# SURVEY OF IN-SERVICE EARLY CHILDHOOD EDUCATORS' KNOWLEDGE, SKILLS, AND CONFIDENCE IN TEACHING SPATIAL SKILLS TO YOUNG CHILDREN

A Dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctorate of Education

by

Adam G. Akerson

December, 2011

## ACKNOWLEDGEMENT

I can still recall as an undergraduate wrestling with the question, "What do I want to be when I grow up?" Little did I know that a career choice in education would have led me to the sense of career fulfillment that I have today. I learned so much as a classroom teacher in partnership with outstanding colleagues and administrators – which sparked my fire to pursue a master's and eventually a terminal degree in the field of education. I would have never guessed my pursuits would have led me to Houston, but I firmly believe it was part of my "story," orchestrated by a Higher Power.

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Abstract

Spatial abilities have been linked to mathematics achievement, in addition to science achievement and creativity in the arts (Clements & Sarama, 2007; Shepard, 1978; West, 1991; Wheatley, 1999). Even though the importance of spatial abilities has been recognized, the percentage of preschool teachers who report teaching spatial abilities either through lessons or free exploration is a mere 32 percent (Sarama & DiBiase, 2004), which may lead some to question the qualifications of early childcare teachers. The educational requirements of early childcare teachers varies *within* states, for programs located in different settings or subject to different regulations, with the result that many practitioners do not hold college degrees, and most are not certified (Whitebook et. al., 2009). Developing the knowledge, skills, and abilities to provide high-quality mathematics education can prove difficult with such a variation in teacher requirements from program to program and state to state.

The purpose of this research study was to examine in-service early childcare teachers’ knowledge, methods, and confidence concerning spatial skills development in their classrooms. The participants included 88 in-service early childhood educators who are currently teaching in a preschool or early childcare center. Archival data that were previously collected utilizing the survey instrument, *Spatial Abilities Survey for In-Service Teachers,* was utilized in this study.

The results of the chi-square and ANOVA analyses revealed a statistically significant relationship between in-service early childhood educators’ level of education

and their knowledge and skills associated with spatial abilities. Furthermore, a statistically significant relationship exists between the setting in which early childhood educators' taught and their knowledge and skills associated with spatial abilities.

With less than desireable performance in the areas of mathematics and science becoming evident through national assessments as early as 4th grade (NCES, 2009), it is essential that our students be afforded a high-quality education as early as preschool, in order to provide a foundation for future success in these areas. A high-quality education starts with the early childhood educator and the knowledge and skills he/she brings to the classroom.

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# CHAPTER I

# INTRODUCTION

More than half of 3-and 4-year-olds in the United States are enrolled in some type of preschool program (National Center for Educational Statistics [NCES], 2008). The National Association for the Education of Young Children (NAEYC) acknowledges that important development and learning occurs between the ages of 3 and 5. Areas of development and learning include all areas of human functioning–physical, social, emotional, cognitive (including perception, reasoning, memory, and other aspects of academic and intellectual development), and language (Copple & Bredekamp, 2009). Early childhood educators are one of the primary stakeholders responsible for ensuring that a preschool program promotes the development and learning of each individual child. Having the knowledge and ability to promote the development and learning of children requires that educators have sufficient knowledge, skill, and training.

During the years from age 3 through age 5, children gradually develop their mental representation capacities, reasoning skills, classification abilities, attention, memory, and other cognitive abilities (Copple & Bredekamp, 2009). Spatial ability is one such area of cognitive development that holds implications for preschool educators. Spatial ability has a vital role in our daily interaction with the environment, such as navigation, recognizing and manipulating objects, performing academic tasks, and recalling locations (Tzuriel & Egol, 2010). High levels of spatial ability have frequently been linked to creativity, not only in the arts, but in science and mathematics as well (Clements & Sarama, 2007; Shepard, 1978; West, 1991; Wheatley & Reynolds, 1999).

The development of spatial abilities can prove beneficial across a variety of content areas including mathematics and science. Educators should recognize that beginning in the early childhood years, the spatial skills needed for learning geometry have already begun to develop (National Mathematics Advisory Panel [NMAP], 2008). Spatial strategies can be applied in a variety of mathematic areas including: (a) using diagrams and drawings as a method of solving problems, (b) solving algebraic word problems through these approaches, (c) searching for numerical patterns, (d) considering how fractions can be broken down into geometrical regions, (e) graphing, and (f) conceptualizing mathematical functions (Casey, 2004; Geary, Salts, Liu, & Hoard, 2000). It is important for teachers and educational leaders to have an understanding of spatial abilities and how they can incorporate them into their classrooms, schools, and districts.

It is apparent that the development of spatial abilities can have a positive impact on children's learning and development. Unfortunately, many educators may be lacking current knowledge regarding curriculum issues, including spatial skills that are needed to provide a high-level of education to young children. Challenges that contribute to early childhood educators' knowledge include a lack of standard entry-level credentials, variations in program settings, relatively low compensation, and high turnover rates (Barnet, 2004). There appears to be clear evidence that higher levels of teacher qualifications are associated with higher quality classroom environments (Barnett, 2003; Loeb, Fuller, Kagan, & Carroll, 2004; Shonkoff & Phillips, 2000). The literature is less than clear, however, about what level of qualification is *necessary* for the effective teaching of preschool children. Early childhood educators' preparation and qualifications may play a role in developing a high-quality classroom environment, yet for those early childhood educators working in preschools without such qualification, on-going professional development may help provide the support necessary to enhance the quality of their existing classrooms and curriculum.

National organizations, like NCTM, have begun to include spatial abilities within their standards for mathematics (NCTM, 2000), and since 2002, the number of states with published early learning standards has nearly doubled (Barnett, et al., 2010). However, what constitutes proficiency from one program to another appears inconsistent (Carmichael et al., 2010). Additionally, the percentage of preschool teachers who report teaching spatial abilities either through lessons or free exploration is a mere 32 percent (Sarama & DiBiase, 2004), and the *explicit* mathematics instruction seems to be lacking in preschool classrooms (NMAP, 2008).

**Purpose of the Study**

The purpose of this research study was to investigate in-service early childhood educators' educational backgrounds and prior years of teaching experience with respect to their knowledge, skills, and confidence concerning spatial skills development in their classrooms. This study also investigated the setting, public or private, in which in-service early childhood educators' taught with respect to their knowledge, skills, and confidence concerning spatial skills development in their classrooms.

Regardless of the level of education obtained by early childhood educators, this research study may potentially reveal gaps that exist in the preparation and practice of promoting spatial skills development amongst the vast array of children that these early childhood educators care for. Gaining an understanding of early childhood educators' knowledge, skills, and confidence concerning spatial skills, how these educators define spatial skills, and gathering information regarding the methods early childhood educators use in teaching spatial skills and how comfortable they are using those methods. The information gathered can also be used to help guide the development of future professional development and resources for early childhood educators in the area of spatial skills development.

**Need for the Study**

In a joint position statement from the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM), both groups affirm that making available a high quality, challenging, and accessible mathematics education for children in early childhood programs can provide a vital foundation for future mathematics learning (NAEYC & NCTM, 2002/2010). National professional standards put forth by the National Council of Teachers of Mathematics outline core ideas that should be embedded in the teaching of mathematics for 3 to 6-year old children. The five core mathematic content areas include: number and operations, measurement, algebra (including patterns), data analysis, and geometry and spatial sense (NCTM, 2000). Further examination of the geometry content standards reveals that spatial abilities and spatial sense are considered essential to the development of mathematics (Delgado & Prieto, 2004; Casey, Nuttall, & Pezaris, 1997).

Affirmation of the importance placed on mathematics by such groups as NAEYC and NCTM, may be evident from our nation’s performance on national mathematics assessments. In 2009, a report from The National Assessment of Educational Progress (NAEP) found that a little more than one-third of fourth and eighth-graders performed at or above the proficient level in math, while 18% of fourth graders and 27% of eighth graders scored below the basic level (NCES, 2009). The results at twelfth-grade were no more encouraging, 26% of students scored at or above the proficient level and 36% of students scored below the basic level (NCES, 2010).

With less than desireable performance in the areas of mathematics and science becoming evident through national assessments as early as 4$^{th}$ grade, it seems critical that a child's beginning mathematics and science experiences be examined in hopes of fostering more proficient students. Knowing that important development occurs in children between the ages of 3 and 5, including cognitive development (Copple & Bredekamp, 2009), it seems imperative that the foundation for a high-quality, challenging, and accessible mathematics education be made available and incorporated into national and state standards as early as the preschool level, and it appears many states are beginning to adopt such standards.

The National Institute for Early Education Research reported that more than 75% of states had some sort of early learning standards, which encompass standards for the years before kindergarten (Barnett, Hustedt, Friedman, Boyd, & Ainsworth, 2007). Additionally, national reports and public policy have supported the creation of a standards-based curriculum as means of building children's school readiness by improving teaching and learning in the early childhood years (Bowman, Donovan, & Burns, 2001). The development and implementation of early learning standards will certainly aid in the attainment of expected student outcomes and school readiness. In order to ensure student success, early childhood educators must be aware of the standards and qualified to implement the standards with fidelity. However, the necessary credentials of qualified preschool teachers who can adequately execute the standards are not well defined.

One-half of preschool teachers have a four-year degree, and the most-educated preschool teachers work in public schools, where 87% of teachers have at least a bachelor's degree (Saluja, Early, & Clifford, 2002). Other research suggests that teachers with a bachelor's or higher degrees in early childhood provide better-quality preschool experiences (Barnett, 2003; Bowman, Donavan, & Burns, 2001; Whitebook, 2003). When compared to teachers who have no formal early childhood educators, those holding certificates in early childhood are able to create more positive classroom environments (Pianta et al. 2005). Professional development can supply a crucial component in enhancing the quality early care and education of young children in preschool settings, particularly where teacher qualifications may not be as stringent. The effects of teachers on student achievement compound dramatically if students receive a series of effective or ineffective teachers (NMAP, 2008). To keep the consequences of ineffective teachers from compounding itself, it seems imperative that the knowledge, skills, and confidence concerning the spatial skills of in-service early childhood teachers be examined, to determine if a need for professional development exists.

**Research Questions**

Upon review of the literature related to (1) early childhood educator preparation, (2) spatial abilities and geometric thinking, and (3) early childhood mathematics standards and learning opportunities, this study sought to address the following research questions.

1. Is in-service early childhood educators' educational background related to their level of knowledge, skills, and confidence regarding spatial skill development in their classrooms?
2. Is in-service early childhood educators' prior teaching experience related to the level of knowledge, skills, and confidence regarding spatial skill development in their classrooms?
3. Is in-service early childhood educators' level of knowledge, skills, and confidence regarding spatial skill development related to the setting of the early childhood center in which they teach?

**Definition of Terms**

The following are operational terms and definitions that will be used for the study.

*Developmentally appropriate*- a framework of principles and guidelines for best practice in the care and education of young children, which promotes young children's optimal learning and development. The desired outcomes for children's learning and development should be based on the understanding that knowledge must inform decision making, goals must be challenging and achievable, and teaching must be intentional to be effective (Copple & Bredekamp, 2009).

*Federal-funded Preschool*- programs such as Head Start, which promote school readiness for children, ages three to five, in low-income families by offering educational, nutritional, health, social and other services.

*In-service Early Childhood Educator*- an early childhood educator who instructs children from the ages of 3 to 5 years-old in a preschool program either privately, state, or federally funded.

*Mental Rotation*-the process of imagining an object rotated into a different orientation in space (Shepard & Metzler, 1971), which may include two- or three-dimensional objects (Kolb & Whishaw, 1990).

*Non-Public Preschool*- a preschool that typically cares for and educates children while parents are working (Michel, 1999), and rely on private funds for operation, which includes childcare centers.

*Preschool*- an early childhood program in which an emphasis is placed on a child's learning and development. The children most commonly enrolled are between the ages of 3 and 5 years-old. Preschool programs are run by professionally trained adults. Preschools are typically housed in elementary schools and childcare centers.

*Professional Development*- is a process that aims to provide in-service participants with a new set of experiences, skills, resources, and knowledge that will support them as they implement the ideas they have studied in the field (Holmes, Signer, & MacLeod, 2011). Professional development often covers the entire spectrum of education and training that it available including: introductory trainings, to informal workshops or other continuing education, to college-level work for credit or a degree (Whitebook, Gomby, Bellm, Sakai, & Kipnis, 2009).

*Spatial Ability*- a form of mental activity that enables individuals to create spatial images and to manipulate them in solving various practical and theoretical problems (Hegarty & Waller, 2006).

*Spatial Orientation*- the ability to imagine different perspectives or orientations in space (Hegarty & Waller, 2004), while remaining unconfused by the changing orientation in which spatial configurations may be presented (Kolb & Whishaw, 1990).

*Spatial Perception*- the ability to determine spatial relations despite of any information that may be potentially distracting (Linn & Petersen, 1985).

*Spatial Tasks*- the ability to think and reason through comparison, manipulation, and the transformation of mental pictures (Casey et al., 2008).

*Spatial Visualization*- the ability to mentally manipulate, rotate, twist, or invert objects without reference to one's own self (Hegarty & Waller, 2006).

*State-funded preschool*- preschool programs that receive state funds to educate children who are typically identified as at-risk.

**Summary**

Children benefit most from teachers who have the skills, knowledge, and judgment to make good decisions and are given the opportunities to use those abilities (Copple & Bredekamp, 2009). Providing teachers with resources, tools, and opportunities for professional development that improve their understanding of the curriculum and how children learn can prove beneficial toward having these teachers make appropriate instructional decision. Spatial abilities are an area that has been linked to mathematical achievement (Battista & Clements, 1991; Geary, Saults, Liu, & Hoard, 2000; Shepard, 1978; West, 1991). With as much as 36% of twelfth-graders scoring below the basic level in mathematical proficiency (NCES, 2010), a further look into spatial abilities could prove beneficial in moving students beyond the basic level of proficiency.

The purpose of this research study was to examine in-service early childhood educators' educational backgrounds, prior years of teaching experience, and the setting in which they taught, in relation to their knowledge, skills, and confidence concerning spatial skills development in their classrooms. These data gathered through this study may prove beneficial in developing a better understanding of in-service early childhood educators' knowledge regarding spatial abilities. These data collected may also prove beneficial in developing appropriate professional development opportunities for early childhood educators regarding spatial abilities, while impacting the learning outcomes in their classrooms.

The following chapter contains a literature review relevant to the subject of this study. The topics examined that are relevant to this study include: (1) early childhood educator preparation, (2) spatial abilities and geometric thinking, and (3) early childhood mathematics standards and learning opportunities.

# CHAPTER II

# REVIEW OF RELATED LITERATURE

The purpose of this research study was to determine if background, setting, and teaching experience of in-service early childhood educators' affect their knowledge, skills, and confidence concerning spatial skills development in their classrooms. The chapter is divided into the following sections: (1) early childhood educator preparation, (2) spatial abilities and geometric thinking, and (3) early childhood mathematics standards and learning opportunities.

## Early Childhood Educator Preparation

A current body of research exists acknowledging that higher levels of teacher qualifications are associated with higher quality classroom environments (Barnett, 2003; Burchinal, Cryer, Clifford, & Howes, 2002; Bowman, Donovan, & Burns, 2001; Shonkoff & Phillips, 2000; Vu, Jeon, & Howes, 2008). Early childcare and education programs have their beginnings in two separate historical traditions: either primarily to care for children's basic needs while parents worked, similar to a daycare or babysitter, or to promote children's learning and development through a more structured school experience (Michel, 1999). Having two distinct beginnings has created a plethora of early childhood programs that operate in a variety of settings. At the federal level, there are more than 20 early childhood funding sources, each with its own regulations, and all 50 states have their own separately funded governed early childhood programs (Whitebook et al., 2009). Beyond state and federal programs, there are privately funded preschools and child care centers that are available for those who do not qualify for state or federal programs.

**Early childcare enrollment.** According to *The State of Preschool 2010*, an annual survey of state-funded preschool programs by the National Institute for Early Education Research (NIEER), the enrollment of 3 and 4 year-old children in state-funded preschool programs totaled nearly 1.3 million children. Nationwide, there are 10 states that do not currently provide a state-funded preschool program. Of all 3 year-olds enrolled in some form of preschool program, just 4% were in state funded prekindergarten programs. The percentage was slightly higher for 4 year-olds with 27% of 4 year-olds attending some form of prekindergarten were doing so through a state funded program (Barnet et al., 2010).

In addition to state-funded preschool opportunities, Head Start, a national program that promotes school readiness by enhancing the social and cognitive development of children through the provision of educational, health, nutritional, social and other services (www.nhsa.org), provided 7% of 3 year-olds and 11% of 4-year-olds with access to preschool (Barnet et al., 2010). Even with state and national preschool programs available to those who qualify, two-thirds of preschoolers are enrolled in some other form of preschool program (Barnet et al., 2010). With such an array of preschool programs available, and the majority of them not funded by the state or nationally, there are inconsistencies in such programs, a point that was echoed by Secretary of Education Arnie Duncan in remarks made at the release of *The State of Preschool 2010* report:

> We know that high-quality early childhood programs are one of the best investments we can make in a child's future. But we also know that the quality of too many early childhood programs is uneven. The NIEER report states that funding levels in some of the states have fallen so low as to bring into question

> the effectiveness of their programs by any reasonable standard. That is not acceptable. (para. 12)

With a better understanding of what children are enrolled in early childhood programs, the educators teaching in these programs deserve a closer look. Specifically, what qualifications are required of these educators, and how are they being compensated, and retained to the profession.

**Teacher qualifications.** To answer questions about teacher quality and effectiveness, K-12 researchers generally rely on administrative data collected by school districts, and on federally supported national surveys that assess teacher preparation, teacher qualifications, and student achievement (Whitebook et al., 2009). However, these sorts of administrative data are not as applicable or prevalent in assessing the effectiveness of preschool programs and their teachers. The educational requirement for teachers in early care education programs seems rather inconsistent. The requirements of teachers in early care education programs varies *within* states, for programs located in different settings or subject to different regulations (e.g., public school-based preschool, Head Start, subsidized child care, or privately funded early childhood programs), with the result that many preschool practitioners do not hold college degrees, and most are not certified (Whitebook et al., 2009).

To determine the basic training and education of early childhood educators, there must be an assumption of variability, rather than any kind of shared baseline for professional preparation (Barnett, Hustedt, Friedman, Boyd, & Ainsworth, 2007). The teacher requirements of early childhood educators within states and programs range from little or no pre-service preparation required, all the way to a B.A. degree or higher and there appears to be widespread variability in the actual qualifications of the teachers within any one program type or setting. Each of the 50 states sets different teacher standards for early childhood education programs; the only exceptions are nationwide federal government programs such as Head Start, Early Head Start, and Military Child Care (Whitebook, et al., 2009).

***State and national funded early childhood programs.*** Prior to the 1980's, there were eleven states that provided state-funded prekindergarten programs. During the 1980's, following a wave of education reform publications, one being *A Nation At-Risk*; and, longitudinal research studies demonstrating the benefits of preschool interventions including the 1960's Perry Preschool Project and the 1970's Carolina Abecedarian Project. As a result of these types of publications and research studies, the number of states providing state-funded prekindergarten programs began to rapidly increase. The growth of state-funded prekindergarten programs continued through the 1990's and into the 2000's. Reasons for the growth were the influence of National Education Goals, lack of school readiness, and research in neuroscience establishing the connection between healthy brain development in young children and their capacity to learn (Mitchell, 2001). Although there is an increase in preschool services in recent years, the credentials of preschool teachers working in state-funded prekindergarten vary (Whitebook et. al, 2009).

*The State of Preschool 2010*, identifies 27 of the 52 state-funded prekindergarten programs in the 40 states that offer prekindergarten programs (some have more than one program), require prekindergarten teachers to hold a bachelor's degree and many of these programs also require teacher certification (Whitebook et. al, 2009). As of 2005, only 17 states required teachers in all programs to have a bachelor's degree.

***Head Start.*** Established in 1965, Head Start promotes school readiness for children, ages three to five, in low-income families by offering educational, nutritional, health, social and other services. Head Start programs promote school readiness by enhancing the social and cognitive development of children through the provision of educational, health, nutritional, social and other services to enrolled children and families. Early Head Start, which was launched in 1995, provides support to low-income infants, toddlers, pregnant women and their families. Early Head Start programs enhance children's physical, social, emotional, and intellectual development; assist pregnant women to access comprehensive prenatal and postpartum care; support parents' efforts to fulfill their parental roles; and help parents move toward self-sufficiency. Head Start and Early Head Start serve children in families earning income at or below the federal poverty level. In 2011, the poverty level for a family of four in the 48 contiguous states and the District of Columbia is $22,350 (U.S. Department of Health and Human Services [USDHHS], 2011).

The Office of Head Start (OHS) provides grants to approximately 1600 local public and private non-profit and for-profit agencies to provide Head Start and Early Head Start services throughout the United States and territories. These programs operate in the way that's best for their communities. Some programs are half day, some are full day, and others home based. Many programs offer a variety of service options, including partnerships with schools, centers and family child care (eclkc.ohs.acf.hhs.gov/).

On December 12, 2007, President Bush signed into law the *Improving Head Start for School Readiness Act of 2007*, which reauthorized the Head Start program. This law contains significant revisions to the previous Head Start Act and authorizes Head Start through September 30, 2012. The Head Start Act outlined degree and credentialing requirements for teachers in its Head Start classroom in center-based programs. The requirements of Head Start teachers will be changing over the next few years. The current minimum qualifications required of Head Start teachers include either (a) a Child Development Associate (CDA) credential that is appropriate to the age of the children being served or (b) a state-awarded certificate for preschool teachers that meet or exceed the requirements for a Child Development Associate (CDA) credential. Currently, 77 percent of Head Start teachers surpass the minimum qualifications and have at least an Associate of Arts (AA) degree in Early Childhood Education.

The *Improving Head Start for School Readiness Act of 2007* also outlined teacher requirements for the future. As of October 1, 2011, each Head Start classroom in center-based programs must have a teacher with minimum qualifications of an associate, baccalaureate, or advanced degree in early childhood education, and as of September 30, 2010 at least 50% of Head Start teachers nation-wide must have obtained a baccalaureate or advanced degree in Early Childhood Education or a baccalaureate or advanced degree in any subject, and coursework equivalent to a major relating to early childhood education with experience teaching preschool-age children. In addition, all teaching assistants in center-based programs are required to hold one of the following: (a) have a CDA credential, (b) be enrolled in a CDA credential program that will be completed within 2 years; or (c) Have an associate or baccalaureate degree (in any area) or be enrolled in a program leading to such a degree. Furthermore, the Office of Head Start expects every grantee to make reasonable progress in increasing its numbers of teachers with qualifying baccalaureate degrees.

In February of 2009 Head Start received an economic boost from the *American Recovery and Reinvestment Act* (ARRA). The ARRA provided $2.1 billion for Head Start and Early Head Start, primarily to expand the program from about 890,100 to about an additional 60,600 children and families, which will also lead to an increase in teachers. Due in large part to the funding from ARRA, Head Start and Early Head Start increased their total staff of full-time employees, which includes classroom teachers, by 10,000 from 2009-2010. The Office of Head Start officials reported that some programs that received ARRA funds experienced challenges hiring staff with the required qualifications (Ashby & Jones, 2010).

***Non-public preschool teacher qualifications.*** Each state has its own licensing requirements that regulate care-giver training in non-public preschools and these requirements appear to vary greatly across all 50 states particularly in regards to non-public or privately run child-care centers. Non-public or private preschools typically care for and educate children while parents are working (Michel, 1999). In 2010, according to the U.S. Department of Labor Bureau of Labor Statistics (USDLBLS) more than 94% of fathers and 63% of mothers with children under six-years old were working outside the home. Additionally, many parents who do not work outside the home look toward private center-based programs to provide enriching social and educational experiences for their children.

In 2008, child care workers accounted for nearly 1.3 million jobs across the United States, and is continued to grow faster than the average through 2018 (USDLBLS, 2011). Currently, there are 12 states that require no pre-service training for teachers working in non-public child care programs, with the remainder of states requiring some form of training (NEA, 2010). Unfortunately, state-standards for privately run, child-care programs tend to be significantly lower than those of school-based prekindergarten and Head Start programs (National Education Association [NEA], 2010).

Table 1 displays the minimum qualifications of teachers in non-public child care centers by state. The qualifications vary greatly from state to state. A number of states have no minimum requirements of its teachers, while other states require a Child Development Associate (CDA) credential, or even college coursework in an early childhood program.

Table 1

*Minimum Qualifications of Teachers in Non-Public Child Care Centers*

| Minimum Qualifications | State |
|---|---|
| No Requirements | Alaska, Idaho, Iowa, Kentucky, Louisiana, Michigan, Missouri, Nevada, North Dakota, Ohio, South Dakota, Wyoming |
| Prior experience or observation in licensed preschool or child care center by licensing agent | Kansas, Maine, Mississippi, Montana, Nebraska, Oregon, West Virginia |
| High school diploma or GED | Arkansas, Connecticut, Indiana, South Carolina, Tennessee, Utah |
| Prior experience with high school diploma/GED | Arizona, Georgia, New York, North Carolina, Oklahoma, Pennsylvania, Rhode Island, Texas, Washington |
| Clock hours in early childhood education | Alabama, Florida, Maryland, New Mexico, Virginia, Wisconsin, and The District of Columbia |
| Vocational or occupational education program | Colorado, Delaware, Massachusetts, New Hampshire |
| Child Development Associate (CDA) or Certified Child Care Professional (CCP) credential | Hawaii, Illinois, Minnesota, New Jersey, Vermont |
| College coursework in early childhood or equivalent | California |

Note. Adapted from An NEA Policy Brief “Raising the Standards for Early Childhood Professionals Will Lead to Better Outcomes,” 2010, *National Education Association*.

***Texas.*** The State of Texas has two sets of teaching staff regulations for center-based early childhood programs serving preschool age children. Teachers and assistant teachers employed in child care centers that are licensed by the state of Texas are only required to complete a high school degree or be employed in a recognized early childhood careers program, but requirements for state-funded, public prekindergarten teaching staff are substantially higher (Bellm et al., 2002).

According to the U.S. Bureau of Labor Statistics' May 2010 Occupational Employment Statistics for Texas preschool teachers, more than 31,000 preschool teachers are employed in the state, who service approximately 215,000 children, with federally funded head start enrollment accounts for another 67,632 children. In Texas, state funded prekindergarten is available to 4 year-olds who meet one of a number of risk factors including: free or reduced-price lunch eligibility, homelessness or unstable housing, limited English proficiency, participation in foster care, or parent on active military duty or who has been injured or killed on duty. If parents are willing to pay tuition, non-eligible children may enroll in a state funded prekindergarten program at the district’s discretion (Barnett et al., 2010).

The *No Child Left Behind* (NCLB) Act of 2001 aims to ensure that every child is taught by a teacher with strong content knowledge by requiring teachers to be "highly qualified," which the law defines as having: (1) a bachelor's degree; (2) full state certification; and (3) demonstrated competency, as defined by the state, in each core academic subject that they teach. Since Texas defines its public education system as EC-12 and serves early childhood and prekindergarten students with Title I, Part A Funds, the highly qualified teacher requirements outlined in NCLB apply to early childhood and prekindergarten teachers.

According to the Texas Education Agency (TEA) prekindergarten teachers must complete a bachelor’s degree, a teaching certificate, and an Early Childhood or Kindergarten Endorsement. To obtain a teaching certificate, an applicant must have completed a bachelor’s degree and teacher training in a certified program; a Kindergarten endorsement requires satisfactory completion of a test related to working with this age group and/or early childhood education coursework. Teachers responsible for a classroom with children whose first language is not English must also obtain English as a Second Language Endorsement. The state does not require assistant teachers to meet any pre-service educational requirements, but individual school districts may establish requirements of their own (Texas Education Agency, 2011).

The enrollment in state-funded preschool programs, including Texas, is in excess of one million children (Barnet et al., 2010), not to mention those who attend a childcare center or daycare. Unfortunately, the qualifications of early childcare educators serving these children are far from uniform, which leaves one to question the compensation of these educators and the rate of turnover among those in the profession.

**Early childhood teacher compensation and turnover.** Preschool teacher turnover is high, relative to other professions, with annual turnover rates as much as 50% (Barnett, 2003). Perhaps one of the reasons for such a high rate of turnover is the compensation of early childhood educators. There is relatively little information available regarding compensation of early childhood educators; however, the U.S. Department of Labor, Bureau of Labor Statistics (2011), offers some insight into the level of compensation. As of 2011, the median annual salary of a child care worker was $17,440 and $22,120 for a preschool teacher. Employee benefits in child day care services and non-public preschools are minimal, with a substantial number of child care centers offering no healthcare benefits to any teaching staff. In contrast, as of 2008, the most recent year of which data was available, the median annual salary of a kindergarten teacher was $49,370 (USDLBLS, 2011). Additionally, many child care workers and preschool teachers work a 12 month-year, which suggests an even greater gap between the salaries of child care workers, preschool teachers, and kindergarten teachers (Whitebook et al., 2009).

Nationally, it is estimated that a quarter of entering public-school teachers leave teaching within the first three years, while the rates are even higher in schools with low academic achievement (Marvel, Lyter, Peltola, Strizek, & Morton, 2007). Furthermore, as much as 50% of all beginning teachers, regardless of their grade level, leave the profession in the first five years (Ingersoll, 2003). However, there is little research on teacher turnover at early child care centers and preschools.

Data provided by the U.S. Department of Labor suggests that the teacher turnover rates in K-12 and early childhood education differ considerably from those in early childhood education. In 2006, the U.S. Department of Labor data indicated that the estimated job openings resulting from the flow of workers out of an occupation was 29.5 percent for those who identified themselves as child care workers, which was more than double the figure for preschool teachers (13.5 percent) and three times that of elementary school teachers (9.8 percent) (USDLBLS, 2008).

More recent research conducted by Holochwost, DeMott, Buell, Yannetta, and Amsden (2009) investigated the intent of beginning early childcare educators to stay in the field of early childhood education. The majority (60.4%) reported that they planned to remain in the field for 5 or more years. Annual salary, as estimated by the educator, did not bear a statistically significant relationship to how long one intended to remain in the field. However, the availability of health, disability, and pension benefits were the three chief environmental factors associated with significantly higher intent scores to remain in the early childhood education field. This makes intuitive sense: in a low wage field, security—from high medical bills, disabling injury, and old age—is critical, given that employees do not earn enough to build large cash reserves. As long as they feel protected from uncertainty, workers may be willing to stay in a field with wages that force them to live frugally.

The research by Holochwost et al. (2009) also suggests that once teachers have moved beyond 5 years' experience educator's intent to remain in the field reached a plateau, which should make retaining early childhood educators beyond five years a priority. Investigating the qualifications of early childhood educators, along with how long they intend to remain in the field, can be beneficial towards identifying appropriate training and professional development opportunities to impact student achievement. Spatial skills and spatial thinking are important areas in which early childhood teachers should be knowledgeable. Spatial skills and spatial thinking has been found to be a significant predictor of achievement in mathematics and science (Clements & Sarama, 2007; Shepard, 1978; West, 1991; Wheatley & Reynolds, 1999). This will be the focus of the following section.

**Spatial Abilities and Geometric Thinking**

Geometry is an essential component of mathematics instruction and has the ability to help students to describe and represent the world (Oberdorf & Taylor-Cox, 1999). Spatial skills are a facet of geometry and mathematics instruction. Spatial thinking provides a way to conceptualize relationships in a problem prior to solving it (Clements & Sarama, 2007). Additionally, spatial skills involve the ability to think and reason through the comparison, manipulation, and transformation of mental pictures (Casey et al., 2008). Wheatley and Reynolds (1999) suggest that students can give greater meaning to their mathematical activities if they are encouraged to construct and transform mental images. Spatial tasks help develop concepts of measurement, geometry, number, and proportion (Clements, Battista, Sarama & Swaminathan, 1997). The benefits associated with spatial abilities are certainly not new phenomena. There have been a variety of psychologists, researchers, and committees that have contributed to the knowledge regarding how and when spatial abilities develop. This particular literature review of spatial abilities will address the work put forth by Jean Piaget and Barbel Inhelder, Pierre and Dina van Hiele, and the National Research Council's Committee on Early Childhood Mathematics.

**Piaget and Inhelder.** Jean Piaget and Barbel Inhelder were instrumental in bringing knowledge regarding what a child should know about space and how a child's knowledge about space develops. Piaget and Inhelder believed that children have constructed perceptual space by infancy. It is not until much later that children are able to build up their ideas about space in geometry, or as Piaget and Inhelder refer to it representational space. One of the areas in Piaget and Inhelder's (1967) book *The*

*Child's Conception of Space* analyzed spatial perception and spatial representation within the context of pictorial space, which they viewed as a type of representative space. Piaget and Inhelder suggest that spatial perception gradually evolves and is not available to the child at mental development. Spatial representation moves through three distinct stages: synthetic incapacity, intellectual realism, and visual realism (Piaget & Inhelder, 1967).

Piaget and Inhelder suggest that *synthetic incapacity* is best represented through characteristics of 3 and 4 year olds. Synthetic incapacity is a representation of space, which neglects proportions and distance and projective relationships. An example of synthetic incapacity would include a young child drawing a person as a head with four strokes representing arms and legs, with eyes, nose, and mouth in some configuration. The construction of the image is something different from the perception itself.

*Intellectual realism* is more characteristic of 5, 6, and 7 year olds and refers to spatial representation in which proportions and distance and projective relationships are just beginning to emerge. The interconnectedness of these relationships is not always accurate, but proximities are at least attempted; separations are made among elements of representation; order and direction are found; the relationship of surrounding or enclosure is very important; and continuity is well defined.

The *visual realism* stage is more characteristic of children approaching 8 or 9 years old. This stage is characteristic of a child's drawings in which the beginnings of the use of perspective, proportions and distance are evident in a coordinated and simultaneous fashion. At this stage, what the child perceives is beginning to be represented more accurately and realistically with relation to scaling/proportion, perspective/points of view, and relative distances.

In addition to developing spatial perception and spatial representation through children's drawings, Piaget and Inhelder involved the use of exploration by shape, in which they had children explore different shapes by touch. They found that preschool children were able to discriminate objects as either closed or open-ended based on touch, whereas older children were able to distinguish shapes that had either curved or straight sides. Piaget and Inhelder suggest those children's ideas about shapes do not come from passive looking, but through interacting and engaging with different shapes.

The research reported by Piaget and Inhelder in *The Child's Conception of Space* helped shed light on the child's view of spatial perception and spatial representation. Many of the drawings and activities analyzed by Piaget and Inhelder suggest that in order for young children to engage in geometric thinking, they need to have opportunities and experiences that allow them to interact with different attributes of shapes (Piaget & Inhelder, 1967).

**van Hiele's.** Pierre and Dina van Hiele were also significant in contributing to the development of geometric and spatial thinking. They suggest that children progress through levels of thinking when engaged in geometric inquiry (van Hiele, 1999). An understanding of geometric ideas must be developed through familiarity by experiencing numerous examples and counterexamples, the various properties of geometric figures, the relationships between the properties, and how these properties are ordered. The van Hiele theory of geometric thought includes five hierarchal levels, which include:

1. Visual-this level begins with nonverbal thinking. Figures are judged by their appearance. Attributes or properties of shapes are not thought about;

2. Descriptive/Analytic-at this level, figures possess their properties. Children begin to recognize and categorize shapes by their properties. Properties are established experimentally by observing, measuring, drawing, and by making models. However, children typically do not see and cannot explain the relationships between classes of shapes;
3. Informal deduction-at this level, children have the ability to form abstract definitions, classify hierarchically and pose informal arguments to justify classifications. Children are able to deduce properties of figures and express interrelationships within and between figures. Children are able to understand the inclusion of relationships among classes of shapes, however, the role of axioms, definitions, theorems and their converses are not yet understood;
4. Formal deduction-at this level, students are capable of creating formal deductive proofs. They can conceptualize about relationships between properties of shapes and are able to construct formal proofs. These skills are typical of work found in high school geometry courses; and
5. Rigor-at this level individuals are able to compare different axiomatic system. This level is usually attained by mathematics majors or mathematicians (van Hiele, 1984).

Pierre and Dina van Hiele suggest that with the appropriate educational opportunities, children will have the opportunity to move through all five stages in a hierarchical manner, which is not dependent on age but rather enough experiences that allow children to move from level to level. The van Hiele's call into question the appropriateness of curricula and educational experiences afforded children in academic settings and suggest that they do not provide the appropriate opportunities for children to move through the five levels of geometric learning and reasoning (van Hiele, 1984).

**National Research Council.** In 2009, a publication by the National Research Council's Committee on Early Childhood Mathematics entitled *Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity,* the levels in which children begin to think about shapes and space was discussed. Children appear to move through different levels in thinking as they learn about spatial thinking and geometry. Children have an innate, implicit ability to both recognize and match shapes. Even at the pre-recognition level, children are not explicitly able to consistently distinguish shapes like circles, triangles, and squares from other shapes. At the pre-recognition level, children are just starting to form unconscious visual schemes for the shapes, drawing on some basic knowledge and experience.

Beyond the pre-recognition level, at ages 2 and 3, children begin to think visually or holistically about shapes and have formed schemes, or mental patterns, for shape categories. When these schemes are first built, such schemes are holistic, unanalyzed, and visual. At this visual/holistic level of thinking, children are able to recognize shapes as wholes but may have difficulty forming separate mental images that are not supported by perceptual input. A given figure is a rectangle, for example, because "it looks like a door." Children at this level do not think about shapes in terms of their attributes, or properties. At this level of geometric thinking children are able to construct shapes from parts, but they have difficulty integrating those parts into a coherent whole.

At the ages of 3 and 4, children learn to describe, and then analyze, geometric figures. The culmination of learning at this descriptive/analytic level is the ability to recognize and characterize shapes by their properties. Initially, children at this level learn about the parts of shapes—for example, the boundaries of two-dimensional (2-D) and three-dimensional (3-D) shapes.  Children at this level are also able to move shapes using slides, flips, and turns and predict the effects of rigid geometric motions.

At about the age of 5, children have the ability to move to the third level in which children then increasingly see relationships between parts of shapes, which are properties of the shapes. For example, a student might think of a parallelogram as a figure that has two pairs of parallel sides and two pairs of equal angles.  Children are also able to compare area using superimposition and identify and identify and recreate symmetric figures using motions.  At this level children are also able to recreate and compose a variety of shape sets on grids and in puzzles with systematicity and anticipation.

The levels outlined by the National Research Council in which children begin to think about shapes and space are similar to the van Hiele's in that the levels are hierarchal and tend to build upon one another.  Another similarity to the van Hiele model is the suggestion that unfortunately, due to a lack of good experiences, many children are not able to fully develop their thinking about shapes and space due to ineffective curricula and a lack of the appropriate learning experiences. However, if young children are given the appropriate learning experiences, they have the ability to reach the third level of thinking about shapes and space (NRC, 2009).

Research put forth by notable researchers Piaget and Inhelder, Pierre and Dina van Hiele, and the National Research Council's Committee on Early Childhood

Mathematics have helped advance knowledge regarding children's knowledge of and how children learn about geometric thinking and spatial abilities. As the van Hiele's and the National Research Council have already acknowledged, providing children with the appropriate learning opportunities and a well developed curricula can aid in a child's understanding and development of geometry and spatial thinking. Given the questions surrounding curriculum and the learning opportunities afforded young children, the standards and expectations of early childhood mathematics programs deserve a closer look.

## Early Childhood Mathematics Standards and Learning Opportunities

**Early childhood mathematics standards and curriculum.** State-standards are the foundation upon which almost everything else rests—or should rest. State-standards should guide state assessments and accountability systems; inform teacher preparation, licensure, and professional development; and give shape to curricula, textbooks, software programs, and more (Carmichael, Martino, Porter-Magee, & Wilson, 2010). In 2007, Cronin, Dahlin, Adkins, and Kingsbury published a groundbreaking study with the Northwest Evaluation Association, *The Proficiency Illusion*, which used a common metric to compare states' "proficiency" standards to one another. The results were more than disturbing: In some states, students could score below the tenth percentile nationally and still be considered "proficient." Meanwhile, in other states, students had to reach the seventy-seventh percentile to achieve proficiency. Carmichael et al. (2010) suggests that standards are often ignored in favor of high-stakes testing.

> Standards often end up like wallpaper. They sit there on a state website, available for download, but mostly they're ignored. Educators instead obsess about what's

> on the high-stakes test—and how much students actually have to know in order to pass—which becomes the *real* standard. After making the most superficial adjustments, textbook publishers assert that their wares are "aligned" with the standards. Ed schools simply ignore them (p. 2).

It appears that state-standards and testing seem to vary greatly across grade level and states. Some suggest that a movement toward national standards and assessment can reveal the truth about educational achievement in all content areas, including mathematics (Carmichael et al., 2010; Cronin et al., 2007).

In 2010, The *Common Core State Standards Initiative* (CCSSI) published the *Common Core State Standards Initiative for Mathematics* to bring regularity and rigor to the study of mathematics across the nation. The CCSI is a state-led effort coordinated by the National Governors Association (NGA) Center for Best Practices and the Council of Chief State School Officers (CCSSO). The standards were developed in collaboration with teachers, school administrators, and experts, to provide a framework to prepare children for college and the workforce. The standards have since been adopted by 43 states.

The CCSSI outlined grade-specific standards that define what students should know and be able to do in their study of mathematics from kindergarten through twelfth grade. Beginning in Kindergarten, the CCSSI recommends that instructional time should focus on two critical areas: (1) representing, relating, and operating on whole numbers, initially with sets of objects; and (2) describing shapes and space. The standards specific to geometry include having kindergarteners be able to (1) describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to; (2) correctly name shapes regardless of their orientations or overall size; and (3) identify shapes as two-dimensional (lying in a plane, “flat”) or three dimensional (“solid”). Kindergartners should also be able to (4) analyze and compare two-and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/similarities, differences, parts (e.g., number of sides and vertices/”corners”) and other attributes (e.g., having sides of equal length); (5) model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes; and (6) compose simple shapes to form larger shapes. For example, “Can you join these two triangles with full sides touching to make a rectangle?”

Currently, there is no *Common Core State Standards Initiative for Mathematics* prior to Kindergarten. However, many states have developed their own early learning standards. These standards often serve as a component of accountability systems. The number of states with published early learning standards has grown from 27 in 2002 to 49 as of 2010 (Barnett, et al., 2010). The age levels addressed in the early learning standards vary across states. In 17 states the standards targeted children ages 3 to 5, 12 states targeted 3- and 4-year-olds, and 11 states targeted children finishing prekindergarten or starting kindergarten (NRC, 2009). To inform their early learning standards in mathematics, states have used a variety of resources including those from the National Council of Teachers of Mathematics and the National Mathematics Advisory Panel.

Beginning in 2000, the National Council of the Teachers of Mathematics (NCTM) for the first time included prekindergarten in its *Principles and Standards for School*

*Mathematics* (PSSM). The PSSM are guided by six major principles including equity, curriculum, teaching, learning, assessment, and technology. The PSSM describe the mathematics content and process areas children are expected to know and be able to do from prekindergarten through second grade. The geometry standards for instructional programs state that children from prekindergarten through second grade should be able to use visualization, spatial reasoning, and geometric modeling to solve problems with the expectations that all students in prekindergarten through grade 2 should be able to:

- create mental images of geometric shapes using spatial memory and spatial visualization;
- recognize and represent shapes from different perspectives;
- relate ideas in geometry to ideas in number and measurement; and
- recognize geometric shapes and structures in the environment and specify their location (NCTM, 2000).

The PSSM acknowledges that the standards proposed should not be seen as all encompassing, "Those who design curriculum frameworks, assessments, instructional materials, and classroom instruction based on *Principles and Standards* will need to make their own decisions about emphasis and order" (NCTM, 2000, p. 31)." In 2006, the NCTM published *Focal Points*, which suggests areas of emphasis in mathematics. One of the areas *Focal Points* asked for greater emphasis was in geometry, specifically non-number topics in the primary grades.

In addition to the standards set forth by the NCTM, The National Mathematics Advisory Panel (NMAP), a group of nationally-known mathematicians and experts on mathematics learning and education was formed to examine the "best available scientific evidence" regarding mathematics education, and make recommendations for its improvement. The NMAP made a number of recommendations and identified "Benchmarks for the Critical Foundations" for progress in mathematics learning at each stage from pre-school through grade 7, with a particular focus on readiness for algebra.

In the NMAP (2008) *Foundation for Success,* the panel acknowledges that although early exposure to basic geometric shapes, names, and other concepts may be helpful in developing children's formal geometric knowledge and skills, this is not sufficient. The NMAP states that "students must eventually transition from concrete (hands-on) or visual representations to internalized abstract representations (p. 29)." The NMAP also acknowledges that the crucial steps needed to make such transitions are not clearly understood at present and that a need exists regarding learning and curriculum research in these areas.

> Teachers should recognize that from early childhood through the elementary school years, the spatial visualization skills needed for learning geometry have already begun to develop…young children appear to possess at least an implicit understanding of basic facets of Euclidean concepts. However, formal instruction is necessary to ensure that children build upon this knowledge to learn geometry. Instructional materials can play a defining role in mathematics classrooms, affecting both what and how teachers teach (p. 29).

In a 2006 HighScope press release, the U.S. Department of Education, Institute for Education Sciences, funded a three-year $1.5 million project to develop a mathematics curriculum entitled *Numbers Plus: A Comprehensive Approach to Early Mathematics Education.* The research was conducted by The HighScope Educational

Research Foundation. The project was designed to be consistent with current research on child development and teaching practices, while aligning with the early childhood standards of the NCTM. The curriculum was to serve as a supplement to the general HighScope approach, which is utilized in some HeadStart programs. The HighScope Curriculum is based on the fundamental premise that children are active learners, who learn best from pursuing their own interests while being actively supported and challenged by adults. The heart of the HighScope daily routine is the plan-do-review sequence in which children make choices about what they will do, carry out their ideas, and then reflect on their activities with adults and peers.

**Mathematics learning opportunities.** In 2005, The National Center for Early Development and Learning (NCEDL) conducted two major studies of state-funded pre-kindergarten programs: The Multi-State Study of prekindergarten that included six states and the State Wide Early Education Programs Study that included five states. Using these two studies in combination provides detailed information on pre kindergarten teachers, children, and classrooms in 11 states. The studies took place during the 2001-2002 school-year. It was estimated that 79% of all children in the United States who were participating in state-funded pre-kindergarten were in one of these 11 states, and 83% of state dollars spent on pre-k were in one of these 11 states (Barnett, Hustedt, Robin, & Schulman, 2003). Combining the information from these two studies provides a comprehensive look at prekindergarten in the United States.

The most relevant NCEDL data came from observations conducted during visits to prekindergarten classrooms over the course of the fall and the spring. The average amount of time focused on mathematics content in the prekindergarten classrooms was a mere (6.5 percent in the fall, and 6.7 percent in the spring). In a more detailed analysis of the average time focused on mathematics, the data from the NCEDL revealed that the actual activities that took place during this mathematics time suggests that, for about half of the time, mathematics content occurred during whole-group activities (49 percent in the fall and 48 percent in the spring). Free choice/center time was the second most common mathematics setting (31 and 29 percent in the fall and spring respectively), with small group instruction third (11 and 12 percent) (Early et al., 2005).

The NMAP uses the term *explicit instruction* to refer to the variety of ways teachers can intentionally structure children's learning experiences in order to support the learning of mathematics. The panel recommends *explicit instruction* to be utilized throughout the day and that it should come through multiple contexts including whole group, small group, centers, play, and routines. Additionally, the Panel recommends that teachers provide clear models for solving a problem using an array of examples, that students receive extensive practice in use of newly learned strategies and skills, and that students are provided with extensive feedback (NMAP, 2008).

The NCEDL also sought to identify whether mathematics is taught alone or in conjunction with other content. The data indicate that mathematics content co-occurred with other academic content during the majority of the time (61 percent in the fall and 55 percent in the spring). About 20 percent of the time, when mathematics co-occurred with something else, it was with an art or music activity, and between 15 and 18 percent of the time it was with a fine motor activity. Other academic content occurred simultaneously with mathematics about 11 percent of the time for reading (a combination of being read to, pre-reading, and letter-sound), 13 percent for social studies, and 11 percent for science

(Early et al., 2005). These findings indicate that, when mathematics is taught, early childhood education programs rely on integrated or embedded mathematics experiences a majority of the time, rather than including activities with a primary focus on mathematics.

In a smaller scale study conducted by Sarama and DiBiase (2004) that examined mathematics in early childhood settings found results similar to those of the NCEDL. Using prekindergarten classrooms from two different states and a range of preschool settings, including family and group child care providers, preschool teachers were surveyed about their mathematics instruction. Ninety-five percent of teachers reported using manipulatives, while 74 percent used number songs, and 71 percent used games. Only 16 percent reported using mathematical worksheets. When teachers were asked about their preference for teaching mathematics, teachers reported a preference for free exploration rather than through large group lessons. The percentage of teachers who reported teaching spatial abilities through lessons or free exploration was 32 percent. Additionally, 16 percent of teachers reported the use of lessons or activities that required making shapes. Geometry and measurement were the least popular topics among those surveyed.

The limited use of mathematics and the manner that it is taught might lead one to question whether or not the opportunities provided are preparing students for kindergarten. In the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) commissioned by the National Research Council revealed that items from a survey of *kindergarten* teachers who reported how often their students were exposed to classroom instruction in mathematics, including (1) broad exposure to mathematics, (2) instructional emphasis on specific mathematics concepts and skills, and (3) exposure to specific mathematics instructional strategies and activities found that 81 percent of kindergarten teachers indicated that mathematics is a part of their daily classroom routine. Additionally, 65 percent of teachers reported providing more than 30 minutes of mathematics instruction each day. In regards to the mathematical concepts being taught, 66 percent of teachers reported that recognizing and naming geometric shapes was an area emphasis one or more times per week (Hamre, Downer, Kilday, & McGuire, 2008). The time spent teaching and learning mathematics in kindergarten appears to be considerably longer than the time spent on mathematics in prekindergarten classrooms. Yet, even at the kindergarten level the task of recognizing and naming geometric shapes falls well short of the standards put forth by NCTM.

From review of the literature it appears that standards are in place to support the development and learning of geometry and spatial abilities in early childhood classrooms. However, the data available on when and how mathematics, let alone geometry and spatial development, is taught does not seem to align with the standards established by national organizations such as NCTM. Given the minimal qualifications of preschool teachers, particularly those teaching in family and group childcare settings, it appears that preschool programs and teachers could benefit from increased knowledge of mathematical concepts such as geometry and spatial abilities. One method of enhancing teacher knowledge is through professional development opportunities.

**Summary**

As was previously discussed, spatial abilities have been linked to mathematics achievement, in addition to science achievement and creativity in the arts (Clements &

Sarama, 2007; Shepard, 1978; West, 1991; Wheatley & Reynolds, 1999). A few of the skills associated with spatial tasks include the ability to think and reason through comparison, manipulation, and the transformation of mental pictures (Casey et al., 2008). Additionally, children can give greater meaning to their mathematical activities if they are encouraged through spatial tasks (Wheatley & Reynolds, 1999). Spatial tasks help children develop other mathematical concepts including geometry (Clements, Battista, Sarama & Swaminathan, 1997).

At the ages of 3 and 4, children have the ability to learn to describe, and then analyze, geometric figures, and by about the age of 5, children have the ability to see relationships between parts of shapes, which are properties of the shapes. Children are also able to compare area using superimposition, and identify and recreate symmetric figures using motions. By the age of 5 children are also able to recreate and compose a variety of shape sets on grids and in puzzles with systematicity and anticipation (NRC, 2009).

National organizations such as the NAEYC & NCTM have taken note of the importance regarding spatial abilities, and have begun to incorporate spatial abilities into their geometry standards in which children from prekindergarten through second grade are expected to create mental images of geometric shapes using spatial memory and spatial visualization, recognize and represent shapes from different perspectives, relate ideas in geometry to ideas in number and measurement, and recognize geometric shapes and structures in the environment and specify their location (NCTM, 2000). Additionally, the number of states with published early learning standards has grown from 27 in 2002 to 49 as of 2010 (Barnett, et al., 2010). The data available on when and how mathematics, let alone geometry and spatial development, is taught does not seem to align with the standards established by national organizations such as NCTM, with the average amount of time focused on mathematics content in prekindergarten programs being as little as 6.5% (Early, et al., 2005). Such a discrepancy between standards and mathematics instruction calls into attention the qualifications of preschool teachers.

The educational requirements of teachers in early care education programs varies *within* states, dependent upon the setting (e.g., public school-based preschool, Head Start, subsidized child care, or privately funded early childhood programs). Many preschool teachers do not hold college degrees, and most are not certified (Whitebook et al., 2009); most likely they have not had education on math teaching methods. Given the minimal qualifications of preschool teachers, it appears that preschool programs and teachers could benefit from increased knowledge of mathematical concepts such as geometry and spatial abilities.

One method of enhancing teacher knowledge is through professional development opportunities. Focused professional development opportunities utilizing the appropriate content and delivery method can help improve teachers practice, particularly in the area of mathematics (Dunst & Raab, 2010; NAEYC & NCTM, 2002/2010; Thornton, Crim, & Hawkins, 2009). Professional development opportunities could serve as a bridge between the knowledge and experiences of preschool teachers and the expectations for student outcomes regarding geometry and spatial abilities.

# CHAPTER III

# METHODOLOGY

The purpose of this research study was to determine if background, setting, and teaching experience of in-service early childhood educators' affect their knowledge, skills, and confidence concerning spatial skills development in their classrooms. This chapter presents the methodology for this study. The first section summarizes the general purpose and characteristics of the research design and method. The second section includes a detailed description of the study participants, including demographic information, and the sampling procedures and criteria used to select participants for the study. The third section discusses the instrument used for data collection, with a review of the validity and reliability of the instrument. Data collection procedures are presented in the following section, and lastly the data analysis procedures that were used are presented along with a review of the research questions.

## Research Design

This section presents the rationale for the research design. This study uses a quantitative method incorporating a survey design. Survey research is one of the most common types of quantitative research in education (Fowler, 2009; Frankel & Wallen, 2006), with as much as 70% of research falling in this category (Lodico, Spaulding, & Voegtle, 2006). Surveys are particularly beneficial in describing behaviors and gathering people's perceptions, opinions, attitudes, and beliefs about a current issue, particularly in the field of education (Lodico, Spaulding, & Voegtle, 2006).

These data for the study was originally collected by Andrews (2011). Andrews conducted a study to examine the knowledge, skills, and confidence levels of in-service early childhood educators' in the area of spatial skill development of young. The original study also sought to identify professional development experiences of these educators. For the purposes of the Andrews (2011) study, a 26-item survey was developed examining in-service early childhood educators' knowledge of spatial skills. The survey was developed due to the fact that no previously published survey could be identified which adequately measured early childhood educators' knowledge regarding spatial skills. The newly-developed survey collected demographic information including level of education, teaching experience, and the setting in which they taught, public or private. Early childhood educators were also asked items about their knowledge, skills, and confidence regarding spatial skills and their current mathematics curriculum.

This study examined in-service early childhood educators' knowledge, skills, and confidence concerning spatial skills development. This study also examined the relationship between in-service early childhood educators' educational backgrounds and their levels of confidence regarding spatial skills. The independent variables of interest are in-service early childhood teachers' educational backgrounds, prior teaching experience, and the setting in which they teach, public or private. The dependent variables, or criterion measures of interest, included in-service early childhood educators' knowledge, skills, and confidence regarding spatial skills, as measured by the survey instrument *Spatial Abilities Survey for In-Service Teachers*. The perceptions of participants were self-reported using a combination of questions including open-ended, five-point Likert scales, and checklists.

## Research Questions

This study sought to address the following research questions.

1. Is in-service early childhood educators' educational background related to their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?
2. Is in-service early childhood educators' prior teaching experience related to the level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?
3. Is in-service early childhood educators' level of knowledge, skills, and confidence regarding spatial skills development related to the setting of the early childhood center in which they teach?

The level of education, prior teaching experience, and the setting in which in-service early childhood educators taught were self reported by the participants. These archival data collected using the *Spatial Abilities Survey for In-Service Teachers* survey instrument were analyzed to measure the knowledge, skills, and confidence these educators have regarding spatial abilities.

## Participants

This study used archival data collected by Andrews (2011) that investigated the knowledge of in-service early childhood educators' knowledge of spatial skill development in their classrooms using the *Spatial Abilities Survey for In-Service Teachers* survey instrument. In the original study, participants were asked to anonymously participate in the study to determine demographic characteristics of early childhood teachers, their participation in professional development, and their level of knowledge regarding spatial abilities. The original study included 88 in-service early childhood teachers from public and non-public preschools and early childhood centers in and around a large urban area in southeast Texas.

The survey was administered in two separate settings. In the first setting, participants were asked to complete the survey while attending a professional development sponsored by a non-profit organization which provides child care quality improvement projects that offer training for teachers and directors, continuing education scholarships, one-on-one coaching and mentoring, equipment and classroom resources, and financial incentives for completion of educational milestones. There was no fee for attending the training. The non-profit organization's belief is that quality early education opportunities can help level the pathway to success for children by ensuring that they begin kindergarten on track with the foundation they need to excel.

Additional participants were selected from a public early childhood center in a large urban school district in southeast Texas. Children attending this early childhood center must meet at least one of the following criteria:

- be homeless,
- be unable to speak or understand English,

- be economically disadvantaged, be the child of an active-duty member of the U.S. military or one who has been killed, injured, or missing in action while on active duty,
- child is or ever has been in the conservatorship of the Department of Family and Protective Services following an adversary hearing, or
- meet the low-income eligibility criteria for Head Start.

**Summary of demographic data.** This section presents the demographic data of early childhood participants. The demographic variables gender and ethnicity are presented in Table 2.

Table 2

*Participants' Gender and Ethnicity*

| Variable | *n* | Percent |
|---|---|---|
| Gender | | |
| Male | 4 | 4.5 |
| Female | 84 | 95.5 |
| Ethnicity | | |
| Hispanic | 35 | 39.8 |
| Caucasian/White | 29 | 33 |
| African American/Black | 17 | 19.3 |
| American Indian or Alaskan Native | 2 | 2.3 |
| Asian | 1 | 1.1 |

| | | |
|---|---|---|
| Prefer not to Answer | 4 | 4.5 |

A total of 4 males and 84 females completed the survey. Nearly 40% of participants identified themselves as Hispanic, a third were Caucasian/White, and about 20% were African American/Black, with the remaining participants identifying as Asian, American Indian/Alaskan Native, or preferring not to answer the question.

The results for the highest level of education obtained, which are categorical variables, on the *Spatial Abilities Survey for In-Service Teachers* survey were categorized according to participants highest level of education obtained. The education categories include: (a) High School Diploma/GED, (b) Associate's Degree/Child Development Associate Degree, some college, or (c) Bachelor 's Degree or higher. Table 3 displays the frequencies of participants' educational background.

Table 3

*Participants' Highest Level of Education Obtained*

| | *n* | Percent |
|---|---|---|
| High School Diploma/GED | 21 | 23.9 |
| Some College/2 years Associate's degree | 35 | 39.8 |
| Bachelor's degree of higher | 32 | 36.4 |
| Total | 88 | 100 |

Based on the response of highest level of education obtained from the survey, data indicated that more than one third of survey respondents have some college experience or a Bachelor's degree or higher. Additionally, nearly one fourth of participants held a high school diploma or general education diploma.

The results for the prior years of teaching experience, which are categorical variables, on the *Spatial Abilities Survey for In-Service Teachers* survey are presented in Table 4.

Table 4

*Participants' Prior Years Teaching Experience*

| | *n* | Percent |
|---|---|---|
| 0-5 Years of Teaching Experience | 38 | 43.2 |
| 6 to 10 Years of Teaching Experience | 23 | 26.1 |
| > 10 Years of Teaching Experience | 27 | 30.7 |
| Total | 88 | 100 |

In table 4, the results of prior years teaching experience from the survey data indicate that early childhood educators with 0-5 years of teaching experience make up the largest percentage of participants. However, each category contained more than 25% of the total participants.

The results for the setting in which early childhood educators' taught, which are categorical variables on the *Spatial Abilities Survey for In-Service Teachers* survey, are presented in Table 5.

Table 5

*Setting in Which Early Childhood Educators' Taught*

| | *n* | Percent |
|---|---|---|
| Public | 37 | 42 |
| Non-public | 51 | 58 |
| Total | 88 | 100 |

The results of setting in which early childhood educators' taught indicate that the majority of participants are teaching in non-public early childhood centers. However, even though in the minority, early childhood educators teaching in a public setting represented more than 40% of participants.

**Instrumentation**

This study utilized a quantitative design. Quantitative data, collected through survey analysis provided the researcher with the opportunity to determine the level of in-service early childhood teachers' knowledge, skills, and confidence regarding spatial skills. Data from the survey instrument *Spatial Abilities Survey for In-Service Teachers* were reviewed for the purposes of this study.

**Spatial abilities survey for in-service teachers.** The *Spatial Abilities Survey for In-Service Teachers* survey included 26 items using a combination of questions including open-ended, five-point Likert scales, and checklists. The survey contained nine questions relating to demographic information such as sex, ethnicity, years of teaching experience, level of education, and certification. Four questions addressed in-service early childhood educators' math preparation and professional development experiences. Four questions addressed mathematics curriculum, standards, and the time spent teaching mathematics.

Three questions addressed the type of school or early childhood center and student population in which the participant taught. Six questions specifically addressed in-service early childhood educators' understanding of spatial abilities and classroom practices regarding spatial abilities.

**Instrument validity.** The survey instrument *Spatial Abilities Survey for In-Service Teachers* appears to contain both face and content validity. Gall, Gall, and Borg (2007) define face validity as the extent to which an instrument measures what it purports to measure. The items in the *Spatial Abilities Survey for In-Service Teachers* survey address the specific components of the study, which includes in-service early childhood educators' educational backgrounds, experience, and opportunities for professional development, in addition to their knowledge, skills, and confidence concerning spatial skills development in their classrooms. The face validity of the survey instrument used for this data collection was achieved by: (a) feedback from three subject matter experts and (b) review of the literature regarding the subject matter.

Content validity, as it relates to survey research consists of two parts: sampling validity and item validity. Sampling validity can be established by having participants examine the survey to ensure that there are no additional sections needed to address the issue under investigation, while item validity requires examination of the survey to determine whether the items that make up the sections of the survey in fact belong in those sections (Lodico, Spaulding, Voegtle, 2006). Fraenkel & Wallen (2006) also acknowledge the importance of having colleagues review the instrument, placing particular emphasis on the content and format of the instrument. The survey instrument developed by Andrews (2011) placed importance on all of the factors described above as being associated with content validity.

**Survey Collection Procedures**

In the original study, the survey was administered to in-service early childhood educators attending a professional development session sponsored by a non-profit organization in a large urban city in southeast Texas. The survey was also administered to in-service early childhood educators in a public early childhood center located in a large urban school district in southeast Texas. All participants were asked to anonymously participate in the study by completing the *Spatial Abilities Survey for In-Service Teachers* survey, and were assured confidentiality. Once completed, the surveys were collected by the principal investigator. All paper data are stored in a secured, locked location in the main office of the lead researcher in the original study. Since the surveys were anonymous, no names are included on these paper data.

**Data Analysis**

The *Spatial Abilities Survey for In-Service Teachers* survey from the professional development sessions and the public early childhood center were randomly shuffled together before analysis to keep the researcher from showing any bias toward either group from which the survey was administered. To address the dependent variables, knowledge and skills, a scoring rubric was developed by the researcher. There was no pre-developed rubric available that could be used to score educators' knowledge and skills regarding spatial abilities, therefore it was necessary for the researcher to develop one.

To specifically determine the dependent variable, participants' knowledge of spatial abilities, question number seventeen from the *Spatial Abilities Survey for In-Service Teachers* survey was analyzed. Question seventeen asks participants: "To the best of your knowledge, how do you define spatial skills/abilities?" Each response was scored using a four-point rubric outlined in Appendix B. The guidelines for scoring the rubric were developed by the researcher after performing a review of the literature. The meta-analysis conducted by Linn and Petersen (1985) provides a working definition of spatial abilities. Linn and Petersen describe spatial abilities as the spatial perception, mental rotation, or orientation of images or objects. This definition was used as a baseline to determine the scoring of each participant's response to question seventeen, with partial credit awarded based on a broader definition. In order to receive a score of three, participants must have defined spatial skills and/or abilities as involving the manipulation, visualization, or orientation of spatial images or objects. Two points were assigned to a participant who was able to indicate that spatial skills and/or abilities are associated with a specific area of mathematics. One point was assigned to participants who were able to state that spatial skills and/or abilities are associated with mathematics. Zero points were assigned if participants were unable to define or state anything related to spatial skills or spatial abilities.

The second dependent variable, participants' skills in teaching spatial abilities was analyzed using question eighteen from the survey. Participants were asked: "How do you teach spatial skills? Specifically, what objectives, activities, and materials are involved?" Based on the written response, each participant was assigned a score using the rubric in Appendix C. The guidelines for scoring the rubric were developed by the researcher after a review of the literature regarding spatial abilities. The National Research Council (2009) acknowledges that the culmination of learning at the descriptive/analytic level, which is appropriate for children as early as three years of age, is the ability to recognize and characterize shapes by their properties. Initially, children at this level learn about the parts of shapes—for example, the boundaries of two-dimensional (2-D) and three-dimensional (3-D) shapes. Children at this level are also able to move shapes using slides, flips, and turns and predict the effects of rigid geometric motions. Given children's ability levels at this stage and the content standards set forth by organizations like NCTM, which state that children from prekindergarten through second grade should be able to use visualization, spatial reasoning, and geometric modeling to solve problems (NCTM, 2000), the researcher found it appropriate to develop a rubric that incorporated a variety of activities and materials early childhood educators make available to their students, in addition to the objectives for understanding spatial abilities early childhood educators derive their knowledge from.

In order to receive the full three points for their response, each participant must have stated any combination of three or more objectives, activities, or materials that are involved in teaching spatial skills and/or abilities. To receive a score of two points, each participant must have stated any combination of two objectives, activities, or materials that are involved in teaching spatial skills and/or abilities. Participants received a score of one point if they were able to state any objective, activity, or material involved in teaching spatial abilities. If the participants were unable to state an objective, activity, or material involved in teaching spatial abilities, they received a score of zero points.

The third dependent variable, the confidence level of participants regarding spatial abilities utilized survey question twenty-one, in which participants were asked to rate their confidence regarding spatial abilities using a five-point Likert scale. The scale in which participants self-reported their level of confidence consisted of the following choices: “Not Confident,” “Somewhat Confident,” “Confident,” “Very Confident,” and “Extremely Confident.” The specific confidence areas included: (1) creating lessons for developing spatial skills, (2) implementing curriculum and instruction concerning spatial skills, and (3) assessing children’s spatial skills.

In order to determine a participant’s overall confidence score, each question was assigned a score ranging from 0 *(not confident)* to 4 *(extremely confident).* The scores were then summed, for a total of up to 12 points. In addition to a sum score, each of the three areas regarding confidence were examined separately based on participants’ self-reported level of confidence for each question ranging from 0 *(not confident)* to 4 *(extremely confident).* To ensure inter-rater reliability, all data was scored by two raters (Laudico, Spaulding, & Voegtle, 2006), the principal investigator and a graduate assistant. When differences between the two raters were observed, the principal investigator and graduate assistant discussed the rating and reached a consensus.

**Research question one.** To address the first research question: *Is in-service early childhood educators’ educational background related to their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?* The researcher grouped participants according to the independent variable, which is the highest degree of education obtained. The independent variable was composed of three categories, (a) participants who have obtained a High School Diploma/GED, (b) Associate’s

Degree/Child Development Associate Degree, some college, or (c) Bachelor 's Degree or higher, which is one of the requirements of public prekindergarten teachers in the state of Texas (Texas Education Agency, 2011).

**Research questions two.** To analyze the second research question: *Is in-service early childhood educators' prior teaching experience related to their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?* Participants were placed in subgroups based on the independent variable, which is years of teaching experience. The first subgroup is based on a review of the literature that found as much as 50% of beginning teacher leave the profession in the first five years (Ingersoll, 2003). Participants were grouped by either (a) 0-5 years of teaching experience, (b) 6-10 years of teaching experience, or (c) more than 10 years of teaching experience.

**Research questions three.** To analyze the last research question: *Is in-service early childhood educators' level of knowledge, skills, and confidence regarding spatial skills development related to the setting of the early childhood center in which they teach?* Participants were grouped according to their self-reported setting in which they taught, public or private.

## Quantitative Analysis

To determine if a statistical significance exists, a series of statistical analyses were employed to analyze and interpret these data. For the purposes of this study, these data were entered into two statistical software programs, *IBM SPSS* (19.0) and StatXact (9.0), for analysis. Descriptive and inferential statistics including means and standard deviations were analyzed through *IBM SPSS* (19.0). Chi-square tests, including exact tests, and analyses of variance (ANOVAs) were analyzed using StatXact (9.0). Descriptive statistics were first used to analyze each of the individual explanatory variables. Frequencies and percentages of participants in the sample were determined for each of these variables.

Chi-square tests were used to address participants' knowledge and skills regarding spatial abilities. This test is based on a comparison between expected frequencies and actual, obtained frequencies. A chi-square ($X^2$) statistic is used to investigate whether distributions of categorical variables differ from one another (Field, 2009). Data measured were analyzed using a Fisher exact test, since the assumptions criteria for the Pearson chi-square test were not met, due to having < 5 counts in at least one cell for each analysis (Gall, Gall, & Borg, 2007).

In research question one, the independent variable, early childhood educators' educational background was used to determine if a statistically significant relationship exists between participants who have obtained a (a) High School Diploma/GED, (b) Associate's Degree/Child Development Associate Degree, and (c) Bachelor 's Degree or higher, in relation to their knowledge, skills, and confidence regarding spatial abilities.

For research question two, the independent variable early childhood educators' prior teaching experience was used to determine if participants teaching experience (a) 0-5 years of teaching experience, (b) 6-10 years of teaching experience, and (c) more than 10 years of teaching experience, was related to their knowledge, skills, and confidence regarding spatial skills.

The independent variable early childhood setting, public and non-public, was used to determine if the setting was related to early childhood educators' knowledge, skills, and confidence regarding spatial skills. In regards to the dependent variables, early childhood educators' knowledge and skills, a Fisher exact test was performed due to the fact that the expected frequencies of each category were not greater than 5. The Fisher exact test is a method for computing the exact probability of the chi-square statistic that is accurate when sample sizes are small (Field, 2009).

To address the third dependent variable, confidence regarding spatial abilities, multiple analyses were used. To analyze the sum confidence in each research question the data arranged itself as a one-way ANOVA. A one-way ANOVA is recommended for use when comparing the means of two or more groups who are drawn from the same population (Field, 2009). For research questions one and two, which contain three or more groups, a Kruskal-Wallis one-way ANOVA test, which is a non-parametric method for testing whether samples originate from the same distribution (Field, 2009), was performed. For the Kruskal-Wallis one-way ANOVA, a Fisher exact test was unable to be calculated, which led to the use of a Monte Carlo exact test. In the case of a Monte Carlo exact test, the confidence intervals were reported. The sum confidence in research question three was analyzed using a Wilcoxon-Mann-Whitney *U* test, since this independent variable contained two groups, public and non-public.

To further analyze the confidence regarding spatial abilities, each component of confidence was analyzed: (1) creating lessons for developing spatial skills, (2) implementing curriculum and instruction concerning spatial skills, and (3) assessing children's spatial skills. For each component a chi-square analysis was run using a Fisher exact test due to the fact that the expected frequencies of each category were not greater than 5.

**Summary**

This chapter reviewed how the *Spatial Abilities Survey for In-Service Teachers* survey was used to investigate in-service early childhood educators' educational background, and years of teaching experience, with regard to their knowledge, skills, and confidence concerning spatial skills development in their classrooms. This chapter also addressed how the survey was used to investigate the setting, public or private, in which in-service early childhood teachers teach concerning their knowledge, skills, and confidence about spatial skills development. Details regarding the research design, method, participants, sampling procedures, participants, validity, and reliability of the instrument were also discussed, followed by a review of the data analysis plan used in the study.

# CHAPTER IV

# RESULTS

The purpose of this research study was to determine if background, setting, and teaching experience of in-service early childhood educators' affect their knowledge, skills, and confidence concerning spatial skills development in their classrooms. This study utilized archival data collected in spring 2011. This chapter presents the results of 88 early childhood educators who completed the *Spatial Abilities Survey for In-Service Teachers* survey during the spring of 2011.

This chapter begins with the frequencies of knowledge, skills, and confidence levels of early childhood educators. Following the frequencies, results of the chi-square analyses using Fisher exact tests, and ANOVA tests that were used to determine if a relationship exists between in-service early childhood teachers' educational background, years of teaching experience, and the setting in which they taught and their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms are presented. Due to the different types of survey items in questions seventeen, eighteen, and twenty-one, different forms of data were created and these are presented separately as they required different types of analyses.

## Knowledge of Spatial Abilities

To specifically determine the dependent variable, early childhood educators' knowledge of spatial skills and abilities, question seventeen from the *Spatial Abilities Survey for In-Service Teachers* survey was analyzed. Question seventeen asks participants: "To the best of your knowledge, how do you define spatial skills/abilities?" Each response was scored using a four-point rubric outlined in Appendix B. Table 6 displays the frequencies of each response. In order to receive the full three points, participants must have defined spatial skills and/or abilities as involving the manipulation, visualization, or orientation of spatial images or objects. Two points were assigned to participants who were able to define spatial skills and/or abilities as being associated with a specific area of mathematics. One point was assigned to participants who were able to state that spatial skills and/or abilities are associated with mathematics. Zero points were assigned if participants were unable to define or state anything related to spatial skills or spatial abilities.

Table 6

*Frequencies of Responses of a Definition for Spatial Abilities*

| Definition | Frequency | Percent |
|---|---|---|
| Unable to define or state anything related to spatial skills or spatial abilities. | 58 | 65.9 |
| Defines spatial skills and abilities as being associated with mathematics. | 13 | 14.8 |
| Defines spatial skills and abilities as being associated with a specific area of mathematics. | 4 | 4.5 |
| Defines spatial skills and abilities as the manipulation, visualization, or orientation of spatial images or objects. | 13 | 14.8 |
| Total | 88 | 100 |

The frequency of responses to how spatial abilities are defined indicated that 65.9% of early childhood educators were unable to define or state anything related to spatial skills or spatial abilities. The percentage of participants who defined spatial abilities as being associated with mathematics or a specific area of mathematics was 19.3%. Furthermore, 14.8% of participants were able to define spatial skills and abilities as the manipulation, visualization, or orientation of spatial images or objects.

**Skills in Teaching Spatial Abilities**

The second dependent variable, early childhood educators' skills in teaching spatial skills and abilities utilized question number eighteen from the survey. Participants were asked: "How do you teach spatial skills? Specifically, what objectives, activities, and materials are involved?" Based on the written responses, participants were assigned a score of 0-3 using a four-point rubric outlined in Appendix C. Table 7 displays the frequencies of each response.

Table 7

*Frequencies of Responses of Skills Teaching Spatial Abilities*

| | Frequency | Percent |
|---|---|---|
| Unable to state an objective, activity, or material involved in teaching spatial abilities. | 59 | 67 |
| States one objective, activity, or material involved in teaching spatial abilities. | 13 | 14.8 |
| States any combination of two objectives, activities, or materials involved in teaching spatial abilities. | 8 | 9.1 |
| States any combination of three objectives, activities, or materials involved in teaching spatial abilities. | 8 | 9.1 |
| Total | 88 | 100 |

The responses to how spatial abilities are taught indicate that the majority of early childhood educators were unable to state one object, activity, or material involved in teaching spatial skills. The percentage of participants who were able to state one or two objects, activities, or materials involved in teaching spatial abilities was 23.9%. Additionally, 9.1% of early childhood educators surveyed were able to state any combination of three objects, activities, or materials involved in teaching spatial abilities.

**Confidence in Spatial Abilities**

The third dependent variable, the confidence level of participants regarding spatial abilities utilized survey question number twenty-one, in which participants were asked to rate their confidence regarding spatial abilities using a five-point Likert scale. The third dependent variable, the confidence level of participants regarding spatial abilities utilized survey question twenty-one, in which participants were asked to rate their confidence regarding spatial abilities in each of the following areas: (1) creating lessons for developing spatial skills, (2) implementing curriculum and instruction concerning spatial skills, and (3) assessing children's spatial skills. Participants self-reported their confidence in the three areas using a Likert scale with the following choices: "Not Confident," "Somewhat Confident," "Confident," "Very Confident," and "Extremely Confident." In addition to calculating a sum score to determine overall confidence, each confidence area received individual analysis, which is addressed in the results of each research question. Table 8 displays the frequencies of the spatial abilities sum score confidence levels.

Table 8

*Frequencies of the Spatial Abilities Sum Score Confidence Levels*

| Confidence Score | Frequency | Percent |
|---|---|---|
| 0 | 12 | 13.6 |
| 1 | 3 | 3.4 |
| 2 | 3 | 3.4 |
| 3 | 12 | 13.6 |
| 4 | 3 | 3.4 |
| 5 | 4 | 4.5 |
| 6 | 18 | 20.5 |
| 7 | 4 | 4.5 |
| 8 | 3 | 3.4 |
| 9 | 15 | 17 |
| 10 | 1 | 1.1 |
| 11 | 2 | 2.3 |
| 12 | 8 | 9.1 |
| Total | 88 | 100 |

The confidence level sum score appeared to vary greatly from a sum score of 0-12, with the most common sum score of six being reported 20.5% of the time. The next most common confidence score was nine (17%), and the third most common score was a tie between zero and three (13.6%). Furthermore, 62.8% of participants were below the median confidence score of 6, which led the researcher to further examine how the areas of (1) creating lessons for developing spatial skills, (2) implementing curriculum and instruction concerning spatial skills, and (3) assessing children's spatial skills, differ in regards to confidence levels across participants.

**Research Question One**

Research Question One: *Is in-service early childhood educators' educational background related to their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?*

A series of Fisher exact tests were performed to investigate the relationship between in-service early childhood educators' educational background and their level of knowledge and skills regarding spatial abilities. Data measured were analyzed using a Fisher exact test, since the assumptions criteria for the Pearson chi-square test were not met, due to having < 5 counts in at least one cell for each analysis (Gall, Gall, & Borg, 2007). A Kruskal-Wallis one-way ANOVA, with a Monte Carlo exact test, was used to investigate the relationship between highest level of education and overall confidence regarding spatial abilities, followed by an individual analysis of each confidence component using a chi-square analysis with a Fisher exact test.

**Highest level of education and knowledge of spatial abilities.** Table 9 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' educational background and their level of knowledge regarding spatial abilities, as scored using the rubric in Appendix B.

Table 9

*Crosstabulations for Education Background and Level of Knowledge regarding Spatial Abilities*

| | Definition of Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| High School Diploma/GED | 20 (95.2%) | 1 (4.8%) | 0 | 0 |
| Some College/AA/CDA | 28 (80%) | 4 (11.4%) | 1 (2.9%) | 2 (5.7%) |
| Bachelor's Degree or higher | 10 (31.2%) | 8 (25%) | 3 (9.4%) | 11 (34.4%) |
| Total | 58 (65.9%) | 13 (14.8%) | 4 (4.5%) | 13 (14.8%) |

The results of the crosstabulations in Table 9 indicate that 65.9% of participants were unable to define spatial abilities. Additionally, 95.2% of participants whose highest level of education obtained was a high school diploma/GED, and 80% of those with some college/Associate's degree were unable to define or state anything related to spatial skills or abilities. In comparison, 31.2% of participants with a Bachelor's degree or higher were unable to define or state anything related to spatial skills or abilities. Furthermore, 85% of the thirteen participants who earned full credit for their definition of spatial abilities had an earned Bachelor's degree or higher. To determine if a statistically significant relationship exists between in-service early childhood educators' educational background and their level of knowledge regarding spatial abilities, a Fisher exact test was run. The results appear in Table 10.

Table 10

*Results of the Pearson Chi-square Test for Education Background and Level of Knowledge Regarding Teaching Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 29.77 | .000* |

* p < .001

The results of the Fisher exact test used to investigate the variables highest level of education obtained and knowledge of spatial abilities was statistically significant at the $p < .001$ level indicating that a significant relationship exists between the spatial abilities knowledge of in-service early childhood educators and their highest level of education obtained. A follow up comparison of educational background using additional chi-square analysis with a Fisher exact test revealed that a statistically significant relationship exists between participants who hold a high school diploma and those who hold a Bachelor's degree, $X^2$ (1) = 21.42, p = .000. Additionally, the statistically significant relationship exists between participants with some college/Associate's degree and a Bachelor's degree, $X^2$ (1) = 16.99, p = .000.

**Highest level of education and skills teaching spatial abilities.** Table 11 presents the results of the Chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' educational background and their skills associated with teaching spatial abilities, as scored using the rubric in Appendix C.

Table 11

*Crosstabulations for Education Background and Teaching Spatial Skills*

| | Skills Teaching Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| High School Diploma/GED | 20 (95.2%) | 1 (4.8%) | 0 | 0 |
| Some College/AA/CDA | 28 (80%) | 5 (14.3%) | 2 (5.7%) | 0 |
| Bachelor's Degree or higher | 11 (34.4%) | 7 (21.9%) | 6 (18.7%) | 8 (25%) |
| Total | 59 (67%) | 13 (14.8%) | 8 (9.1%) | 8 (9.1%) |

The results of the crosstabulations in Table 11 indicate that 67% of participants were unable to state an objective, activity, or material involved in teaching spatial abilities. Additionally, 95% of participants whose highest level of education obtained was a high school diploma/GED, and 80% of those with some college/Associate's degree were unable to state an objective, activity, or material involved in teaching spatial abilities. All eight (100%) of the participants who earned the maximum score for their response to the skills associated with teaching spatial abilities had an earned Bachelor's degree or higher. To determine if a statistically significant relationship exists between in-service early childhood educators' educational background and their level of knowledge regarding spatial abilities, a Fisher exact test was performed.

Table 12 presents the results of the Fisher exact test used to investigate in-service early childhood educators' highest level of education obtained and their skills associated with teaching spatial abilities.

Table 12

*Results of the Pearson chi-square test for Education Background and Skills Teaching Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 30.62 | .000* |

* $p < .001$

The results of the Fisher exact test used to investigate the variables highest level of education obtained and skills teaching spatial skills was statistically significant at the $p < .001$ level indicating that a significant relationship exists between the skills of in-service early childhood educators used for teaching spatial abilities and their highest level of education obtained. A follow up comparison of educational background using additional chi-square analysis with a fisher exact test revealed that a statistically significant relationship exists between participants who hold a high school diploma and those who hold a Bachelor's degree, $X^2$ (1)= 19.68, p = .000. Additionally, the statistically significant relationship exists between participants with some college/Associate's degree and a Bachelor's degree, $X^2$ (1)= 17.64, p = .000.

**Highest level of education and confidence regarding spatial abilities.** The Kruskal-Wallis *H* test was used for analysis of participants sum confidence score. The Kruskal-Wallis H test was used because the independent variable has three different categories: (1) High School Diploma/GED, (2) Associate's Degree/Child Development Associate Degree, and (3) Bachelor 's Degree or higher. The Kruskal-Wall *H* test tested to see if the results differed significantly between the three groups possible in the independent variable (Gall, Gall, & Borg, 2007). Table 13 presents the results of the

Kruskal-Wallis test used to investigate the relationship between in-service early childhood educators' highest level of education obtained and their confidence associated with spatial abilities.

Table 13

*Results of the Kruskal-Wallis One-way ANOVA test for Educational Background and Confidence Regarding Spatial Skills (p-value via Monte Carlo)*

| | | | | Monte Carlo p-value (2-tailed) | | |
|---|---|---|---|---|---|---|
| | | | | | 99% Confidence Interval | |
| | KW Test Statistic Value | df | Asymp. p-value (2-tailed) | p-value | Lower Bound | Upper Bound |
| Kruskal-Wallis One-way ANOVA | .491 | 2 | .782 | .779 | .768 | .790 |

The results revealed that there was not a statistically significant relationship at the $p < .05$ between in-service early childhood educators' educational background and their sum confidence level regarding spatial abilities.

***Creating lessons for developing spatial abilities.*** Table 14 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' educational background and their level of confidence creating lessons for developing children's spatial abilities.

Table 14

*Crosstabulations Educational Background and Confidence Level Creating Lessons for Developing Spatial Abilities*

| | Creating Lessons for Developing Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| High School Diploma/GED | 5 (23.8%) | 3 (14.3%) | 6 (28.6%) | 6 (28.6%) | 1 (4.7%) |
| Some College/AA/CDA | 8 (22.9%) | 6 (17.1%) | 12 (34.3%) | 5 (14.3%) | 4 (11.4%) |
| Bachelor's Degree or Higher | 4 (12.5%) | 10 (31.3%) | 6 (18.7%) | 8 (25%) | 4 (12.5%) |
| Total | 17 (19.3%) | 19 (21.6%) | 24 (27.3%) | 19 (21.6%) | 9 (10.2%) |

The results of the crosstabulations in Table 14 indicate that 59.1% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 40.9% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in creating lessons for developing spatial abilities were those with some a Bachelor's degree or higher (12.5%). The highest percentage of participants who were *not confident* in creating lessons for developing spatial abilities were those with a high school diploma/GED (23.8%).

Table 15 presents the results of the Fisher exact test used to investigate in-service early childhood educators' highest level of education obtained and their level of confidence creating lessons for developing spatial abilities.

Table 15

*Results of the Pearson Chi-square Test for Educational Background and Confidence Creating Lessons for Developing Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 7.27 | .524 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' educational background and their level of confidence creating lessons for developing spatial abilities.

***Implementing curriculum and instruction concerning spatial abilities.*** Table 16 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' educational background and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 16

*Crosstabulations Educational Background and Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities*

| | Implementing Curriculum and Instruction Concerning Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| High School Diploma/GED | 5 (23.8%) | 3 (14.3%) | 5 (23.8%) | 5 (23.8%) | 3 (14.3) |
| Some College/AA/CDA | 4 (11.4%) | 9 (25.7%) | 11 (31.5%) | 4 (11.4%) | 7 (20%) |
| Bachelor's Degree or Higher | 4 (12.5%) | 8 (25%) | 7 (21.9%) | 7 (21.9%) | 6 (18.7%) |
| Total | 13 (14.8%) | 20 (22.7%) | 23 (26.1%) | 16 (18.2%) | 16 (18.2%) |

The results of the crosstabulations in Table 16 indicate that 62.5% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 37.5% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in implementing curriculum and instruction concerning spatial abilities were those with some college/AA/CDA (20%). The highest percentage of participants who were *not confident* in implementing curriculum and instruction concerning spatial abilities were those with a high school diploma/GED (23.8%).

Table 17 presents the results of the Fisher exact test used to investigate in-service early childhood educators' highest level of education obtained and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 17

*Results of the Pearson Chi-square Test for Educational Background and Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 4.776 | .796 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' educational background and their level of confidence implementing curriculum and instruction concerning spatial abilities.

***Assessing children's spatial abilities.*** Table 18 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' educational background and their level of confidence-assessing children's spatial abilities.

Table 18

*Crosstabulations for Educational Background and Confidence Assessing Children's Spatial Abilities*

| | Assessing Children's Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| High School Diploma/GED | 6 (28.6%) | 2 (9.5%) | 6 (28.6%) | 5 (23.8%) | 2 (9.5%) |
| Some College/AA/CDA | 8 (22.9%) | 8 (22.9%) | 11 (31.4%) | 4 (11.4) | 4 (11.4) |
| Bachelor's Degree or Higher | 4 (12.5%) | 8 (25.0%) | 8 (25.0%) | 7 (21.9%) | 5 (15.6%) |
| Total | 18 (20.5%) | 18 (20.5%) | 25 (28.4%) | 16 (18.1%) | 11 (12.5%) |

The results of the crosstabulations in Table 18 indicate that 59% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 41% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in assessing children's spatial abilities were those with some a Bachelor's degree or higher (15.6%). The highest percentage of participants who were *not confident* in assessing children's spatial abilities were those with a high school diploma/GED (28.6%).

Table 19 presents the results of the Fisher exact test used to investigate in-service early childhood educators' highest level of education obtained and their level of confidence assessing children's spatial abilities.

Table 19

*Results of the Pearson Chi-square Test for Educational Background and Confidence Assessing Children's Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 5.57 | .712 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' educational background and level of confidence in assessing children's spatial abilities.

**Summary.** The results from the Fisher exact test indicate a statistically significant relationship exists between the level of knowledge, and skills teaching spatial abilities of in-service early childhood educators' and their highest level of education obtained. In regards to the level of confidence concerning spatial abilities, the results of the Kruskal-Wallis one-way ANOVA using the Monte Carlo exact test and chi-square analysis of individual components of confidence did not reveal that a statistically significant relationship exists with respect to in-service early childhood educators' highest level of education obtained. The next variable to be analyzed in regards to the knowledge, skills, and confidence levels of in-service early childhood educators was their prior years of teaching experience.

**Research Question Two**

Research Question Two: *Is in-service early childhood educators' prior teaching experience related to the level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?*

A series of Fisher exact tests were tested to investigate the relationship between in-service early childhood educators' prior years of teaching experience and their level of knowledge and skills regarding spatial abilities. Similar to research question one, data measured were analyzed using a Fisher exact test, since the assumptions criteria for the Pearson chi-square test were not met, due to having < 5 counts in at least one cell for each analysis (Gall, Gall, & Borg, 2007). A Kruskal-Wallis one-way ANOVA with a Monte Carlo exact test was performed to investigate the relationship between prior years of teaching experience and sum confidence level regarding spatial abilities, in addition to a chi-square analysis of each confidence level component.

**Teaching experience and knowledge of spatial abilities.** Table 20 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' prior years of teaching experience and their level of knowledge regarding spatial abilities, as scored using the rubric in Appendix B.

Table 20

*Crosstabulations for Prior Years of Teaching Experience and Level of Knowledge regarding Spatial Abilities*

| | Definition of Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 0-5 Years Teaching Experience | 21 (55.3%) | 10 (26.3) | 1 (2.6) | 6 (15.8%) |
| 6-10 Years Teaching Experience | 11 (47.8) | 4 (17.4%) | 2 (8.7%) | 6 (26.1%) |
| >10 Years Teaching Experience | 18 (66.7%) | 7 (25.9%) | 1 (3.7%) | 1 (3.7%) |
| Total | 50 (56.8%) | 21 (23.9%) | 4 (4.6%) | 13 (14.8%) |

The results of the crosstabulations in Table 20 indicate that 56.8% of participants were unable to define spatial abilities. The largest percentage of participants who were unable to define spatial abilities came from the category more than 10 years of teaching experience (66.7%), followed by 0-5 years of teaching experience (55.3%), and 6-10 years of teaching experience (47.8%). Additionally, 15.8% of participants from the 0-5 years of teaching experience category, 26.1% of participants from the 6-10 years of teaching experience category, and 3.7% of participants with more than10 years of teaching experience category earned the maximum score, by defining spatial skills and abilities as the manipulation, visualization, or orientation of spatial images or objects.

Table 21 presents the results of the Fisher exact test performed to investigate in-service early childhood educators' prior years of teaching experience and their knowledge of spatial abilities.

Table 21

*Results of the Pearson Chi-square Test for Prior Years of Teaching Experience and Level of Knowledge Regarding Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 6.831 | .347 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' skills used for teaching spatial abilities and their highest level of education obtained.

**Teaching experience and skills teaching spatial abilities.** Table 22 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' prior years of teaching experience and their skills associated with teaching spatial abilities, as scored using the rubric in Appendix C.

Table 22

*Crosstabulations for Prior Years Teaching Experience and Skills Teaching Spatial Abilities*

| | Skills Teaching Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| 0-5 Years Teaching Experience | 29 (76.3%) | 3 (7.9%) | 3 (7.9%) | 3 (7.9%) |
| 6-10 Years Teaching Experience | 12 (52.2%) | 4 (17.4%) | 4 (17.4%) | 3 (13%) |
| >10 Years Teaching Experience | 18 (66.7%) | 6 (22.2%) | 1 (3.7%) | 2 (7.4%) |
| Total | 59 (67%) | 13 (14.8%) | 8 (9.1%) | 8 (9.1%) |

The results of the crosstabulations in Table 22 indicate that 67% of participants were unable to state an objective, activity, or material involved in teaching spatial abilities. Of the participants with 0-5 years of teaching experience, 76.3% were unable to state an objective, activity, or material involved in teaching spatial abilities, followed by 66.7% of participants with more than 10 years of teaching experience, and 52.2% of participants with 6-10 years of teaching experience. Furthermore, 13% of participants with 6-10 years of teaching experience earned the maximum score of three points by stating any combination of three objectives, activities, or materials involved in teaching spatial abilities, followed by 7.9% of participants with 0-5 years of teaching experience, and 7.4% of participants with more than 10 years of teaching experience.

Table 23 presents the results of the Fisher exact test performed to investigate in-service early childhood educators' years of prior teaching experience and their skills associated with spatial abilities.

Table 23

*Results of the Pearson Chi-square Test for Prior Years of Teaching Experience and Skills Teaching Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 6.788 | .353 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between the skills of in-service early childhood educators used for teaching spatial abilities and their prior years of teaching experience.

**Teaching experience and confidence regarding spatial abilities.** The Kruskal-Wallis *H* test was used for analysis of the sum confidence level. The Kruskal-Wallis *H* test was used because the independent variable has three possible categories: (1) 0-5 years of teaching experience, (2) 6-10 years of teaching experience, and (3) greater than 10 years of teaching experience. The Kruskal-Wallis one-way ANOVA was performed to see if the results differed significantly between the three groups, as they relate to the participants overall confidence associated with spatial abilities. Table 24 presents the results of the ANOVA.

Table 24

*Results of the Kruskal-Wallis One-way ANOVA test for Prior Years Teaching Experience and Confidence Regarding Spatial Skills (p-value via Monte Carlo)*

| | | | | Monte Carlo p-value (2-tailed) | | |
|---|---|---|---|---|---|---|
| | | | | | 99% Confidence Interval | |
| | KW Test Statistic Value | df | Asymp. p-value (2-tailed) | p-value | Lower Bound | Upper Bound |
| Kruskal-Wallis One-way ANOVA | .032 | 2 | .984 | .985 | .982 | .988 |

The results of the Kruskal-Wallis one-way ANOVA, using a Monte Carlo exact did not indicate a statistically significant relationship between prior years of teaching experience and overall confidence regarding spatial abilities.

***Creating lessons for developing spatial abilities.*** Table 25 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' prior years of teaching experience and their level of confidence in creating lessons for developing children's spatial abilities.

Table 25

*Crosstabulations for Prior Years Teaching Experience and Confidence Level in Creating Lessons for Developing Spatial Abilities*

| | Creating Lessons for Developing Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0-5 Years Teaching Experience | 8 (21%) | 7 (18.4%) | 12 (31.5%) | 9 (23.7%) | 2 (5.3%) |
| 6-10 Years Teaching Experience | 3 (13%) | 6 (26.1%) | 8 (34.8%) | 2 (8.7%) | 4 (17.4%) |
| >10 Years Teaching Experience | 6 (22.2%) | 6 (22.2%) | 4 (14.8%) | 8 (29.6%) | 3 (11.1%) |
| Total | 17 (19.3%) | 19 (21.6%) | 24 (27.3%) | 19 (21.6%) | 9 (10.2%) |

The results of the crosstabulations in Table 25 indicate that 59.1% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 40.9% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in creating lessons for developing spatial abilities were those with 6-10 years teaching experience (17.4%). The highest percentage of participants who were *not confident* in creating lessons for developing spatial abilities were those with more than 10 years of teaching experience (22.2%).

Table 26 presents the results of the Fisher exact test performed to investigate in-service early childhood educators' prior years of teaching experience and confidence in creating lessons for developing spatial abilities.

Table 26

*Results of the Pearson Chi-square Test for Prior Years of Teaching Experience and Confidence in Creating Lesson for Developing Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 8.061 | .442 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' prior years of teaching experience and their level of confidence creating lessons for developing spatial abilities.

***Implementing curriculum and instruction concerning spatial abilities.*** Table 27 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' prior years of teaching experience and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 27

*Crosstabulations for Prior Years Teaching Experience and Confidence Level Implementing Curriculum and Instruction Concerning Spatial Abilities*

| | Implementing Curriculum and Instruction Concerning Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0-5 Years Teaching Experience | 6 (15.8%) | 7 (18.4%) | 11 (29%) | 7 (18.4%) | 7 (18.4%) |
| 6-10 Years Teaching Experience | 2 (8.7%) | 6 (26.1%) | 8 (34.8%) | 3 (13%) | 4 (17.4%) |
| >10 Years Teaching Experience | 5 (18.5%) | 7 (26%) | 4 (14.8%) | 6 (22.2%) | 5 (18.5%) |
| Total | 13 (14.8%) | 20 (22.7%) | 23 (26.1%) | 16 (18.2%) | 16 (18.2%) |

The results of the crosstabulations in Table 27 indicate that 62.5% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 37.5% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in implementing curriculum and instruction concerning spatial abilities were those with more than 10 years of teaching experience (20%). The highest percentage of participants who were *not confident* in implementing curriculum and instruction concerning spatial abilities were also those with more than 10 years of teaching experience (23.8%).

Table 28 presents the results of the Fisher exact test performed to investigate in-service early childhood educators' prior years of teaching experience and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 28

*Results of the Pearson Chi-square Test for Prior Years of Teaching Experience and Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 4.089 | .862 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' prior years of teaching experience and their level of confidence implementing curriculum and instruction concerning spatial abilities.

***Assessing children's spatial abilities.*** Table 29 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to in-service early childhood educators' prior years of teaching experience and their level of confidence in assessing children's spatial abilities.

Table 29

*Crosstabulations for Prior Years Teaching Experience and Confidence Level in Assessing Children's Spatial Abilities*

| | Assessing Children's Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0-5 Years Teaching Experience | 8 (21%) | 7 (18.4%) | 12 (31.6%) | 7 (18.4%) | 4 (10.5%) |
| 6-10 Years Teaching Experience | 3 (13%) | 6 (26.1%) | 8 (34.8%) | 3 (13%) | 3 (13%) |
| >10 Years Teaching Experience | 7 (26%) | 5 (18.5%) | 5 (18.5%) | 6 (22.2%) | 4 (14.8%) |
| Total | 18 (20.5%) | 18 (20.5%) | 25 (28.3%) | 16 (18.2%) | 11 (12.5%) |

The results of the crosstabulations in Table 29 indicate that 59% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 41% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in assessing children's spatial abilities were those with more than 10 years of teaching experience (14.8%). The highest percentage of participants who were *not confident* in assessing children's spatial abilities were also those with more than 10 years of teaching experience (26%).

Table 30 presents the results of the Fisher exact test performed to investigate in-service early childhood educators' prior years of teaching experience and their level of confidence in assessing children's spatial abilities.

Table 30

*Results of the Pearson Chi-square Test for Prior Years of Teaching Experience and Confidence Assessing Children's Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 3.713 | .893 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between in-service early childhood educators' prior years of teaching experience and their level of confidence in assessing children's spatial abilities.

**Summary.** The results from the Fisher exact test indicated that there was not a statistically significant relationship between the level of knowledge regarding spatial abilities, or skills associated with teaching spatial abilities, and in-service early childhood educators' prior years of teaching experience. In regard to the level of confidence concerning spatial abilities, the results of the Kruskal-Wallis one-way ANOVA with a Monte Carlo exact test and chi-square analysis of individual components of confidence did not reveal a statistically significant difference with respect to in-service early childhood educators' prior years of teaching experience. The last variable to be analyzed in regards to the knowledge, skills, and confidence levels of in-service early childhood educators is the setting in which they teach.

**Research Question Three**

Research Question Three asked: *Is in-service early childhood educators' level of knowledge, skills, and confidence regarding spatial skills development related to the setting of the early childhood center in which they teach?*

A series of Fisher exact tests were performed to investigate the relationship between in-service early childhood educators' prior years of teaching experience and their level of knowledge and skills regarding spatial abilities. Similar to research question one and two, data measured were analyzed using a Fisher exact test, since the assumptions criteria for the Pearson chi-square test were not met, due to having < 5 counts in at least one cell for each analysis (Gall, Gall, & Borg, 2007). A Wilcoxon-Mann-Whitney *U* test was used to analyze the early childhood setting in which in-service early childhood educators' taught and their overall level of confidence regarding spatial abilities, followed by a chi-square analyses with Fisher exact tests to analyze the specific components of confidence.

**Setting and knowledge of spatial abilities.** Table 31 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to the setting in which in-service early childhood educators' taught and their level of knowledge regarding spatial abilities, as scored using the rubric in Appendix B.

Table 31

*Crosstabulations for Early Childhood Setting and Level of Knowledge regarding Spatial Abilities*

| | Definition of Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| Non-public | 43 (84.3%) | 6 (11.8%) | 0 | 2 (3.9%) |
| Public | 15 (40.5%) | 7 (19%) | 4 (10.8%) | 11 (29.7) |
| Total | 58 (65.9%) | 13 (14.8%) | 4 (4.5%) | 13 (14.8%) |

The results of the crosstabulations indicate that 65.9% of participants were unable to define spatial abilities. Of the 51 participants teaching in a non-public early childhood setting 84.3% were unable to define spatial abilities, compared to 40.5% of participants working in a public early childhood center. On the contrary, 3.9% of participants working in non-public early childhood centers were able to define spatial skills and abilities as the manipulation, visualization, or orientation of spatial images or objects, compared to 29.7% of participants teaching in a public early childhood education center. To determine if a statistically significant relationship exists between the setting in which in-service early childhood educators' taught and their level of knowledge regarding spatial abilities, a Fisher exact test was performed.

Table 32 presents the results of the Fisher exact test used to investigate the setting in which in-service early childhood educators' taught and their knowledge of spatial abilities.

Table 32

*Results of the Pearson Chi-square Test for Early Childhood Setting and Skills Teaching Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 22.16 | .000* |

*p < .001

The results of the Fisher exact test used to investigate the variables early childhood setting and knowledge of spatial abilities was statistically significant at the $p < .001$ level indicating that a significant relationship exists between the spatial abilities knowledge of in-service early childhood educators and the early childhood setting in which they taught.

**Setting and skills teaching spatial abilities.** Table 33 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to the setting in which in-service early childhood educators' taught and their skills associated with teaching spatial abilities, as scored using the rubric in Appendix C.

Table 33

*Crosstabulations for Early Childhood Setting and Skills Teaching Spatial Abilities*

| | Skills Teaching Spatial Abilities Score | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 3 |
| Non-public | 42 (82.3%) | 7 (13.7%) | 1 (2%) | 1 (2%) |
| Public | 17 (46%) | 6 (16.2%) | 7 (18.9%) | 7 (18.9%) |
| Total | 59 (67%) | 13 (14.8%) | 8 (9.1%) | 8 (9.1%) |

The results of the crosstabulations in Table 33 indicate that 67% of participants were unable to state an objective, activity, or material involved in teaching spatial abilities. Specifically, 82.3% of early childhood educators teaching in a non-public setting were unable to identify an objective, activity, or material involved in teaching spatial abilities, compared to 46% of educators working in a public early childhood center. Conversely, 2% early childhood educators teaching in a non-public setting were able to state any combination of three objectives, activities, or materials involved in teaching spatial abilities, compared to 18.9% of educators working in a public early childhood center. To determine if a statistically significant relationship exists between the setting in which early childhood educators' taught and their skills associated with teaching spatial abilities, a Fisher exact test was performed.

Table 34 presents the results of the Fisher exact test used to investigate the setting in which in-service early childhood educators' teach and their skills associated with spatial abilities.

Table 34

*Results of the Pearson Chi-square Test for Early Childhood Setting and Skills Teaching Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 17.9 | .000* |

*p < .001

The results of the Fisher exact test used to investigate the variables early childhood setting and skills teaching spatial abilities were statistically significant at the $p < .001$ level, indicating that a significant relationship exists between the setting in which in-service early childhood educators' teach and their skills in teaching spatial abilities.

**Setting and confidence regarding spatial abilities.** The Wilcoxon-Mann-Whitney *U* test was used to analyze the early childhood setting and overall level of confidence regarding spatial abilities. A non-parametric test was used in this study because two groups were being compared on an ordinal scale with four possible values. The two groups being compared include public and non-public early childhood settings. The Wilcoxon-Mann-Whitney *U* test is used to see if the results differed significantly between the two groups possible in the independent variable (Gall, Gall, & Borg, 2007). The results of this non-parametric test appear in Table 35.

Table 35

*Results of the Wilcoxon-Mann-Whitney Independent Samples Test for Early Childhood Setting and Confidence Regarding Spatial Skills (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Wilcoxon-Mann-Independent Samples Test | 1158 | .068 |

The results of the Wilcoxon-Mann-Whitney *U* test in Table 35 revealed that there was not a statistically significant relationship between the setting in which early childhood educators' taught and their overall level of confidence regarding spatial abilities.

***Creating lessons for developing spatial abilities.*** Table 36 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to the setting in which in-service early childhood educators' taught and their level of confidence in creating lessons for developing spatial abilities.

Table 36

*Crosstabulations for Setting and Confidence in Creating Lessons for Developing Spatial Abilities*

| | Creating Lessons for Developing Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| Non-public | 14 (27.5%) | 9 (17.6%) | 13 (25.5%) | 11 (21.6%) | 4 (7.8%) |
| Public | 3 (8.1%) | 10 (27%) | 11 (29.7%) | 8 (21.6%) | 5 (13.6%) |
| Total | 17 (19.3%) | 19 (21.6%) | 24 (27.3%) | 19 (21.6%) | 9 (10.2%) |

The results of the crosstabulations in Table 36 indicate that 59.1% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 40.9% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in creating lessons for developing spatial abilities were those teaching in public settings (13.6%). The highest percentage of participants who were *not confident* in creating lessons for developing spatial abilities were those teaching in non-public settings (27.5%).

Table 37 presents the results of the Fisher exact test used to investigate the setting in which in-service early childhood educators' taught and their level of confidence in creating lessons for developing children's spatial abilities.

Table 37

*Results of the Pearson Chi-square Test for Setting and Confidence in Creating Lessons for Developing Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 5.842 | .219 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between the level of confidence in creating lessons for developing spatial abilities and the setting in which in-service early childhood educators' taught.

***Implementing curriculum and instruction concerning spatial abilities.*** Table 38 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to the setting in which in-service early childhood educators' taught and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 38

*Crosstabulations for Setting and Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities*

| | Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| Non-public | 10 (19.6%) | 12 (23.5%) | 14 (27.5%) | 10 (19.6%) | 5 (9.8%) |
| Public | 3 (8.1%) | 8 (21.6%) | 9 (24.3%) | 6 (16.2%) | 11 (29.7%) |
| Total | 13 (14.8%) | 20 (22.7%) | 23 (26.1%) | 16 (18.2%) | 16 (18.2%) |

The results of the crosstabulations in Table 38 indicate that 62.5% of all participants rated their confidence level as: 2 *(confident)*, 3 (*very confident*), or 4 (*extremely confident*). Conversely, 37.5% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in implementing curriculum and instruction concerning spatial abilities were those teaching in a public setting (29.7%). The highest percentage of participants who were *not confident* in implementing curriculum and instruction concerning spatial abilities were also those teaching in a non-public setting (19.6%).

Table 39 presents the results of the Fisher exact test used to investigate the setting in which in-service early childhood educators' taught and their level of confidence implementing curriculum and instruction concerning spatial abilities.

Table 39

*Results of the Pearson Chi-square Test for Setting and Confidence Implementing Curriculum and Instruction Concerning Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 6.852 | .146 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between the level of confidence implementing curriculum and instruction concerning spatial abilities and the setting in which in-service early childhood educators' taught.

***Assessing children's spatial abilities.*** Table 40 presents the results of the chi-square crosstabulations that fell into each combination of categories as they relate to the setting in which in-service early childhood educators' taught and their level of confidence assessing children's spatial abilities.

Table 40

*Crosstabulations for Setting and Confidence in Assessing Children's Spatial Abilities*

| | Confidence Assessing Children's Spatial Abilities Score | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| Non-public | 15 (29.4%) | 9 (17.7%) | 13 (25.5%) | 10 (19.6%) | 4 (7.8%) |
| Public | 3 (8.1%) | 9 (24.4%) | 12 (32.4%) | 6 (16.2%) | 7 (18.9%) |
| Total | 18 (20.5%) | 18 (20.5%) | 25 (28.4%) | 16 (18.2%) | 11 (12.5%) |

The results of the crosstabulations in Table 40 indicate that 59.1% of all participants rated their confidence level as: 2 *(confident),* 3 (*very confident*), or 4 (*extremely confident*). Conversely, 40.9% of all participants rated themselves as 0 (*not confident*) or 1 (*somewhat confident*). The highest percentage of participants who were *extremely confidence* in assessing children's spatial abilities were those teaching in a public setting (18.9%). The highest percentage of participants who were *not confident* in assessing children's spatial abilities were those teaching in a non-public setting (29.4%).

Table 41 presents the results of the Fisher exact test used to investigate the setting in which in-service early childhood educators' taught and their level of confidence in assessing children's spatial abilities.

Table 41

*Results of the Pearson Chi-square Test for Setting and Assessing Children's Spatial Abilities (p-value via Fisher)*

| | Test Statistic Value | Exact p-value (2-tailed) |
|---|---|---|
| Pearson Chi-square | 7.829 | .099 |

The results of the Fisher exact test indicated there was not a statistically significant relationship between the level of confidence in assessing children's spatial abilities and the setting in which in-service early childhood educators' taught.

**Summary.** The results from the Fisher exact test indicated that a statistically significant relationship exists between both the level of knowledge, and skills of early childhood educators in teaching spatial abilities. The results of the Wilcoxon-Mann-Whitney independent samples test, using a Fisher exact test, and chi-square analysis of individual components of confidence did not reveal a statistically significant relationship between the level of confidence regarding spatial abilities and the setting in which in-service early childhood educators' taught.

**Summary**

The results show a statistically significant relationship exists between in-service early childhood educators' highest level of education obtained and their knowledge and skills associated with spatial abilities. In regards to prior years of teaching experience, no statistically significant relationships were found to exist. A statistically significant relationship was found to exist between the setting in which in-service early childhood educator's taught and their knowledge and skills associated with spatial abilities. Lastly, the results did not indicate a statistically significant relationship exists between any components of in-service early childhood educators' level of confidence regarding spatial abilities, across all independent variables analyzed in this study.

# CHAPTER V

# DISCUSSION

The purpose of this research study was to determine if background, setting, and teaching experience of in-service early childhood educators' affect their knowledge, skills, and confidence concerning spatial skills development in their classrooms. This study utilized archival data collected in spring 2011. In the original study, the survey was administered to 88 in-service early childhood educators in two settings. In the first setting, participants were asked to anonymously participate in the study while attending a professional development session sponsored by a non-profit organization. In the second setting, a public early childhood education center in a large urban city in southeast Texas, participants were asked to anonymously participate in an exploratory inquiry into early childhood educators' perception of their own knowledge, skills, and confidence regarding spatial abilities.

The research study was an attempt to add to the general knowledge of what is known about early childhood educators' understanding of spatial abilities. The study was also an investigation that sought to provide implications for early childhood educator preparation requirements and professional development opportunities, as they relate to their understanding of spatial abilities.

The previous chapter presented the results of the study, which were obtained from analysis of the data. The purpose of this chapter is to interpret the results of the study and to provide a context for the study's findings. Specifically, this chapter will discuss and review each of the research questions separately. Lastly, this chapter will discuss the limitations of the study and implications for further research.

A review of literature found no prior studies that addressed early childhood educators' knowledge, skills, and/or confidence regarding spatial abilities, which contributes to the need for this study. However, the importance of spatial abilities as they relate to success in future mathematics has been well documented (Clements & Sarama, 2007; Shepard, 1978; West, 1991; Wheatley & Reynolds, 1999). Not only are spatial abilities important for future mathematics success, they are developmentally appropriate. At the ages of 3 and 4, children have the ability to learn to describe, and then analyze, geometric figures, and by about the age of 5, children have the ability to see relationships between parts and properties of shapes, which are properties of the shapes. Children are also able to compare area-using superimposition, and identify and recreate symmetric figures using motions (National Research Council, 2009). Additionally, national organizations like the National Council for Teacher of Mathematics have recognized the importance of spatial abilities and incorporated them into their five core mathematical content areas (NCTM, 2000), yet early childhood educators' knowledge, skills, and confidence regarding spatial abilities remains largely undetermined.

**Findings from Research Question One**

The first research question in this study examined the relationship between early childhood educators' educational background and their knowledge, skills, and confidence regarding spatial abilities by asking: *Is in-service early childhood teachers' educational background related to their level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?*

A chi-square analysis using a Fisher exact test indicated a statistically significant relationship exists between early childhood educators' educational background and their knowledge of spatial abilities. Specifically, these data indicate that participants with a Bachelor's degree were able to more accurately define spatial abilities than participants with a high school diploma/GED or some college/AA/CDA .

Additionally, the Fisher exact test indicated a statistically significant relationship between early childhood educators' educational background and the skills they identified as being associated with teaching spatial skills and abilities. Based on the data, participants with higher levels of education were able to state more objectives, activities, and/or materials associated with teaching spatial abilities.

A Kruskal-Wallis *H* test was performed to investigate the relationship between in-service early childhood educators' educational background and overall confidence regarding spatial abilities. The test indicated that there was not a statistically significant relationship between the level of confidence regarding spatial abilities and in-service early childhood educators' educational background. Each component of confidence was further examined and analyzed using a chi-square analysis with a Fisher exact test. The test indicated there was not a statistically significant relationship between participants' educational background and their level of confidence: (1) creating lessons for developing spatial skills, (2) implementing curriculum and instruction concerning spatial skills, and (3) assessing children's spatial skills. The data suggests that in-service early childhood participants' level of confidence regarding spatial abilities is unrelated to their level of education obtained. These data further suggests that participants with a Bachelor's degree may have similar confidence levels regarding spatial abilities as participants with a high school diploma/GED.

The results of the Fisher exact test investigating the relationship between early childhood educators’ educational background, their knowledge of spatial abilities, and the skills they identified as being associated with teaching spatial abilities supports the increase in minimum teacher education requirements. The requirements of early childhood educators should follow those set forward by national programs like Head Start. As of October 1, 2011, under the Improving Head Start for School Readiness Act of 2007, federally funded early childhood program Head Start increased the minimum center-based teacher qualifications to an associate, baccalaureate, or advanced degree in early childhood education. Early childhood programs will be able to provide children and families with the educational opportunities they deserve if these settings are able to hire educators who have increased qualifications, knowledge about developmentally appropriate practices for young children, and skills to teach what is developmentally appropriate.

**Findings from Research Question Two**

The second research question in this study examined the relationship between early childhood educators’ prior years of teaching experience and their knowledge, skills, and confidence regarding spatial abilities by asking: *Is in-service early childhood teachers’ prior teaching experience related to the level of knowledge, skills, and confidence regarding spatial skills development in their classrooms?*

A chi-square analysis with a Fisher exact test did not reveal a statistically significant relationship between participants’ prior years of teaching experience and their knowledge or skills associated with spatial abilities. Using a Kruskal-Wallis one-way ANOVA to investigate prior years of teaching experience and overall confidence, in addition to a chi-square analysis with a Fisher exact test, did not indicate a statistically significant relationship between prior years of teaching experience and any of the individual components of confidence evaluated in the study.

Preschool teacher turnover is high, relative to other professions, with annual turnover rates as much as 50% (Barnett, 2003). The annual turnover rate does not seem to reflect early childhood educators' intent to remain in the profession. Nearly 60% of early childcare educators intend on remaining in the field for 5 or more years (Holochwost et al., 2009). The contrast between intent to remain in the profession and annual turnover rates may be influenced by a variety of factors, including minimum teacher qualifications. The requirements of teachers in early care education programs vary *within* states, including those located in different settings or subject to different regulations (e.g., public school-based preschool, Head Start, subsidized child care, or privately funded early childhood programs). The result is that many preschool practitioners do not hold college degrees, and most are not certified (Whitebook et al., 2009). The lack of consistency in early childhood teacher requirements may explain why the prior years of teaching experience for participants in this study were unrelated to the knowledge, skills, or confidence levels of early childhood educators' who were surveyed. The lack of consistency, regarding minimum teacher qualifications and requirements, across early childhood settings, provides the context to look at the findings from research question three.

**Findings from Research Question Three**

The third research question in this study examined the relationship between the setting in which early childhood educators' taught and their level of knowledge, skills, and confidence regarding spatial abilities by asking: *Is in-service early childhood teachers' level of knowledge, skills, and confidence regarding spatial skills development related to the setting of the early childhood center in which they teach?*

A chi-square analysis with a Fisher exact test indicated a statistically significant relationship exists between the setting in which early childhood educators' teach and their knowledge of spatial abilities with public school educators showing more knowledge than non-public educators. Furthermore, these data indicate that participants teaching in public early childhood settings, versus non-public settings have increased knowledge of spatial skills and abilities.

The Fisher exact test also indicated a statistically significant relationship between the setting in which early childhood educators' teach and the objectives, activities, and materials they identified as being associated with teaching spatial skills and abilities. Based on the data, participants who taught in a public early childhood setting, versus a non-public setting, are able to state an increased number of skills associated with teaching spatial abilities.

A Wilcoxon-Mann-Whitney test was performed to investigate the relationship between the setting in which in-service early childhood educators' taught and their overall confidence regarding spatial abilities. The test did not indicate a statistically significant relationship between the setting in which early childhood educators' teach and their overall level of confidence regarding spatial abilities. To further analyze the individual components of confidence, a chi-square analysis with a Fisher exact test was run. The test did not reveal a statistically significant relationship. Thses data suggest that in-service early childhood participant's level of confidence in creating lessons, implementing curriculum and instruction, and assessing spatial abilities are unrelated to the setting in the participants' taught.

The results of research question three appear to be similar to those of research question one, with both educational background and setting in which participants' taught being related to their knowledge of spatial abilities and the skills they associated with teaching spatial abilities. One reason for the similarity could be that in Texas, teachers and assistant teachers employed in child care centers that are licensed by the state of Texas are only required to complete a high school degree or be employed in a recognized early childhood careers program (Bellm et al., 2002), but requirements for state-funded, public prekindergarten teachers staff include a bachelor's degree, a teaching certificate, and an Early Childhood or Kindergarten endorsement (Texas Education Agency, 2011).

In addition to educational background, participants in public early childhood settings may be provided more frequent opportunities to attend professional development workshops, particularly in the areas of mathematics. Participants working in public early childhood centers may also be using an adopted curriculum that addresses the importance of spatial abilities and provides developmentally appropriate activities to address children's spatial skills development. Participants working in non-public settings may not have a prescribed curriculum or be afforded the same professional development opportunities as the educators working in public settings due to any number of factors including personal and/or financial.

**Limitations of the Study**

The *Spatial Abilities Survey for In-Service Teachers* survey was a newly developed instrument designed to examine the knowledge, skills, and confidence levels of in-service early childhood educators' in the area of spatial skill development of young children. The original study sought to identify professional development needs of these educators in the area of spatial abilities. One of the limitations of the study was that the survey was previously untested. However, there was no previously developed instrument that would examine the variables of interest.

Limitations similar to those associated with development of the survey were evident in the rubric designed by the researcher to score in-service early childhood educators' level of knowledge and skills in teaching spatial abilities. Even though the rubric was developed based on a review of the literature regarding spatial abilities and the skills associated with teaching spatial abilities, the scoring may be viewed as somewhat subjective. In an attempt to eliminate the subjectivity of scoring open-ended responses and establish consistency in scoring of the participant's knowledge of spatial abilities and their skills used to teach spatial abilities, the scoring was completed by the researcher and a graduate assistant to establish inter-rater reliability.

Since survey data was utilized, the researcher did not have the opportunity to interview participants about their responses to open-ended questions on the survey that asked: "To the best of your knowledge, how do you define spatial skills/abilities?" or "How do you teach spatial Skills? Specifically, what objectives, activities, and materials are involved?" One of the major limitations to survey data in general is that it relies on a self-reported method of data collection. Intentional deception, poor memory, or misunderstanding of the question can all contribute to inaccuracies in data. Having the opportunity to administer follow-up interviews may have clarified any inaccuracies in data, if they do indeed exist.

Another study limitation was the size of the population. It is difficult to draw inferential conclusions of early childhood educators based on a sample of 88 participants in-service early childhood educators' from two different educational settings.

**Implications for Future Research**

The examination of in-service early childhood educators' knowledge, skills, and confidence regarding spatial abilities is noticeably absent from a review of the literature regarding this subject, which warrants further study in this area. The results of this study hold implications for sample of early childhood participants in this study, but in order to make broader generalizations, additional studies including larger sample sizes are needed.

To obtain a better understanding of the knowledge, skills, and confidence levels of in-service early childhood educators' future research could benefit from a qualitative component in which the researcher can conduct follow-up interviews with participants to better understand the extent of their knowledge, skills, and confidence regarding spatial abilities. A limitation of survey research is that some participants may be sensitive to one or more of the questions being asked which would affect how they respond to a particular question. The only way to know if a participant is sensitive to a question would be for the researcher to conduct a follow-up interview in which qualitative data could be obtained. Further exploration might also include observations of early childhood educators during their mathematics teaching, to see the types of activities being afforded the students in their classrooms. It is possible these educators are providing opportunities for spatial skills development, but are unaware of it, or do not know what to call it.

Another area that deserves further examination is the qualifications of early childhood educators, particularly as they relate to mathematics and spatial abilities. As documented by Whitebook et al. (2009), the requirements of teachers in early care education programs varies *within* and *across* states, with minimum qualifications ranging from a high school diploma/GED to college coursework in early childhood education. How the minimum qualifications impact programs and states in regards to early childhood educator knowledge, skills, and confidence regarding spatial skills remains unseen. The minimum qualifications required of different programs also supports the need for further research regarding the setting in which early childhood educators' teach, whether it be a public school-based preschool, Head Start, subsidized child care, or privately funded early childhood program.

**Summary**

Children benefit most from teachers who have the skills, knowledge, and judgment to make good decisions and are given the opportunities to use those abilities (Copple & Bredekamp, 2009). The findings from this study provide support for increased levels of education among early childhood educators regarding spatial abilities. For early childhood educators currently teaching who lack the knowledge and skills essential for teaching spatial abilities in their classrooms, this study provides support for increased education through continuing education and/or professional development opportunities that address spatial abilities.

The results of this study also suggest that early childhood educators teaching in a non-public settings hold the least qualifications (high school diploma/GED) and are in need of the most education, as they relate to their knowledge and skills regarding spatial abilities. In Texas, prekindergarten teachers teaching in a public setting must hold a bachelor's degree, a teaching certificate, and an Early Childhood or Kindergarten

Endorsement (Texas Education Agency, 2011), which is not representative of the nation as a whole, since states require different qualifications of their prekindergarten teachers. This study suggests that further education and/or professional development opportunities could serve as a bridge between the knowledge and experiences of early childhood educators' teaching in non-public and public early childhood settings, as they relate to spatial abilities. Focused professional development opportunities utilizing the appropriate content and delivery method can help improve teacher practice, particularly in the area of mathematics (Dunst & Raab, 2010; NAEYC & NCTM, 2002/2010; Thornton, Crim, & Hawkins, 2009).

The National Council of the Teachers of Mathematics (2000) included prekindergarten in its *Principles and Standards for School Mathematics* (PSSM) which expects children in prekindergarten through second grade to be able to use visualization, spatial reasoning, and geometric modeling to solve problems. For children to be able to use skills associated with spatial abilities, it is imperative that early childhood educators are knowledgeable in the area of spatial abilities in order to prepare their students for success in Kindergarten and beyond. With less than desireable performance in the areas of mathematics and science becoming evident through national assessments as early as $4^{th}$ grade (NCES, 2009), it is essential that our students be afforded a high-quality education as early as preschool in order to provide a foundation for future success in mathematics and science. A high-quality education starts with the early childhood educator and the knowledge and skills he/she brings to the classroom. Continued education and appropriate professional development opportunities can provide early childhood educators with the tools they need to positively impact student learning.

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# APPENDIX A
# SPATIAL ABILITIES SURVEY FOR IN-SERVICE TEACHERS

Spatial Abilities Survey for In-service Teachers

## 1. Sex

☐ Male
☐ Female

## 2. Ethnicity

☐ American Indian or Alaskan Native
☐ Asian or Pacific Islander
☐ Hispanic
☐ African American/Black
☐ Caucasian/White
☐ Prefer not to answer

Other (Please specify)

## 3. What grade(s)/subject area(s) are you currently teaching?

4. **Which grade(s)/subject area(s) have you taught in the past?**

5. **How many years have you been teaching?**
   - ☐ 1st year
   - ☐ 2nd year
   - ☐ 3rd year
   - ☐ 4th -5th year
   - ☐ 6th- 10th year
   - ☐ 11th-20th year
   - ☐ More than 20 years

6. **How many years of experience do you have in your CURRENT POSITION?**
   - ☐ 1st year
   - ☐ 2nd year
   - ☐ 3rd year
   - ☐ 4th -5th year
   - ☐ 6th- 10th year
   - ☐ 11th-20th year
   - ☐ More than 20 years

**7. What is the highest level of education you have completed?**

- ☐ Less than high school
- ☐ High School of GED
- ☐ Some College
- ☐ 2-Year College (Associate's Degree)
- ☐ 4-Year College (Bachelor's Degree)
- ☐ Some Master's Hours
- ☐ Master's Degree
- ☐ Doctoral Degree
- ☐ Professional Degree (MD or JD)

Other (Please Specify)

| |
|---|
| |

## 8. Teacher's Certificate(s) Held

- ☐ Teacher's Certificate(s) Held
- ☐ EC-4 Generalist
- ☐ EC-4 English as a Second Language (ESL)/Generalist
- ☐ EC-4 Bilingual Generalist
- ☐ EC-4 Special Education
- ☐ EC-6 Generalist
- ☐ EC-6 ESL/Generalist
- ☐ EC-6 Bilingual Generalist
- ☐ 4-8 English/Language Arts and Reading
- ☐ 4-8 Mathematics
- ☐ 4-8 Science
- ☐ 4-8 Social Studies
- ☐ English as a Second Language (ESL) Supplemental
- ☐ Reading Specialist
- ☐ Educational Diagnostician
- ☐ Gifted and Talented Supplemental
- ☐ Special Education Supplemental
- ☐ Bilingual Education Supplemental
- ☐ Other (please specify)

## 9. Program for gaining certification

- ☐ Alternative Certification/Accelerated Program
- ☐ Post-Baccalaureate Program
- ☐ Undergraduate Certification
- ☐ Master’s Certification
- ☐ Other (Please Specify)

**10.Did you take a math methods course in your teacher preparation program?**

☐Yes
☐No
☐Not Sure

**11. How many hours of professional development do you obtain yearly?**

☐Less than 10
☐10-20
☐21-30
☐31-40
☐41-50
☐51-60
☐61-70
☐More than 70

**12. What percentage of professional development experiences are math related?**

☐Less than 10%
☐10-20%
☐21-30%
☐31-40%
☐41-50%
☐51-60%
☐61-70%
☐71-80%
☐81-90%
☐91-100%

**13. What percentage of your professional development experiences pertain to spatial abilities?**

☐Less than 10%
☐10-20%
☐21-30%
☐31-40%
☐41-50%
☐51-60%
☐61-70%
☐71-80%
☐81-90%
☐91-100%

**14. In what type of school do you teach?**

☐Public
☐Private

**15. Is your school a Title 1 school?**

☐Yes
☐No
☐Not Sure

**16. What percentage (estimate) of students receive free or reduced lunch in your school?**

**17. To the best of your knowledge, how do you define spatial skills/abilities?**

**18. How do you teach spatial skills? Specifically, what objectives, activities, and materials are involved?**

**19. Do you use a standard curriculum to teach MATHEMATICS? If yes, please name and tell how much time per day or week you spend teaching math with the standard curriculum(s).**

☐ Yes

☐ No

If yes, please explain

**20. Do you use the following to teach MATH? If yes, please explain how often and how much time the students spend involved per day or per week.**

| | Yes | No |
|---|---|---|
| Centers/Stations | ☐ | ☐ |
| Math Tubs | ☐ | ☐ |

If yes, please explain

**21. How would you rate your confidence in...**

| | Not Confident | Somewhat Confident | Confident | Very Confident | Extremely Confident |
|---|---|---|---|---|---|
| CREATING lessons for developing spatial skills? | ☐ | ☐ | ☐ | ☐ | ☐ |
| IMPLEMENTING curriculum and instruction concerning spatial skills | ☐ | ☐ | ☐ | ☐ | ☐ |
| ASSESSING children's spatial skills | ☐ | ☐ | ☐ | ☐ | ☐ |

**22. In general, how would you rate YOUR ABILITIES in…**

| | Poor | Below Average | Average | Above Average | Excellent |
|---|---|---|---|---|---|
| Mathematics | ☐ | ☐ | ☐ | ☐ | ☐ |
| Geometry | ☐ | ☐ | ☐ | ☐ | ☐ |
| Spatial Abilities | ☐ | ☐ | ☐ | ☐ | ☐ |

**23. Do you find boys or girls to be better at activities involving spatial skills? Please explain.**

☐ Boys
☐ Girls
☐ Neither
Please Explain

**24. How comfortable do you feel teaching SPATIAL SKILLS with the following methods?**

| | Not Comfortable | Somewhat Comfortable | Comfortable | Very Comfortable | Extremely Comfortable |
|---|---|---|---|---|---|
| Standard Curriculum | ☐ | ☐ | ☐ | ☐ | ☐ |
| Themes | ☐ | ☐ | ☐ | ☐ | ☐ |
| Project Approach | ☐ | ☐ | ☐ | ☐ | ☐ |
| Centers/ Stations | ☐ | ☐ | ☐ | ☐ | ☐ |
| Math Tubs | ☐ | ☐ | ☐ | ☐ | ☐ |
| Play | ☐ | ☐ | ☐ | ☐ | ☐ |
| Story Books | ☐ | ☐ | ☐ | ☐ | ☐ |
| Technology | ☐ | ☐ | ☐ | ☐ | ☐ |
| Music | ☐ | ☐ | ☐ | ☐ | ☐ |
| Drama | ☐ | ☐ | ☐ | ☐ | ☐ |
| Games | ☐ | ☐ | ☐ | ☐ | ☐ |
| Math workbooks or worksheets | ☐ | ☐ | ☐ | ☐ | ☐ |

**25. Do you use math-related computer software in the classroom or in a computer lab? If yes, what math-related software do your students use and how often?**

☐ Yes, in both the classroom and computer lab.
☐ Yes, in the classroom.
☐ Yes, in the computer lab.
☐ No, students do not use math-related computer software.

Please list math-related software and how often.

**26. Which of the following manipulatives do you think help students gain MATHEMATICAL KNOWLEDGE? Check all that apply.**

| | Yes | No |
|---|---|---|
| Wooden Blocks | ☐ | ☐ |
| Maps | ☐ | ☐ |
| Geoboards | ☐ | ☐ |
| Tangrams | ☐ | ☐ |
| Rulers | ☐ | ☐ |
| Puzzles | ☐ | ☐ |
| Puppets | ☐ | ☐ |
| Pattern Blocks | ☐ | ☐ |
| Climbing and riding toys | ☐ | ☐ |
| Dolls | ☐ | ☐ |
| Magnetic letters | ☐ | ☐ |
| Magnetic numbers | ☐ | ☐ |
| Felt board | ☐ | ☐ |
| Board games | ☐ | ☐ |
| PlayBrix cardboard bricks | ☐ | ☐ |
| Unit cubes | ☐ | ☐ |
| Playdough/clay | ☐ | ☐ |
| Tape Measure | ☐ | ☐ |
| Calculators | ☐ | ☐ |
| Small bears, fish (counters) | ☐ | ☐ |
| Spinners | ☐ | ☐ |

| | | |
|---|---|---|
| Dice | ☐ | ☐ |
| Kitchen objects | ☐ | ☐ |
| Lincoln logs | ☐ | ☐ |
| Ring toss | ☐ | ☐ |
| Bean bags | ☐ | ☐ |
| Clocks | ☐ | ☐ |
| Bingo chips | ☐ | ☐ |
| Pipe Cleaners | ☐ | ☐ |
| LEGO Bricks | ☐ | ☐ |
| Base ten blocks | ☐ | ☐ |
| Standard scale | ☐ | ☐ |
| Balance scale | ☐ | ☐ |
| Coins | ☐ | ☐ |
| Lacing shapes | ☐ | ☐ |
| Thermometer | ☐ | ☐ |
| Tinker Toys | ☐ | ☐ |
| Abacus | ☐ | ☐ |
| Transportation toys | ☐ | ☐ |
| 2-D and 3-D figures | ☐ | ☐ |
| Measuring cups | ☐ | ☐ |
| Art Tools | ☐ | ☐ |
| Protractor | ☐ | ☐ |
| Compass | ☐ | ☐ |

Other (please specify)

# APPENDIX B
# IN-SERVICE EARLY CHILDHOOD EDUCATORS' KNOWLEDGE OF SPATIAL ABILITES

Appendix B

**Scoring Rubric for In-Service Early Childhood Educators' Knowledge of Spatial Abilities**

| **Score** | **Criteria** |
|---|---|
| 0 points | The early childhood teacher is unable to define or state anything related to spatial skills or spatial abilities. |
| 1 point | The early childhood teacher defines spatial skills and abilities as being associated with mathematics. |
| 2 points | The early childhood teacher defines spatial skills and abilities as being associated with a specific area of mathematics. |
| 3 points | The early childhood teacher defines spatial skills and abilities as the manipulation, visualization, or orientation of spatial images or objects. |

# APPENDIX C
# SCORING RUBRIC FOR IN-SERVICE EARLY CHILDHOOD EDUCATORS' SKILLS IN TEACHING SPATIAL ABILITIES

Appendix C

**Scoring Rubric for In-Service Early Childhood Educators' Skills in Teaching Spatial Abilities**

| Score | Criteria |
|---|---|
| 0 points | The early childhood teacher is unable to state an objective, activity, or material involved in teaching spatial abilities. |
| 1 point | The early childhood teacher is able to state one objective, activity, or material involved in teaching spatial abilities. |
| 2 points | The early childhood teacher is able to state any combination of two objectives, activities, or materials involved in teaching spatial abilities. |
| 3 points | The early childhood teacher is able to state any combination of three objectives, activities, or materials involved in teaching spatial abilities. |