approved Consent Form for Parents

North Carolina State University
INFORMED CONSENT FORM FOR PARENTS
THIS CONSENT INFORMATION IS VALID SEPTEMBER 24, 2013 THROUGH SEPTEMBER 24, 2014

Architecture and Learning Motivations: Toward an Understanding of the Influences of Indoor-Outdoor Relationship of Space in Early Childhood Institutions
Muntazar Monsur

This research is conducted as part of a PhD in Design degree in the College of Design, North Carolina State University, Raleigh, North Carolina.

Please initial your understanding of each paragraph, below, on the line provided. Do not initial each paragraph until and unless you understand it.

DESCRIPTION
The aim of the study is to understand the influence of indoor-outdoor spatial relationship of a classroom on children's learning motivation. The majority of children's waking hours are spent in childcare centers. Previous studies indicate that both the indoor and outdoor environment motivate activities among children and their teachers. A goal of the research is to learn how strong relationships between the indoors and outdoors in a classroom can contribute to the quality of the learning environment in early childhood.

______

PURPOSE
It is expected that findings of this research will demonstrate the value of indoor-outdoor spatial relationships in preschools and childcare centers and benefit the design and development processes of preschools and childcare centers by influencing the practice of architects, landscape architects, designers, educators, and policy makers. ______

PROCEDURES
During the usual classroom activities your child's class will be observed to assess children's Learning motivation level. Some still photographs will be taken during classroom activities.

______

The researcher will NOT interact with your child during the whole process and the systematic observation will be conducted from a distance.

______

The sole purpose of this research is to observe collective behavior, however, your child might be individually observed while participating in regular classroom activities. ______

This is NOT an assessment of any kind of your child's ability.

______

RISKS
The goal of this project is to observe children's and teachers' regular classroom activities and it involves no unusual risks to your child.

______

BENEFITS
It is likely that children, teachers, caregivers, parents, center directors and head of schools will benefit indirectly from the information imparted about the influence of indoor-outdoor space relationship of space on learning motivation in school environments. Findings of this study may also inform architects, landscape architects, designers, educators and researchers about design decisions related to childcare centers and preschools for improved learning environment and learning motivation.

____

COMPENSATION
Participants will not receive compensation for their involvement in the study. _______

CONFIDENTIALITY
The information gathered by the researchers will be kept strictly confidential. The data resulting from the participation of your child will be combined with others who take part in the study and used in presentations but her/his identity will not be

revealed.

____

The photographs taken during the project will be used to document the research study and may be used in presentations of the research results but the name of your child will not be used. Face of your child in presented photographs will always be covered or blurred. However, she/he may be recognized. You may decline your child appear in pictures. ________

CONTACT

If you have any questions at any time regarding the study or the procedures, you may contact the Principal Investigator, Muntazar Monsur, M Arch, PhD in Design, College of Design, NC State University, 2911 Ligon St, A24, Raleigh, NC 27607 or by telephone (919) 699-1986; mmonsur@ncsu.edu or you may also contact his advisor Professor Robin Moore, MCP, Director, The Natural Learning Initiative, College of Design, NC State University, Campus Box 7701, Raleigh, NC 27695-7701 or by telephone (919) 515-8345; robin_moore@ncsu.edu. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Dr. Samuel Snyder; Campus Box 7801; Raleigh, NC 27695; (919) 513-4328 – Phone; (919) 515-5901 – Fax; sssnyder@ncsu.edu.

____

PARTICIPATION

The participation of your child in this study is voluntary; you may decline her/his participation. If you decide your child participates, you may withdraw her/him from the study anytime. If your child withdraw from the study before data collection is completed her/his data will be destroyed.

____

CONSENT

I have read and understand the above information. I have received a copy of this form.
I agree to participate in this study.

________________	____________________	___________	
Name (please print)	Child's Name (please print)	Signature	Date

PHOTO RELEASE

I agree to permit my child to be photographed as part of the study activity. I understand that her/his picture may be shown in presentations of the research results but her/his name will not be used in any way and her/his face will be blurred or covered to make sure that they are not recognized.

________________	____________________	___________	
Name (please print)	Child's Name (please print)	Signature	Date

WITNESS

I witness that the above individual understands the information contained in this form. He or she has received a copy of this form. He or she agrees to participate in this study.

________________	____________________	___________
Name (please print)	Signature	Date
________________	____________________	___________
Project Investigator	Signature	Date

Appendix 1.5: Systematic Observation Tool for Behavioral Data

Center Code:

Classroom Code:

Date:

Time:

Total number of children	
Number of boys	
Number of girls	
Average age of children	
Number of teachers	

Weather condition	1	2	3
Sky condition	1	2	3

Observation: Teacher Assisted Activities

	1 = When most of the children in the class appear apathetic and unenthusiastic,	2 = When most of the children in the class seem to complete the activity offered by the teacher out of obligation rather than interest.	3 = When most of the children in the class are eager to participate in the activities offered by		Number of distracted children: wondering around, looking outside the window, etc. (each unique child)
Ep. 1: 1-10 min					
Ep. 2: 11-20 min					
Child Engagement level	Average of Ep. 1 and Ep. 2				total

Percentage of distracted children = (total number of distracted children x 100)/total number of children in class

Observation: Free activity sessions

	Ep.1: 0-5 min	Ep.2: 6-10 min	Ep.3: 11-15 min	Ep.4: 16-20 min	Average
Number of children engaged in activities					Total/4 =

Percentage of engaged children = (Average number of engaged children x 100)/total number of children in class

Number of behavioral guidance directives

Teacher assisted period	Free activity sessions	Total

Number of hands-on lessons on display	Number of nature based lessons on display	Comments

Appendix 1.6: IRB Approved Teachers' Questionnaire

North Carolina State University
Questionnaire for Caregivers/Teachers

Architecture and Learning Motivations: Toward an Understanding of the Influences of Indoor-Outdoor Relationship of Space in Early Childhood Institutions

Muntazar Monsur

1. Center Code:

Classroom Code:

Teacher Code

Date:

Time:

2. How many years have you been working in this childcare center?

3. How many years have you been working in childcare centers overall?

4. What describes your educational level best?

High School

High School plus some College

College Degree

Master's Degree

PhD

Other (specify) ____________________

5. Do you have any childcare related degrees (associate degree in early childhood development)?

6. It yes, what are they?

7. Do you use any of the following elements of the classroom for teaching lessons to children?

Window/s of the classroom

An outside view from the classroom

Transitional space adjacent to the classroom

Outdoor environment

Doors

None of the above

Other ____________________

8. If yes, please elaborate how you use the mentioned element/s for teaching lessons to students of your classroom

9. How many zones/areas do you have in your classroom?

10. What are the zones/areas?

11. Which 3 indoor zone/area children use the most?

12. Which 3 indoor zone/area children use the least?

13. Are you responsible for arranging the zones/areas of the classroom?

14. If yes, what are the guiding factors for arranging the classroom?

15. Does position of the windows/doors/skylights etc. effect your decision of the arrangement of the zones in your class?

16. How many hands on technique for teaching do you use per week?

17. Elaborate few examples

18. How many times do you use a natural object to teach a lesson per week inside the class?

19. Elaborate examples.

20. How many techniques for teaching are created by your own?

21. Elaborate examples.

22. How many lessons do involve outdoor in your class per week?

23. Elaborate examples.

24. Do you turn off electric lights other than any purpose of children's nap?

25. Which design features of the classroom you like the most?

26. Which design features of the classroom you like the least?

27. What would you suggest to improve the learning environment of the classroom?

28. Please share any general idea/information which you think is important for this research on the influence of indoor-outdoor spatial relationship in a classroom on learning environment qualities in early childhood.

Appendix 1.7: Center Directors' Survey

Center Code:

Date:

1. What is the length of operation of your center (in years)?

2. What is the current license star rating of your center?

3. Was this building designed as a new care facility or renovated?

4. If renovated, what was the primary function of the building (residence/church/care facility etc.)?

5. How many children are currently enrolled in your center?

6. How many teachers/caregivers are working in your center?

7. What is the age of this building (in years)?

Appendix 1.8: Example of Window Affordance Scale Spreadsheet

	Window Design	Window Scale	Window Operability	Window Visibility	Window Orientation	Total
	1 = flat window, depth of widow seal is not usable 2 = window sill has sufficient depth to put small objects 3 = window depth is sufficient to accommodate children	1 = window is out of scale for children (like a high window) 2 = Window is in regular scale 3 = Window is in appropriate child scale	1 = window is fixed 2 = window is partially operable 3 = can be fully opened	1 = Window has no visibility/acces s 2 = Window has partial visibility and access 3 = Window has full visibility with/without operable screens	1 = East/west 2 = North 3 = South	
Window 1						
Window 2						
Window 3						
Window 4						
Window 5						
Window 6						
Window 7						
Window 8						
Window 9						
Window 10						
Total window affordance score of classroom						

Appendix 1.9: Two-tail Pearson Correlation in SPSS among 15 Independent Variables

	Mean Temperature (oF)	Sky Condition	Class Size	Square Feet per Child	Open Space (%)	Children per Teacher	Number of Girls (%)	Children Average Age	Teacher Qualification	Teacher Experience	Number of Activity Zones	ECERS Composite Score	Door Score	Windows and Views	Transitional Space
Mean Temperature (oF)	1	0.364	-0.406	-.488*	-.496*	.632**	0.047	-0.300	-0.358	-0.163	-.627**	-.445*	-0.203	-0.409	-0.221
Sky Condition		1	0.223	-0.218	0.189	0.391	-0.134	-0.241	-0.403	-0.250	0.0308	-0.005	-0.127	-0.070	0.052
Class Size			1	0.085	.804**	-0.128	-0.225	-0.208	0.243	-0.218	.625**	0.330	0.095	0.286	.505*
Square Feet per Child				1	0.346	-.775**	0.105	0.164	.462*	-0.121	.548**	.591**	0.163	.573**	0.180
Open Space (%)					1	-.435*	-0.0827805	-0.3664163	0.0353527	-0.3650723	.567**	0.2196943	-0.0432471	0.1792104	0.4214491
Children per Teacher						1	-0.053435	-0.0048314	-0.2722676	-0.099788	-.508*	-.427*	0.0131612	-0.4143724	-0.1919043
Number of Girls (%)							1	-0.0879938	0.0480208	-0.2652722	-0.0617929	0.1215157	0.0907968	-0.0738637	-0.1537847
Children Average Age								1	0.0631881	0.3290618	-0.0509384	0.088731	-0.1305209	0.0929474	-.427*
Teacher Qualification									1	0.164855	.656**	.777**	.595**	.802**	.494*
Teacher Experience										1	0.0421233	0.151675	-0.1615204	0.2226457	-0.3054851
Number of Activity Zones											1	.836**	.471*	.799**	.564**
ECERS Composite Score												1	.492*	.938**	0.3949542
Door Score													1	.546**	.611**
Windows and Views														1	.443*
Transitional Space															1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).