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# Daily Calendar Group Time and the Mathematical Skills of Preschoolers

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Walden University
2015

Abstract

Daily Calendar Group Time and the Mathematical Skills of Preschoolers

by

Deborah A. LaVine

MA, Concordia College, 2005

BS, St. Cloud State University, 1987

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

December 2015

Abstract

The evidence supporting the common instructional method of daily calendar group time to teach math skills to prekindergarten children has been inconclusive. The purpose of this study was to examine the effect of exposure to daily calendar group time on prekindergarten children's math score gains in a private early-childhood program located in the suburban Southeast. Vygotsky's sociocultural theory guided this quantitative, causal comparative design wherein archival data from 104 prekindergarten students' pre- and posttest numeracy skill scores on the Young Children's Achievement Test were analyzed. Data from 6 classrooms over 2 school years were compared using multiple linear regression. Four classrooms offered daily calendar group time ($n$ = 72), and the other 2 did not ($n$ = 32). Results from multiple linear regression analyses showed that when pretest scores, English language learner status, and socioeconomic status were controlled for, posttest scores of prekindergarten students who were instructed using the calendar were not significantly different from posttest scores of students with no calendar exposure. The results from this study can be used by prekindergarten administrators and teachers to inform classroom math instructional practices. This study contributes to social change by demonstrating that the instructional practice of prekindergarten daily calendar group time does not assist young children in attaining additional math skills prior to kindergarten entry; other methods of instruction may be more effective.

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# Dedication

This study is dedicated to all early childhood educators, especially those who serve at-risk prekindergarten children. It is my hope that the findings from this study can raise awareness of the essential link between effective early mathematics practices and children's math acquisition skills before kindergarten entry and throughout life.

Acknowledgments

I am grateful to the members of my committee—Dr. Donald Yarosz, Dr. Darragh Callahan, and Dr. Vicki Underwood—for their assistance and support throughout my doctoral program. My thanks go also to the other two members of the "Three Musketeers": Dixie Shaffer from Meadville, Pennsylvania, and Darla Tucker from Chicago, Illinois. They have been more than doctoral candidate colleagues; they have offered support, feedback, and friendship throughout our studies. Most notably, I thank my entire family and my supporters for their encouragement throughout this process over the past 3 years; including my dad, my four daughters, my husband, and my work colleagues. It was an amazing journey. Thank you for believing in me.

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Section 1: Introduction to the Study

## Introduction

Calendar group time is a daily instructional practice experienced by many prekindergarten children across the country (Beneke, Ostrosky, & Katz, 2008). However, over the past decade, some researchers and stakeholders have questioned the developmental appropriateness of the practice (Beneke et al., 2008; Erikson Institute, 2014; Friedman, 2000; North Carolina Office of School Readiness, 2006). According to Beneke and colleagues (2008), daily calendar group time offered no evidence of improving a young child's cognitive understanding of the workings of a calendar. At the local level, in the early childhood center where the study took place, the Beneke et al. (2008) article had been used to encourage prekindergarten practitioners to replace daily calendar group time activities with math activities deemed to be more developmentally appropriate. Likewise, Friedman (2000) argued that there was limited evidence that daily calendar activities were meaningful to young children and their cognitive development. Moreover, published research provides evidence that the instructional method of teaching daily calendar group time may be not only developmentally inappropriate, but also ineffective in teaching the mathematics skills that were intended by classroom teachers (Copple & Bredekamp, 2009; Jung & Conderman, 2013; North Carolina Office of School Readiness, 2006; Obidike & Enemuo, 2013). Other researchers, however, have argued that there is potential value in the mathematical concepts that are taught through the activity (Ethridge & King, 2005). Frueh (2009) added that young children have a greater ability to understand mathematical concepts than previously recognized, advising researchers and educators not to underestimate a young child's ability to grasp such

concepts. Furthermore, current research suggests that young children's developing spatial, temporal, and social understanding are thought to already prepare them to relate to concepts of time and space at 4 and 5 years of age (Droit-Volet, 2011). However, developmentally appropriate mathematics exposure for prekindergarten children is necessary (Copple & Bredekamp, 2009; Jung & Conderman, 2013; Obidike & Enemuo, 2013). A more detailed discussion is found in Section 2.

## Problem Statement

Low mathematics scores in prekindergarten predict lower math achievement through the eighth grade (Claessens & Engel, 2011). In the state of North Carolina, only 34% of students in eighth grade were proficient in mathematics in the 2012–2013 school year (North Carolina Department of Public Instruction, 2013). Low math achievement is especially pronounced in children from low-socioeconomic-status and English language learner (ELL) households (Chang, 2008; Clements, Baroody, & Sarama, 2014; Lamy, 2013). In Wake County, approximately 1,180 at-risk 4-year-olds from predominantly low-socioeconomic-status and ELL homes are being served by early childhood centers participating in the state government-sponsored More at Four Pre-Kindergarten Program (NC Pre-K; Wake County SmartStart, 2015b). Therefore, it is imperative that participating early childhood programs funded by Wake County's NC Pre-K address the math acquisition skills and effective instructional practices needed by at-risk preschoolers.

Many at-risk prekindergarten-aged children are unprepared to enter formal schooling and successfully learn the standard kindergarten mathematics curriculum (Claessens & Engel, 2011; Clements et al., 2014; Geist & Geist, 2009; Jordan, Kaplan,

Oláh, & Locuniak, 2006). However, early childhood teachers struggle to teach prekindergarten children early basic math skills (Beneke et al., 2008; Colozza, 2013; Friedman, 2000; Gillespie, 2005; Kreul, 2013). The nationwide rise in the at-risk prekindergarten population, joined with increased government-sponsored prekindergarten enrollment, makes it urgent to address the basic math skills achievement of at-risk young children in these programs (National Center for Children in Poverty, 2014; U.S. Department of Education, 2014).

Daily calendar group time has been a traditional and popular way for early childhood educators to teach young children early mathematics skills, so its effectiveness in doing so must be addressed (Beneke et al., 2008; Colozza, 2013; Friedman, 2000; Gillespie, 2005). Over the past decade, both local and national controversies have arisen regarding the developmental appropriateness of daily calendar group time (Beneke et al., 2008; Erikson Institute, 2014; Friedman, 2000; North Carolina Office of School Readiness, 2006).

Calendar math skills are normally scaffolded by the teacher using resource guides that provide scripted questions for the teacher to ask (Ethridge & King, 2005). Several teacher resource guides (Colozza, 2013; Gillespie, 2005; Houghton Mifflin Harcourt, 2011) suggest that teachers can use calendar math to teach the skills of numeral identification, counting, sorting, seriation, position, patterning, measurement, graphing, shapes, weather, and time. Although the passing of time is only one of the concepts taught by calendar math, the teaching of time concepts remains controversial (Beneke et al., 2008; Ethridge & King, 2005; Friedman, 2000). Moreover, the teaching of time has been the primary reason that critics oppose teaching calendar math to prekindergarten-

and kindergarten-aged students (Beneke et al., 2008; Ethridge & King, 2005; Friedman, 2000).

The research-verified problem of overall academic unpreparedness of at-risk prekindergarten children affects stakeholders, program administrators, teachers, students, and parents at local Wake County government-sponsored NC Pre-K programs (Wake County SmartStart, 2015b). Therefore, it is important to increase the effectiveness of mathematics instruction provided to at-risk children in local NC Pre-K classrooms. The effectiveness, as well as the problematic aspects, of daily calendar math instructional practices in relation to children's mathematics understanding is important to address. The focus of this study was investigating this issue at the local level and contributing to the knowledge base of the local government-sponsored Wake County NC Pre-K administrators and practitioners concerning the value of the instructional practice of daily calendar group time in promoting early mathematics acquisition in NC Pre-K classrooms.

## Nature of the Study

Causal comparative research is used when a researcher is seeking to determine whether there is a difference between individuals exposed to a particular event and individuals who were not exposed to the event (Lodico, Spaulding, & Voegtle, 2010). In this case, mathematics achievement test scores (dependent variable) of children who participated in calendar math activities (the independent variable) were compared with those of children who did not participate in calendar math activities. The causal comparative design was appropriate because the independent variable had already occurred. In this sense, this was a retrospective causal comparative design, which was an appropriate choice for this study because the goal of the research was to determine

whether there was a significant difference in mathematics achievement test scores of children exposed to calendar math activities versus children not exposed to these activities. Section 3 contains a more detailed discussion of the methodology and design.

Prekindergarten children need effective, developmentally appropriate mathematics exposure (Copple & Bredekamp, 2009; National Association for the Education of Young Children [NAEYC], 2009, 2015; Obidike & Enemuo, 2013). The purpose of this study was to determine whether daily exposure to classroom calendar time improves the mathematical abilities of preschool children through the investigation of the following research questions and hypotheses:

RQ1: Are there statistically significant differences between the early numeracy skills of prekindergarten children who participated in daily calendar group time and the skills of those children who did not participate?

$H1_0$: When pretest scores are controlled for, there is no statistically significant difference between the early numeracy posttest scores of prekindergarten children who participated in daily calendar group time and those of children who did not participate.

$H1_a$: When pretest scores are controlled for, there is a statistically significant difference between the early numeracy posttest scores of prekindergarten children who participated in daily calendar group time and those of children who did not participate.

RQ2: Are there statistically significant differences between the early numeracy skills of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and the skills of such children who did not participate?

$H2_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged

prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

$H2_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

RQ3: Are there statistically significant differences in the early numeracy skills of prekindergarten ELLs who participated in daily calendar group time and the skills of such children who did not participate?

$H3_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate.

$H3_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate.

## Purpose of the Study

This quantitative, causal comparative study examined the relationship between prekindergarten children's participation in daily calendar group time and early mathematics acquisition. The results of this study provide much-needed insight into whether participating in classroom calendar time is related to young children's numeracy understanding at the local level. Furthermore, insights garnered from this study may aid

teachers who serve at-risk children, such as those in the NC Pre-K program and similar state programs, as well as in the early childhood field in general. The results may inspire educators to inquire whether calendar time is relevant to children's beginning basic math skill emergence or whether teachers' energies would be better used trying evidence-based approaches to bolster student math skills. To my knowledge, the results of this study are the first evidence of an investigation into the relationship between the instructional practice of daily calendar group time and the acquisition of mathematics skills by preschool children.

## Theoretical Framework

The theoretical framework for this study was based on Vygotsky's (1962) principle that prekindergarten children have attained a foundational mathematical understanding on which future mathematical instruction can be built. Prekindergarten children have informal knowledge of many mathematical concepts; with guidance from an adult or knowledgeable peer, they can gain understanding of many more (Ginsburg, Greenes, & Balfanz, 2003; Vygotsky, 1962). Vygotsky's principle of the zone of proximal development and principle of the more knowledgeable other were significant underpinnings of this study. Vygotsky theorized that children learn best when taught new concepts just beyond their current level of understanding and benefit when their learning is scaffolded by others who are more knowledgeable than themselves (Vygotsky, 1978). Vygotsky's framework informed both the research questions and the research design.

## Operational Definitions

The following terms are defined as used in this study.

*Calendar math*: A segment of instructional time that uses the monthly calendar to teach children concepts of numeracy, sequencing, patterning, and vocabulary (Beneke et al., 2008).

*Circle time*: A teacher-directed, whole-group period that focuses on cognitive, social, and emotional instructional time (Miller & Moran, 2007).

*High-quality early childhood programs*: Programs that provide practices in educational settings, such as child-teacher interactions, and types of activities that promote learning and development in children (La Paro, Thomason, Lower, Kinter-Duffy, & Cassidy, 2012).

*Norm-referenced measures*: These measures are calculated as a same-age peer achievement level continuum of competence data that may be used to interpret the outcomes of learning environments or effects of instructional practices on children (Popham & Husek, 1969; Stiggins, 1994).

*Number sense*: A child's ability to understand numbers and their use in real-world situations (Gersten & Chard, 2001).

*Scaffolding*: A supportive teaching method that assists a child in accomplishing a task that is beyond his or her current mastery level (Bruner, 1960).

*School readiness*: A concept referring to the child's attainment of social, emotional, and cognitive skills needed to be able to succeed in kindergarten (NAEYC, 2009).

*Socioeconomic status (SES)*: Broadly defined, an individual's access to financial standing, to social status, and to human capital resources (National Center for Education Statistics, 2012).

## Assumptions, Limitations, Scope, and Delimitations

The potential weaknesses in this causal comparative study that were out of my control included the following: The students were not randomly assigned to classrooms, the independent variable had already occurred daily, and manipulation of variables was unattainable.

### Assumptions

I assumed that all participating teachers adhered to all instructional guidelines, that the Young Children's Achievement Test (YCAT; Hresko, Peak, Herron, & Bridges, 2000) was administrated appropriately to each child, and that children tried their best on the test. Furthermore, I assumed that the measure of social disadvantage was accurately applied by the county administrators for eligible children to be accepted into the NC Pre-K program.

### Limitations

Lack of randomization, absence of manipulation, and deficiency of control were all weaknesses of this causal comparative research. The limited number of classrooms within one private preschool, and therefore the size of the sample, limited the power of statistical analysis (Creswell, 2012; Lodico et al., 2010). A larger randomized sample of prekindergarten children would allow a greater ability to generalize to a larger population (Lodico et al., 2010). Randomized assignment to treatment groups was not possible because the children had already been assigned to designated classrooms before the research began. Thus, it was not possible to determine a clear cause-and-effect relationship between the independent and dependent variables; any differences found were based on differences between the groups in other factors related to mathematics

skills. The independent variable of daily calendar group time instruction in all classrooms had already occurred, so the manipulation of variables in this causal comparative study could not be achieved. To minimize these limitations, appropriate statistical controls were used in the data analyses and are described in Chapter 3.

**Scope and Delimitations**

The study was further defined by delimitations. The delimitations that were not out of my control were both the population and the school years studied. This causal comparative research was confined to a single, private early childhood program in a southeastern state involving six prekindergarten classrooms over two school years. Research focused only on children 4 and 5 years of age in prekindergarten classrooms for the school years 2013–2014 and 2014–2015.

## Significance of the Study

Given the need for effective mathematics instruction that supports the mathematical development of children in government-sponsored prekindergarten, a study of effective mathematics interventions for NC Pre-K preschool children was important for several reasons. In this study, I investigated differences in preschoolers' mathematics achievement based on their exposure to daily calendar math group instruction. I used archival data to compare post-YCAT scores, adjusted based on pretest scores, of preschool-aged children to assess their math achievement. Results of the study provide insight into the gap in early childhood education research that examined the value of daily whole-group calendar time in prekindergarten for the acquisition of basic math skills by young children. Furthermore, this study investigated differences in math

achievement related to the socioeconomic and language status of young children who participated in daily calendar group time and those children who did not.

This study provides some evidence to inform NC Pre-K administrators and practitioners concerning whether more research on this topic is advised. As a professional application, prekindergarten administrators can use the data to make a more informed decision regarding the developmental appropriateness of group calendar exposure. Positive social change can result from early math practices that result in effective math acquisition skills for prekindergarten children. If the prekindergarten instructional practice of daily calendar group time is effective in promoting the acquisition of math skills in prekindergarten children, perhaps the practice should continue. If the instructional practice of daily calendar group time is shown to be ineffective, perhaps the practice should be questioned by the NC Pre-K administrators and practitioners.

## Summary

Young children from low-socioeconomic-status and ELL households often lack the rudimentary mathematics skills that are necessary to attain basic math proficiency in kindergarten. This causal comparative study examined whether children's math scores were significantly different depending on whether or not they were exposed to daily calendar group time. This study contributes knowledge and insight to the local government-sponsored NC Pre-K programs as to the effectiveness of daily calendar group time in promoting the development of numeracy skills in NC Pre-K classrooms. Positive social change can result from the evaluation of daily calendar group time instruction and its effectiveness in promoting the math acquisition skills of low-socioeconomic-status and ELL prekindergarten children served in NC Pre-K classrooms.

In Section 2, the literature relevant to prekindergarten children's mathematics acquisition is reviewed. I discuss literature review search strategies, the theoretical foundation of the study, and key variables and concepts. In Section 3, I discuss the research design and approach, the setting and sample, the treatment, the instrumentation and materials, the data collection and analysis, and the ethical procedures followed in the study. Section 4 presents the results of the data analysis. In Section 5, I summarize the research; discuss the findings; and present the conclusions, implications for social change, and recommendations for future studies.

Section 2: Literature Review

## Introduction

Many theories have been proposed to explain how young children develop and learn. This section focuses on six main themes that emerged through the literature review: the understanding of learning theory, the importance of developmentally appropriate practices (DAPs), the influence of SES on mathematics acquisition, the consideration of second language learning on math acquisition, the use of the calendar to teach math concepts in the early childhood classroom, and passage-of-time theories in child development. Although the literature presents these concepts in a variety of contexts, this paper primarily focuses on their application to how young children acquire essential math skills before entering kindergarten.

## Literature Search Strategy

A literature search of current peer-reviewed sources and applicable government documents was used to support this study. An organized list of relevant scholarly articles was obtained by searching multiple databases, including EBSCO Host, NCBI, ProQuest, and Google Scholar. Key words and phrases including *calendar math, calendar time, early math acquisition, early math development, number sense,* and *preschool math* were used to obtain sources. The following additional words and synonyms were used in combination with the keywords to locate resources related to the various topics within the review: *comprehension of time concepts in preschoolers, contextual learning, DAP, early mathematics acquisition, ELLs, mathematics learning theory, prefrontal cortex development in children, preschoolers' concept of time, socioeconomic effects on math acquisition, NAEYC math standards,* and *scaffolding of math concepts*. Literature

published on the topic was located in books, in journals, through government documents, and on the Internet.

## Theoretical Foundation

The theoretical framework for this study was based on the work of constructivist Vygotsky's (1978) social development theory, which reflects recognition of the central role that social interaction plays in the development of cognition in children.

> Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people and then inside the child. This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (p. 57)

Vygotsky argued that a child's development is contingent on interpersonal interactions and the means the culture provides to allow children to develop their own understanding of the world. Vygotsky's work offers two important principles that support the framework for this study: *the zone of proximal development* and *the more knowledgeable other*. In both principles, Vygotsky theorized that cognitive development is dependent on social interaction with others who have higher ability or knowledge about the subject, concept, or process**.**

### The Zone of Proximal Development

Vygotsky's (1978) *zone of proximal development* social development theory is the view that, when children are engaged in social behavior with the guidance of adults or in collaboration with peers, they attain cognitive development that exceeds what they can attain alone. More specifically, Vygotsky believed that a child's cognition develops at a

minimum level when a child performs a task independently and at a maximum level when a child can perform a task with assistance. Therefore, the zone of proximal development lies between what a child can do alone and what he or she cannot do by him- or herself. Vygotsky contended that effective learning came from offering children materials and instruction just beyond their current level of development.

Vygotsky viewed the strategy of *scaffolding* as central to identifying a child's zone of proximal development. Scaffolding was first defined by Bruner (1960) as a temporary framework of support that assists a child in mastering a task beyond the child's current understanding. Bruner warned that scaffolding should be temporary and should be withdrawn when a child can perform a given task independently.

**The More Knowledgeable Other**

The *more knowledgeable other* refers to an individual who has a more advanced understanding or a greater ability level than the learner. A teacher, another adult, or a peer may be the individual with more knowledge or experience. The more knowledgeable other does not need to be a person, however. For example, interactive learning opportunities through electronic performance support systems and educational media programming that assist children through the learning process can be considered more knowledgeable others. The key to the more knowledgeable other is that the individual or program must have more knowledge about the subject, concept, or process than the learner does.

**Classroom Implications**

Vygotsky's theoretical framework has important implications in the early childhood classroom. According to Vygotsky's theory, young children acquire basic

mathematics skills and concepts as they problem solve with their teacher and peers in their early childhood classroom environment (Vygotsky, 1962). Vygotsky's instructional strategy of scaffolding allows a more knowledgeable other, such as the teacher or a more advanced peer, to play an important role in the process of a child's learning new math concepts. Therefore, the process of learning new math skills is a reciprocal experience between peers and teachers and other adults. The more knowledgeable other's role in the process is reduced over time as the child is able to perform the math skill independently. Furthermore, Vygotsky's zone of proximal development plays a significant role in the teaching of new math skills to young children in that children should be offered instruction and materials just beyond their current level of understanding.

Vygotsky's principles of cognitive development and learning have a theoretical impact on the foundation of this study and the instructional practice of calendar time taught to young children. Children who are taught mathematics concepts during daily calendar group time—when the instruction is offered as a social and reciprocal learning opportunity, taught in the zone of proximal development of young children, and scaffolded over time—should show significant gains in calendar math skills compared with children not participating in such instruction. By contrast, if the practice is shown not to be social and reciprocal in nature, is not taught in the zone of proximal development of the participating children, or is not scaffolded over time, then the practice may be considered developmentally inappropriate, and the acquisition of math skills in exposed children may not be significantly different from that of children not exposed to daily calendar group time as an instructional practice.

## Literature Review Related to Key Variables and Concepts

The key variable in the study was the mathematics skills gained by preschool-aged children over the course of a school year, skills that may or may not change because of exposure to daily calendar group time. Additional variables of socioeconomic status (SES) and ELL status contributed to this study. The key concepts in this study were the practice of daily calendar group time with preschoolers, math acquisition in young children, social development learning theory, and Vygotsky's zone of proximal development.

### Gap in the Research

A large gap in research exists in relation to determining the value of the instructional method of daily calendar group time to the participating preschool children's acquisition of basic mathematics skills. Controversy arose in the literature because of a child's theorized inability to perceive the passing of time, but no research has been conducted to determine whether daily calendar group time in preschool classrooms offers benefits that increase the cognitive development of young children. The purpose of this study was to better define the benefit, or nonbenefit, of daily calendar group time for preschoolers in terms of gaining important math skills. This study did not duplicate existing research; it offered an important opportunity to contribute to research and practice at the local level.

### The State of Early Childhood Education

Nearly 12 million of the nation's 20 million children under age 5 are in a weekly nonparental child care arrangement (National Association of Child Care Resourse and Referal Agencies, 2011). Of all 4-year-olds enrolled in North Carolina early childhood

programs who are considered at risk of school failure, 21% attend the state's NC Pre-K program, another 9% attend Head Start, and 3% attend special education programs (National Institute for Early Education, 2015). In Wake County, North Carolina, slightly over 1,182 at-risk 4-year-olds attended the state- and county-sponsored NC Pre-K program both in early childhood centers and in public school classrooms (Wake County SmartStart, 2015b).

NC Pre-K, formally known as the More at Four Pre-Kindergarten Program, has operated since 2001 to offer early care and education to at-risk 4-year-old children from families who are not served in another prekindergarten program (North Carolina Division of Child Development and Early Education, 2015). Eligibility risk factors include being the child of one or more active-duty military personnel or having a developmental delay, an identified disability, a family income at or below 75% of the state median income, limited English proficiency, or a chronic health condition.

The NC Pre-K program is supported by general state funds, state lottery funds, federal funds, and nonrequired local fund sources (North Carolina, 2014). Statewide, NC Pre-K classrooms are provided in private licensed child care facilities, public schools, and Head Start programs (North Carolina, 2014). Lead teachers must have a bachelor's degree; they must also hold or be working toward the North Carolina birth-through-kindergarten licensure requirement (North Carolina Division of Child Development and Early Education, 2014). Finally, each NC Pre-K program site is assessed for quality, program impacts, and child outcomes each school year. The benefits of early childhood education are well documented (Schweinhart et al., 2005; Yoshikawa et al., 2013). High-quality early education programs provide young children who are considered at risk of

school failure with early learning environments as an effort to reduce inequalities in early academic achievement (Tucker-Drob, 2012).

**Developmentally Appropriate Practices**

DAPs are evidence-based teaching approaches that take into consideration how young children naturally develop and learn (Copple & Bredekamp, 2009; NAEYC, 2009; Obidike & Enemuo, 2013). Additionally, DAPs are aimed at promoting young children's optimum learning and at meeting young children at their stage of development both as individuals and as part of a group (Copple & Bredekamp, 2009; NAEYC, 2015). Furthermore, DAPs should be taught in the context of a family's culture, values, and expectations that shape its members' lives at home and in their communities (Copple & Bredekamp, 2009; Hanson & Lynch, 2013; Huennekens & Xu, 2010; NAEYC, 2015). These approaches highlight NAEYC (2015) educators' core considerations when implementing these three important DAP concepts.

**NAEYC's core DAP considerations.** NAEYC is the leading association working with early childhood educators and stakeholders to implement DAPs in early childhood classrooms across the world. According to NAEYC (2015), the three central considerations for implementing developmentally appropriate learning experiences in the early childhood classroom are knowledge of what is age appropriate, individually appropriate, and culturally relevant for each child. Evidence-based research in child development and early learning supports educators' knowledge of children's typical development, understanding of individual differences, and appreciation of the importance of a child's cultural influences (Kohler, Christensen, & Kilgo, 2012; NAEYC, 2009, 2015).

***Knowledge of what is age appropriate.*** Young children grow and develop in typical ways. It is vital for early childhood educators to understand how a child's development unfolds during each age and stage of development. With this knowledge, educators can successfully implement learning experiences that are age appropriate (Kohler et al., 2012; NAEYC, 2009). Therefore, it should follow that when young children are exposed to age-appropriate classroom instruction and curriculum, they are likely to acquire the mathematics skills needed upon kindergarten entry.

***Knowledge of what is individually appropriate.*** According to the NAEYC (2009) position statement, "Development and learning proceed at varying rates from child to child, as well as at uneven rates across different areas of a child's individual functioning" (p. 21). Furthermore, early childhood educators need to learn about individual children's interests, abilities, and developmental progress by continually observing children as they interact within their classroom environment and with each other (NAEYC, 2015). Early childhood educators can scaffold each young child's mathematics acquisition when they plan for the individual child's current level of understanding (Anghileri, 2006; Vygotsky, 1962).

***Knowledge of what is culturally important.*** Children learn and develop within a social and cultural context. Early childhood educators must include each child's cultural background in learning experiences to meaningfully offer DAPs to young children (Derman-Sparks, LeeKeenan, & Nimmo, 2015). Furthermore, NAEYC stated that cultural information assists educators in providing young children with meaningful, respectful, and relevant contextual learning experiences. Therefore, educators must learn about children's families' cultural backgrounds, beliefs, expectations, and values that

reflect their lives within their homes and in their communities (Copple & Bredekamp, 2009; Derman-Sparks & Edwards, 2010; Derman-Sparks, LeeKeenan, & Nimmo, 2015; Hanson & Lynch, 2013). Early childhood teachers will be more effective at teaching mathematics skills to young learners when they support a young child's learning in the context of the child's cultural background (Lee, Young, & Amaro-Jiménez, 2011).

**Effective Mathematics Practices in the Early Years**

Prekindergarten children are capable of acquiring important mathematics skills. Research shows that a prekindergarten experience is an important time for young children to gain key mathematical skills and concepts (Aslan, 2013; Clements & Sarama, 2014; Edens & Potter, 2013; Education Commission of the States, 2013; Micanovic & Novovic, 2012). However, math instruction is often given lower priority in prekindergarten classrooms than is needed for young children to acquire the necessary math skills before entering kindergarten (Aslan, 2009; Brendefur, Strother, Thiede, Lane, & Surges-Prokop, 2013; Frueh, 2009). Furthermore, Aslan (2009) and Brendefur et al. (2013) warned that educators often struggle to provide activities and experiences that effectively build basic math skills in young children. Frueh (2009) concurred that the lack of effective early mathematics curriculum and instruction in preschool classrooms has poor outcomes for all children, particularly young children growing up in low-income households and those who are ELLs.

To effectively support young children in their acquisition of basic mathematics skills, educators need to have a solid understanding of how young children develop basic math skill proficiency and what best practices support that development (Clements & Sarama, 2009; Geist & Geist, 2009; NAEYC, 2009, 2015; Obidike & Enemuo, 2013).

Furthermore, educators must understand the factors that may affect the foundation of a child's learning, such as low-income family status or a household not proficient in English (Chang; 2008; Claessens & Engel, 2011; Center for Law and Social Policy [CLASP], 2013; Greenberg & Kahn, 2011). Jordan and colleagues (2006), Claessens and Engel (2011), and Micanovic and Novovic (2012) argued that to increase the academic math skill achievement of young children, early childhood educators must implement planned, effective, systematic, developmentally appropriate instructional approaches and curriculum practices. Conversely, Clements et al. (2014) contended that DAPs alone, especially for those children living in socioeconomically disadvantaged homes, have not been shown to increase young children's math capabilities. Similarly, Voegler-Lee, Kupersmidt, Field, and Willoughby (2012) added that, for early childhood educators to effectively implement developmentally appropriate math practices in the classroom, the practice must be applied continually. The Preschool Curriculum Evaluation Research Consortium (2008) underscored the idea that intentional mathematics instruction is important if young children considered at risk are to successfully absorb early mathematics. Therefore, it should follow that early childhood educators who offer developmentally appropriate mathematics curriculum and instruction implemented intentionally and consistently are more successful in teaching young children important math skills. A growing body of research supports the implementation of DAPs, instructional-based program standards, curriculum-focused resources, and culturally and linguistically responsive practices to effectively build math skills in young learners (NAEYC & National Association of Early Childhood Specialists in State Departments of Education [NAECS/SDE], 2010).

**Early Learning Standards**

Each state has developed instructional-based early learning mathematics standards for prekindergarten-aged children (NAEYC & NAECS/SDE, 2010). *North Carolina Foundations for Early Learning and Development* (North Carolina Foundations Task Force, 2013) is North Carolina's version of early childhood standards, goals, and developmental benchmarks for young children from birth through kindergarten entry. *Foundations* offers age-appropriate expectations divided in five domains: (a) "approaches to play and learning, (b) emotional and social development,(c) health and physical development, (d) language development and communications, and (e) cognitive development" (North Carolina Foundations Task Force, 2013, p. 3). The Task Force addressed prekindergarten mathematics goals and developmental indicators under the cognitive development domain.

The North Carolina Foundations Task Force (2013) outlined 23 mathematics benchmarks for older preschoolers, including that they (a) "rote count in order to 20 with increasing accuracy" (p. 137); (b) "show understanding of first, next, and last during play and daily activities" (p. 138); (c) "seek answers to questions during play and daily activities using an increasing variety of mathematical strategies" (p. 141); (d) "use observation and counting with increasing accuracy to answer questions" (p. 141); and (e) "begin to explain how a mathematical problem was solved" (p. 141).

**Curriculum-Focused Resources**

In North Carolina, state-sponsored prekindergarten classroom teachers are trained to implement classroom practice using the framework curriculum resource *The Creative Curriculum for Preschool, Fifth Edition* (Heroman et al., 2010). The curriculum is

designed to emphasize a project-based investigation approach to develop the skills of young children in four domains: physical, cognitive, language, and social/emotional. The curriculum offers early childhood educators specifics focused on age-appropriate child development, organization of classroom environments, practice-based teaching methods, and family involvement in the learning process. Furthermore, *The Creative Curriculum for Preschool* offers an online record-keeping tool to assist educators with the organization and documentation of children's classroom portfolios, assessment records, and individualized planning.

**Culturally and Linguistically Responsive Practices**

Early childhood classrooms across the country are increasingly diverse, both culturally and linguistically. It is vital that early childhood educators provide classrooms that are sensitive and considerate of each child's culture and home language (Copple & Bredekamp, 2009; Derman-Sparks & Edwards, 2010; Dillon & Wanjiru, 2013: Howes, 2010). Children learn best within early childhood programs when teachers use teaching approaches that are culturally adaptive to their children and community (Derman-Sparks & Edwards, 2010; Howes, 2010).

**Content Standards**

Research supports the implementation of standards in mathematics for early childhood learners (Clements, Sarama, & DiBiase, 2004; NAEYC, 2009; NAEYC & NAECS/SDE, 2010; National Research Council, 2009; Richardson, 2000). In 2000, the National Council of Teachers of Mathematics (NCTM) published a set of standards describing the progression of mathematical knowledge across the grades rather than as an isolated set of standards for each grade. In 2002, NAEYC and NCTM published a joint

position statement that expounded on those NCTM math standards for children in prekindergarten through second grade. In 2006, NCTM published *Curriculum Focal Points*, which breaks down the math standards by grade level. In 2010, NAEYC and NCTM's joint position statement was updated to include recommendations for paths to learning and strategies for teaching in early math (see the Ten Recommendations in this section). In the same year, NAEYC and NAECS/SDE (2010) joined forces in a joint position statement to support policymakers' understanding that early childhood math standards must extend from before kindergarten and into the primary grades and to emphasize that early childhood educators need to work within a consistent framework of standards across educational settings.

NCTM (2013) stated, "Young learners' future understanding of mathematics requires an early foundation based on a high-quality, challenging, and accessible mathematics education" (p. 1). Mathematics achievement goals in early childhood settings should concentrate on the content areas of numbers, geometry, spatial relations, and measurement (NCTM, 2015). The National Research Council (2009) added that most learning time in the early childhood classroom should be devoted to numbers but the other three content areas should be integrated into curriculum and instruction. Similarly, early childhood researchers recommend that numbers, geometry, and measurement should be given the greatest focus during the early years (NAEYC & NAECS/SDE 2010; NCTM, 2015). Algebraic reasoning, data analysis, and probability concepts should receive less emphasis in the prekindergarten years (NCTM, 2015); however, educators should entwine those concepts into math curriculum and instruction where appropriate to promote understanding across concept domains (NAEYC, 2010; NCTM, 2000).

**Number and operations.** The Number and Operations Standard (NCTM, 2000) outlines young children's understanding of whole numbers, operations, and relations. Early childhood mathematics experiences should focus on whole numbers in which children successfully count, compare quantities, and understand the number system (NCTM, 2000).

**Algebra.** The Algebra Standard (NCTM, 2000) is best learned as a set of concepts that investigate patterns, consider purposes, and explore relationships among numbers.

**Geometry.** The Geometry Standard (NCTM, 2000) concentrates on a wider investigation of geometric shapes, as well as the use of visualization, spatial reasoning, and geometric problem solving.

**Measurement.** The Measurement Standard (NCTM, 2000) focuses on the understanding of units, techniques, and methods that offer opportunities to understand measurement as an opportunity to integrate numbers, geometry, functions, statistical ideas, and measurable attributes.

**Data analysis and probability.** The Data Analysis and Probability Standard (NCTM, 2000) focuses on a young child's ability to collect and use numbers to answer early mathematics questions and predict basic probability.

**Ten Recommendations**

In 2002, NAEYC and NCTM published a joint position statement titled *Early Childhood Mathematics: Promoting Good Beginnings* that endorsed 10 major components to effectively teach mathematics to young children (3–6 years old). They

updated the statement in 2010. The 10 joint recommendations (NAEYC/NCTM 2002; NAEYC/NCTM 2010) are as follows:

**Recommendation 1.** Identify with young children's natural curiosity of their physical and social worlds and help them to make sense of their interests through using mathematics.

**Recommendation 2.** Augment young children's current knowledge by building on their language, community, and cultural familiarity.

**Recommendation 3.** Structure mathematics instruction, approaches, and curriculum on the basis of young children's physical, cognitive, linguistic, and social-emotional development.

**Recommendation 4.** Offer instructional practices and curriculum that represent, communicate, and connect mathematical ideas to support young children's reasoning and problem-solving abilities.

**Recommendation 5.** Connect young children's known relationships to important mathematical ideas with coherent and compatible curriculum.

**Recommendation 6.** Understand that young children have a profound and constant relationship with mathematical concepts.

**Recommendation 7.** Integrate activities with mathematics.

**Recommendation 8.** Provide children with plenty of classroom materials, teacher support, and exploratory time to engage in a classroom environment that allows for play, exploration, and manipulation of mathematical concepts.

**Recommendation 9.** Present young children with developmentally appropriate vocabulary, teaching strategies, and mathematical concepts within the early childhood classroom.

**Recommendation 10.** Assess young children's mathematical knowledge and skills.

**Calendar Math as an Instructional Tool**

The effectiveness of daily calendar group time as a preschool instructional tool has been questioned by some researchers and stakeholders (Beneke et al., 2008; Erikson Institute, 2014; Ethridge & King, 2005; Friedman, 2000; North Carolina Office of School Readiness, 2006). The three main arguments against the instructional use of daily calendar group time in the preschool classroom are (a) the prekindergarten child's inability to understand concepts of time; (b) the prekindergarten child's limited attention span to attend fully to the activity; and (c) the prekindergarten child's ability to absorb mathematics concepts using other, more developmentally appropriate means.

First, some researchers and stakeholders argue that the genesis of daily calendar group time by early childhood educators to instruct young children was the inability of 4- and 5-year-olds to perceive the passing of time (Beneke et al., Ethridge & King, 2005; 2008; Friedman, 2000). Friedman (2000) stated that there is little proof that calendar activities over an extended period of time are meaningful to prekindergarten children. Similarly, Beneke and colleagues (2008) argue that the daily ritual of teaching daily calendar group time in front of a classroom calendar to talk with young children about concepts like the days of the week, today and tomorrow, and the current month is beyond

a young child's comprehension. They also stressed that a child's concept of time does not emerge until 7–10 years of age.

Second, some researchers raise the concern that the time spent on daily calendar group time often does not match a young child's short attention span. Beneke and colleagues (2008) argue that daily calendar group time is often lengthy and results in little cognitive gain in understanding the workings of the calendar. If preschool children are unable to comprehend the material offered and unable to attend to the activity presented, the Beneke team concludes, then group calendar instruction is developmentally inappropriate for them.

Third, some researchers contend the instructional tool of daily calendar group time to teach young children math skills is not developmentally appropriate and should be replaced with more developmentally appropriate math practices. Beneke and colleagues (2008) and Ethridge and King (2005) both advocated for more developmentally appropriate methods to build young children's current level of understanding of the passage of time and numeral sense, including the usage of picture charts of the daily classroom schedule, paper chain counting links, and hands-on math activities. For instance, a classroom daily pictorial schedule that illustrates the sequence of daily school activities may be more valuable to a young child than charting monthly calendar dates to illustrate the passing of time.

Whereas some published researchers have expressed concern regarding the instructional practice of whole-group classroom calendar instruction taught to preschoolers, other authors have stressed the key mathematical concepts that are taught through the traditional classroom practice of daily calendar group time (Ethridge & King,

2005). Frueh (2009) contended that young children are more capable of conceptualizing math concepts than has been previously recognized and that their capabilities should not be underestimated. More specifically, Ethridge and King (2005) state that young children experience meaningful learning outcomes when exposed to calendar-focused math activities such as numeral concepts, sorting, patterning, and seriating. To be most effective, Beneke and colleagues (2008) urge that early childhood educators who retain daily calendar group time as part of their daily preschool classroom instructional routine limit the length of time spent on calendar instruction and lessen the focus on concepts of time.

**Passage-of-Time Concepts**

The cognitive ability of prekindergarten-aged children to comprehend the concept of the passage of time is controversial. Classic constructivist Piaget (1969) argued that, because they lack a sophisticated ability to reason, young children are unable to gauge the duration of time accurately. More contemporary researchers believe that a child's ability to understand time concepts is underestimated and is more developed than classic Piagetian theorists once believed (Droit-Volet, 2011; Moss, 2010). Piaget based his theory on a young child's lack of concrete reasoning, whereas contemporary researchers construct their theories on a young child's ability to use temporal understanding of simple passing-of-time concepts.

**The Effect of Socioeconomics**

According to the National Center for Children in Poverty (2014), 22% of all children who reside in the US live in families whose yearly incomes fall below the federal poverty level. The economically disadvantaged population has risen over the past

decade, as has enrollment of young children in government-sponsored preschool programs (Barnett & Carolan, 2015; CLASP, 2013; National Center for Children in Poverty, 2014; U.S. Department of Education, 2014). Recent data state that 932,163 U.S. preschool children who live in poverty attend federally funded Head Start programs (CLASP, 2013). Therefore, the necessity of addressing the academic needs of improvised young children is imperative.

Young children who live in socioeconomically disadvantaged homes often struggle to gain basic mathematics skills they will need to be successful in kindergarten (Claessens & Engel, 2011; Geist & Geist, 2009; Jordan et al., 2006). Similarly, researchers argued that many prekindergarten-aged children living in low-SES households were unprepared to enter formal schooling and to learn standard kindergarten core mathematic curriculum and are thus at risk of school failure (Claessens & Engel, 2011; Geist & Geist, 2009; Jordan et al., 2006; Son, Kwon, Jeon, & Hong, 2013). Lamy (2013) reported that young children living in socioeconomically disadvantaged homes are often raised by parents who tend to be less educated, to have fewer financial resources, and to experience more stress than parents in higher-SES families; they are less able to assist their children in learning and their children have shown significantly lower math skills. Moreover, young children's lower early math skill attainment before kindergarten predicts lower mathematics, reading, and science achievement throughout a child's school years (Brendefur et al., 2013; Claessens & Engel, 2011; Witzel, Ferguson, & Mink, 2012). Claessens and Engel (2011) warned that children with lower early math skills are at greater risk of being retained in kindergarten through eighth grade. Young

children in low SES families are negatively affected throughout their formal schooling (Brendefur, et al., 2013; Claessens & Engel, 2011).

**English Language Learners**

The ELL population is mounting in the U.S. educational system. An estimated 10.7% of the student population, or approximately 5.3 million students, are ELLs (Batalova & McHugh, 2010). Moreover, the student population of ELLs continues to increase more rapidly than the U.S. student population as a whole. More specifically, the National Center for Education Statistics (2012) stated that the ELL population in U.S. schools has grown 65% from 1993 to 2010, whereas the general student population has grown approximately 9% over the same time period.

According to Aud and colleagues (2010), the largest groups of young minority children in the country are Hispanic. More specifically, Gasbarra and Johnson (2008) offered that Hispanic students comprised 20.5%, or one fifth, of the nation's public school student population. Payán and Nettles (2013) added that nearly 79% of ELLs are from Spanish-speaking backgrounds, but ELL students speak more than 450 different languages. Gasbarra and Johnson (2008) and Payán and Nettles (2013) concur that Asian and European languages make up a noteworthy segment of the ELL population.

Researchers agreed that ELLs struggle to gain basic mathematics skills before entering kindergarten (Chang, 2008; Stein, 2011). Chang (2008) adds that ELLs lag considerably behind their English-proficient peers in math readiness skills. Experts maintained that ELLs need culturally and linguistically sensitive learning (Dillon & Wanjiru, 2013). However, other researchers argued that early educators often fail to adequately support ELLs' math skill achievement in the early childhood classroom as a

result of their lack of knowledge in dual language attainment and math skill acquisition (Perry, 2011; Stein, 2011; Steinberg, 2013). In addition, Stein (2011) added that most early childhood teachers lack the training necessary to address culturally and linguistically diverse learners and the ability to adapt the curriculum and the instruction to meet students' differing needs. Perry (2011) stressed that early childhood educators often lack the knowledge to provide the instructional methods necessary to support both young children's second language acquisition and ELL's early math acquisition.

To complicate the issues, researchers often disagree on the state of early childhood educators' sensitivity to the cultural and linguistic differences of ELLs. According to the California Department of Education (2009), for many years early childhood educators have shown sensitivity to the cultural and linguistic differences of young children. However, many researchers stated concern with educators' indifferences toward the cultural and linguistic needs of ELLs in U.S. classrooms (Derman-Sparks & Edwards, 2010; Gestwicki, 2012; Hanson & Lynch, 2013; Modica, Ajmera, & Dunning, 2010; Shockley & Banks, 2011).

Early childhood educators often have the misunderstanding that, because mathematics employs symbolism to communicate schemas, young ELL children can more easily grasp mathematics-focused skills (Garrison, 1997). However, contrary to this widely held belief, language plays a vital role in communicating mathematical concepts and mathematical processes (Lee et al., 2011; Steinberg, 2013). Effectively providing classroom instruction to develop young ELLs' math acquisition skills is a dual task: one of developing language and the other of developing content (Lee et al., 2011). Therefore,

the lack of English language proficiency puts young ELLs at a huge disadvantage in gaining the necessary math skills before entering kindergarten.

Orosco, Swanson, O'Connor, and Lussier (2011) suggested that young ELLs' struggles with solving mathematical word problems are due more to their lack of comprehension of concepts presented in a second language than to math measures or calculation challenges. The purpose of their experimental study was to investigate the math comprehension program Dynamic Strategic Math (DSM) and its effectiveness in building ELLs' math word problem–solving performance. Six second-grade Latino ELLs participated from an English-as-a-second-language Southern California elementary school. The DSM program was designed to teach the children general math vocabulary, math comprehension strategies, and the use of probes to interpret math problems in both their native language and English. A pretest and two posttests were given to each child to assess DSM's effectiveness. The study found that all six students involved in the study benefited from DSM intervention because they received math instruction that was tailored to their oral language, vocabulary, and problem-solving needs from an interactive approach.

**Literature Related to Methodology**

The lack of previous empirical research indicates a large gap in knowledge regarding the instructional practice of daily calendar group time as it relates to the acquisition of basic math skills in prekindergarten children. Although a thorough literature review addressed the current knowledge of DAPs in teaching young children math skills, no research was identified that explored either a quantitative or qualitative

measure of math skills acquired by children who participated in daily calendar group time compared with skills acquired by those children who did not participate.

Zaghlawan and Ostrosky's (2011) exploratory study examined challenging behaviors identified during circle time activities in eight Head Start classrooms. It is important to this study because circle time is the main delivery method for calendar instruction in this local version of daily calendar group time. Zaghlawan and Ostrosky collected 24 circle time observations from eight classrooms—three observations per classroom over 21 days—and asked the teachers to complete the Teacher Impression of Circle Time Survey (TICTS) once for each circle time observation. Thus, three surveys were collected from each teacher. In Part 1 of the TICTS, teachers rated challenging behavior occurrences during circle time on a 4-point scale ranging from *rarely* to *fairly often*. In Part 2 of the TICTS, teachers answered open-ended questions regarding prevention and intervention strategies they implemented during circle time to keep children engaged in circle time activities. Zaghlawan and Ostrosky found that calendar time was one of the circle time activities most likely to result in challenging behavior. If the delivery method of daily calendar group time instruction is negatively affected by children's disruptive behaviors, then this may have an effect on the results of this study.

Dobbs-Oates & Robinson's (2012) correlational study examined the relationship between a young child's challenging behavior in the classroom and his or her ability to gain important mathematical skills. This study applied multidimensional assessments to examine prekindergarten classroom behavior and children's attainment of early math skills. Computerized personal interviews were given to parents or primary caregivers to collect details about the children's developmental histories and home environments.

Home visits were used to assess children's current math skill abilities. Lastly, early educators completed the Early Childhood Longitudinal Study–Birth Cohort; National Center for Education Statistics [2009]) to collect the teacher's perception of each child's classroom behavior. Results showed that the early childhood educator's rating of the child's classroom behavior was associated with the child's math skill attainment. This study is important because it underscores the importance of a child's behavior during learning time and his or her ability to attain math skills.

VanMarle, Chu, Li, & Geary's (2014) recent experimental study contributed to the understanding of preschoolers' acquisition of numeracy skills. In this quantitative study, 155 Title I preschoolers were examined using the Wechsler Preschool and Primary Scale of Intelligence, third edition (Wechsler, 2002), the Conflict EF (executive function) scale (Beck, Schaefer, Pang, & Carlson, 2011), the Test of Early Mathematical Ability–3 (Ginsburg & Baroody, 2003), the Panamath program (Halberda, Mazzocco, & Feigenson, 2008), the Phonological Awareness Literacy Screening (PALS; Invernizzi, Sullivan, Meier, & Swank, 2004), and the 13-item Counting Knowledge Task (Gelman & Gallistel, 1978). All results were tabulated and examined using a regression model of analysis.

The in-depth results of this study supported the conclusion that a preschooler's ability to verbally count, recognize numerals, and give a number were significant predictors ($p < .0132$) of his or her mathematics achievement. Additionally, a preschooler's capability to intuitively estimate greater and lesser value sets influenced the child's ability both to recognize numerals and to understand the meaning of number words.

Bumgarner, Martin, and Brooks-Gunn (2013) also employed a regression model to predict math gains of ELLs using both approaches to learning and English proficiency as independent variables. Bumgarner and colleagues examined a sample of 1,293 first- and second-generation Hispanic immigrant kindergarten students over a 3-year period. Children's math test scores were analyzed at three intervals (spring of kindergarten, spring of first grade, and spring of third grade). The math assessments examined children's understanding of number sense, measurement, geometry, spatial sense, data analysis, patterns, algebra, and functions. Math assessments were administered Spanish for those children not proficient in English. Three regression models were used to control for each student's math achievement score, allowing the dependent variable to measure change in math scores compared with each of the previous testing intervals. Results indicated that approaches to learning did not predict higher math scores in kindergarten but did predict scores in first and third grade. However, in third grade, approaches to learning predicted higher math scores only for students who were proficient in English.

Experimental and qualitative studies were alternative research designs considered for this study. However, both of these designs were rejected. The experimental research design is a traditional, rigorous approach to conducting quantitative research, but its requirement to control, through random assignment, all extraneous variables that may influence the dependent variable in this study is not practical because of logistical considerations (Creswell, 2012; Lodico et al., 2010; Triola, 2012). Because the independent variable (daily calendar group time) had already occurred, controls could not be implemented as required for an experimental design (Lodico et al., 2010). Random assignment of children to classrooms was not possible, as the children had already been

assigned to classrooms before the study. The lack of the researcher's ability to apply randomization, manipulation, and control makes experimental research a poor design for this study. Qualitative research was also considered. However, qualitative research was inappropriate because valid and reliable assessments of children's mathematics scores are available and self-report would be inappropriate. Campbell and Stanley (1963) concluded that quasi-experiments are worth undertaking when an experimental design is not possible to implement in an educational setting. In this educational setting, quasi-experimental research was chosen as the best design to answer the research questions presented in this study.

## Summary and Conclusions

Many factors contribute to a young child's ability to attain basic mathematics skills. The influences of a high-quality preschool experience, exposure to developmentally appropriate mathematical curriculum and instruction, the family's SES, the child's ELL status, and the exposure to math concepts in the home all contribute. Early childhood program standards need to be based on current research, DAPs, flexible expectations, and measurable outcomes. Effective approaches in teaching early mathematics to young children are the key to young children's acquisition of necessary math skills before entering kindergarten. Early childhood educators' teaching approaches and curriculum should be grounded in the understanding of child development and mathematics trajectories.

However, published knowledge in early childhood education shows a large gap in research on the effectiveness of using daily calendar group time as a curriculum and instructional approach in prekindergarten classrooms to teach young children math skills.

This study attempts to compare the mathematical gains of young children who were exposed to daily calendar group time with those of children who were not exposed to daily calendar group time.

# Section 3: Research Method

## Introduction

The review of literature produced recurring themes emphasizing the importance of prekindergarten children gaining basic mathematical skills before entering kindergarten (Brendefur et al., 2013; Chang, 2008; Claessens, Duncan, & Engel, 2009; Claessens & Engel, 2011; Clements et al., 2014; Geist & Geist, 2009; Georges, 2009; Jordan et al., 2006; Lamy, 2013; Mazzocco, Feigenson, & Halberda, 2011; Steinberg, 2013; Witzel et al., 2012). Developmentally appropriate mathematics curriculum and instruction are crucial components of the effort to assist young children in gaining essential math skills before entering kindergarten (NAEYC & NCTM, 2010). Children living with socioeconomic challenges and those not proficient in the language of instruction need ongoing math enrichment (Claessens & Engel, 2011; Geist & Geist, 2009; Jordan et al., 2006; Perry, 2011; Stein, 2011; Steinberg, 2013). It has not been determined whether or not eliminating calendar activities during group time has an impact on mathematical outcomes for children in prekindergarten classrooms. Yet the controversy surrounding this issue has encouraged early childhood educators to replace traditional daily calendar group time with activities deemed to be more developmentally appropriate (Beneke et al., 2008; Erikson Institute, 2014; Friedman, 2000; North Carolina Office of School Readiness, 2006).

The research method used in this study is presented in this section. The research design, setting, and sample are defined and defended. The treatment, instrumentation, and materials are outlined and supported. The data collection and analysis process, as well as the plan for the protection of participants' rights, are shared and justified in this section.

## Research Design and Approach

In this study, I used a quantitative causal comparative research design, also referred to as ex post facto research, because the independent variable had already occurred (Creswell, 2012; Lodico et al., 2010; Triola, 2012). This design is used to determine whether differences exist between two or more groups on one dependent variable. In this research, the dependent variable was the YCAT test scores of prekindergarten children, and the independent variable was participation (or not) in daily calendar group time activities. SES and ELL were also included as covariates.

According to Lee (1985), an ex post facto design is an after-the-fact research approach in which the investigation begins after the experience has already occurred without interference from the researcher. Creswell (2012) added that ex post facto designs should be used when the researcher needs to compare two or more groups to explain existing differences between them on some variable or variables of inquiry. This study involved the use of six comparison groups based on the pre-existing characteristic of whether or not students were exposed to daily calendar group time. The existing group structure included classroom teachers who taught the daily calendar group time activity and those who did not. The teaching of daily calendar group time thus became the existing treatment, and students whose teachers did not implement daily calendar group time instruction became members of the comparison group. Archival test data were available to assess numeracy skills between these different groups. The early childhood program included ELLs and students of varying SES, variables that can be controlled statistically. This was used to determine whether there was a statistically significant

difference between the mathematical achievement of prekindergarten students based on participation in daily calendar group time.

For this study, I chose a causal comparative research design because true random assignment was not possible, and comparison classrooms (groups) were compared on one dependent variable (math posttest scores) rather than multiple variables (Lodico et al., 2010). The causal comparative research design allowed for this lack of manipulation. It was not possible for me to control or manipulate young children's participation in daily calendar group time instruction, as it had already occurred.

In this study, I examined differences measured by archival pre- and posttest scores on the math portion of the YCAT instrument in an attempt to determine explanations for the differences. According to Lodico and colleagues (2010), the causal comparative research design is used by researchers in an effort to detect a potential cause-and-effect relationship between the independent variable and the dependent variable. However, I did not have control over the independent variable, so a causal relationship, or lack thereof, was more suggested than proven (Creswell, 2012; Lodico et al., 2010; Triola, 2012). This causal comparative design permitted analysis of the data to determine the effect of the daily calendar group time intervention (independent variable) on math posttest scores (dependent variable) by comparing the scores of children who participated in daily calendar group time with those of children who did not participate.

As a normal routine of the southeast suburban early childhood program selected for study, all students were given standardized pretest and posttest assessments using the Young Children's Achievement Test (YCAT, 4th edition). The YCAT contains five subsets: general information, reading, mathematics, writing, and spoken language. The

YCAT math ability test measures the early numeracy skills of number concepts, numeral recognition, number comparison, number facts, and calculation skills. Pretest and posttest YCAT math ability scores from the 2013–2014 and 2014–2015 school years were analyzed for all six classrooms of children to determine the relationship between participation in daily classroom calendar time teaching instruction and the early numeracy skills of prekindergarten children. This quantitative analysis helped to pinpoint the amount of growth in basic math skills experienced by prekindergarten children who were or were not exposed to daily calendar group time throughout a school year.

## Setting and Sample

The research setting was a suburban southeastern early childhood program that served children from 3 to 7 years of age. The program was nationally accredited by NAEYC and was a 5-star facility, the highest rating offered by the state. Fifty percent of the children who attended the program were considered at risk and were funded by the state. The program housed two NC Pre-K classrooms, a private-pay prekindergarten classroom, and a combination K–1 classroom. (This study focused only on the three prekindergarten classrooms.) In terms of ethnic background, 45% of the prekindergarten children were Caucasian, 30% were African American, and 25% were Hispanic. Furthermore, 28% of the families and children spoke a first language other than English. Approximately 20% of all students came from Spanish-speaking homes. One child qualified for state support as the child of an active military parent.

The selected early childhood program was targeted for four key reasons: (a) the program served a large number of prekindergarten children (ages 4–5 years) from various economic and ethnic backgrounds, (b) the program participated in the government-

sponsored NC Pre-K program, (c) the program had available pre- and posttest archival data based on norm-referenced outcomes, and (d) the program was identified as a high-performing preschool as indicated by NAEYC accreditation and the state's star rating.

There were 112 anticipated total student participants with archival YCAT scores over the 2013–2014 and 2014–2015 school years; each prekindergarten classroom teacher served approximately 18 students each school year. Three classrooms of prekindergarten children made up the 2013–2014 school year group, and three classrooms of prekindergarten children made up the 2014–2015 group. The YCAT mathematics scores were compared between groups of children who were exposed to daily calendar math (treatment groups) and groups who were not exposed to daily calendar math (comparison groups).

Random assignment of participants was not possible, as student participants had already been assigned to each prekindergarten classroom. YCAT scores of students who attended any of the six prekindergarten classrooms in the 2013–2014 or 2014–2015 school year were eligible for this study. There were 76 total calendar students (Classroom 3 + Classroom 1) and 36 total noncalendar students (Classroom 2), for a total of 112 students. Under these conditions, a medium-sized effect of (Cohen's $d = .57$) was met to achieve power of .8 (Cohen, Cohen, West, & Aiken, 2013).

The study included 70 socioeconomically disadvantaged children assigned to four study classrooms and 34 non-socioeconomically disadvantaged children in two additional study classrooms, totaling six groups whose scores were compared. Of these, 66 preschoolers were from English-speaking homes and 38 preschoolers were from non-English-speaking homes.

## Treatment

In the study classrooms where daily calendar group time was taught, children and teachers used the calendar at circle time as they (a) sequentially counted up to the number of days reached in the current month, (b) rhythmically clapped out patterns as they counted up to the number of days reached in a month, (c) serially counted and charted the number of days until special events (e.g., children's birthdays, field trips, and special events), (d) graphed the day of the week using the current date on the calendar, and (e) recorded the weather for the current date.

In study classrooms where daily calendar group time was not taught, children and teachers followed similar circle time routines as those teachers who implemented the daily calendar group time activity; they (a) welcomed each child individually, (b) counted the number of children present, (c) counted the number of children absent, (d) observed daily weather conditions, (e) removed a daily link off a paper chain, (f) sang theme-related songs, and (g) discussed daily concepts.

## Instrumentation and Materials

As a standardized pretest and posttest instrument, the selected early childhood program used the fourth edition of the YCAT to measure student performance in five subcategories: general information, reading, mathematics, writing, and spoken language (Hresko et al., 2000). An examiner used the YCAT instrument with young children between the ages of 4 years 0 months and 7 years 11 months to score and quantify early academic performance levels by comparing their raw scores with the norm-referenced achievement of same-age peers. In this study, only the archival data on the math section of the YCAT were examined.

The YCAT is a reliable and valid measure of a child's achievement in the five subcategories. The average coefficient for the subtests and the composite all exceed or round to .85, a level representative of high reliability (Cohen, 1960). Both interrater reliability and test-retest reliability are as high as .98 (Hresko et al., 2000). Therefore, the YCAT's content-description, criterion-prediction, and construct-identification validities demonstrate an effective measure of achievement and usefulness (Cohen, 1960).

Archival data on the YCAT for prekindergarten classes from the 2013–2014 and 2014–2015 academic school years were combined into one group in the study to evaluate the relationship between daily calendar group time and children's mathematical scores. Differences in posttest scores were examined as a function of calendar exposure controlling for pretest scores.

For the purpose of this study, the mathematics portion of the YCAT was the only score examined. The math portion of the YCAT assessment consists of 20 items and evaluates children's numbering skills, understanding of number concepts, spatial reasoning, number comparison, recognition of number facts, and calculation skills. Students work one on one with the examiner, who asks students to answer math-related questions and to demonstrate math-related skills (Hresko et al., 2000). When the student misses a total of three questions in a row, the assessment is stopped. The total correct, which is marked on the score sheet, is the raw score for the Math Achievement section. Raw data from this study will be made available on request.

## Data Collection and Analysis

A causal-comparative research design was used in this study. As a normal procedure of the school, YCAT assessments are collected for each student. With prior

permission from the school, I obtained archival copies of student YCAT scores for the 2013–2014 and 2014–2015 school years, with student and teacher identities removed. Parental permission was not necessary, as YCAT assessments are standard procedure at the school. Archival data from students enrolled in three different classrooms over two school years (new students in classes each school year) were analyzed. Classrooms 1 and 2 consisted of 18 children each school year who were considered socioeconomically disadvantaged. Classroom 3, which consisted of mostly non-socioeconomically disadvantaged children, averaged 20 students per school year. ELLs represented almost half of the total student enrollment in Classrooms 1 and 2. Classroom 3 had a significantly lower enrollment of both ELLs and socioeconomically disadvantaged children (Table 1).

Prior to my receiving the data, the school personnel responsible for student records redacted student and teacher identities, gender of the child, and birth date of the child. As a normal practice of the program, school personnel left documented demographic characteristics of ELL/non-ELL status (as defined by YCAT screened in the child's home language), and low SES/non-low SES identifiers (as identified by participation in a government-sponsored NC Pre-K classroom) and classroom affiliation on YCAT score sheets. Each school year, two classrooms of children were exposed to daily calendar group time and one classroom of children was not. This provided six classrooms: four classrooms of early childhood teaching teams that performed daily calendar group time instruction and two that did not.

Table 1

*Number of 4- and 5-Year-Olds Enrolled in Each Classroom*

| Classroom characteristic | Classroom 1 | Classroom 2 | Classroom 3 |
|---|---|---|---|
| Daily calendar group time? | Yes | No | Yes |
| Total students, school years 2013–2014 and 2014–2015 | 36 | 36 | 40 |
| Total low-SES learners | 35 | 32 | 3 |
| Total ELLs | 18 | 15 | 5 |
| 2013–2014 enrolled students, *N* | 18 | 18 | 25 |
| 2014–2015 enrolled students, *N* | 18 | 18 | 15 |

*Note.* Accumulated YCATs were gathered over 2 years for six unique classrooms.

**Descriptive and Inferential Statistical Techniques**

Archival data in this study were analyzed using a variety of descriptive and inferential statistical techniques. Descriptive analysis was used to report the measures of mean scores for calendar exposure controlling for pretest, SES, and ELL status, as well as standard deviations for measures of variability, *t*-values, *p*-values, and the multiple coefficient of determination ($R^2$). According to Triola (2012), in multiple regression statistics, the *p*-values indicate the overall significance of the regression model. The *t*-value measures the proportional difference relative to the variation in the data sample and indicates the calculated difference represented in units of standard error (Cohen et al., 2013). For example, the greater the magnitude of the *t*-value, positively or negatively, the greater the evidence that the null hypothesis can be rejected and that, therefore, there is a statistically significant difference. By contrast, the closer the *t*-value is to zero, the more

probable it is that there is not a significant difference in the variables. $R^2$ measures how closely the multiple regression equation explains the data sample; that is, an $R^2$ of one indicates a perfect fit, whereas an $R^2$ close to zero is a poor fit. Therefore, a data sample with an $R^2$ of .59 indicates that 59% of data sample variation can be explained by the variables.

Multiple linear regression (MLR) analysis was used to draw inferences about the effect of the daily calendar group time on YCAT scores. A .05 alpha level was used to determine statistical significance. MLR analysis is used when a researcher seeks to identify the association between two or more independent variables and one continuous dependent variable (Cohen et al., 2013). An important advantage of the MLR analytic approach is that the calendar effect can be evaluated while controlling for potential confounding variables (e.g., SES, ELL, pretest scores; Cohen et al., 2013). One regression analysis was used to address each of this study's three research questions.

MLR, like most statistical tests, is dependent on concrete assumptions about the variables that are used in the analysis of data. MLR assumes linearity, reliability, homoscedasticity, and normality (Osborne, Waters, & Waters, 2002). First, the assumption of linearity assumes that a linear relationship exists between the independent and dependent variables (Osborne, Waters, & Waters, 2002). Second, the assumption of reliability assumes that the variables are measured without substantial error (Pedhazur, 1997). Third, homoscedasticity reflects that the variance of errors is the same across all levels (Berry & Feldman, 1985). Fourth, the assumption of normality indicates that there is a normal distribution of the means of the samples (Osborne, Waters, & Waters, 2002).

In MLR statistics, it is critical to make sure the analysis meets these assumptions to avoid Type I and II errors, which can over- or underestimate the size of the effect or significance of the results (Osborne, Waters, & Waters, 2002). Furthermore, Osborne and colleagues added that MLR can accommodate for Type I and Type II errors by making sure an analysis meets these assumptions. If violations of the model arise, appropriate adjustments can be made, such as data transformations and alternative model specifications (Cohen et al., 2013). MLR's four assumptions are highly robust to violations, but can certainly be dealt with through the design of the study and easily observed and corrected if they do occur (Osborne et al., 2002). Therefore, this type of analysis offers a substantial benefit to the researcher.

**Research Questions and Hypotheses**

The hypotheses were driven by three primary research questions in this study in search of statistically significant differences between the early numeracy skills of prekindergarten children who participated in daily calendar group time and the skills of those who did not participate.

RQ1: Are there statistically significant differences between the early numeracy skills of prekindergarten children who participated in daily calendar group time and the skills of those who did not participate?

$H1_0$: When pretest scores are controlled for, there is no statistically significant difference between the early numeracy posttest scores of prekindergarten children who participate in daily calendar group time and those of children who did not participate.

$H1_a$: When pretest scores are controlled for, there is a statistically significant difference between the early numeracy posttest scores of prekindergarten children who participate in daily calendar group time and those of children who did not participate.

RQ2: Are there statistically significant differences between the early numeracy skills of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and the skills of such children who did not participate?

$H2_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

$H2_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

RQ3: Are there statistically significant differences in the early numeracy skills of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate?

$H3_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participate in daily calendar group time and those of such children who did not participate.

$H3_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who

participated in daily calendar group time and those of such children who did not participate.

## Protection of Participants' Rights

Walden University Institutional Review Board (IRB) approval, number 09-14-15-033900292, was obtained to ensure that my research procedures adhered to all required ethical practices. Archival copies of the YCAT score sheet from both the 2013–2014 and the 2014–2015 school year were released to me without teacher or student identifying information. The school personnel responsible for student records redacted the name of student, name of teacher, gender of child, and date of birth. As a normal procedure of the program, school personnel left documented demographic characteristics of ELL/non-ELL status (as identified by the YCAT Spanish version or identified by the first language translator for the YCAT), and low SES/non-low SES identifiers (as identified by participation in the government-sponsored NC Pre-K classroom) on the YCAT scores sheets. The collection of students' pretest and posttest YCAT scores was a standard procedure at the selected early childhood program; therefore, permission from parents was not necessary.

The role of the researcher was to analyze the archival data. The dual role of the researcher as the headmaster of the school did not affect the analysis of the data as all YCAT tests were previously administered and scored by third parties and not by the researcher/administrator of this program.

After compiling all YCAT data in a password-protected computer, I shredded all paper copies of student YCAT test scores. As a safeguard of the archival data, including

concerns of confidentiality and protection from harm, the above procedures were closely followed.

## Summary and Conclusion

Researchers in the field of early childhood education agree that young children who do not attain basic mathematics skills prior to entering kindergarten suffer long-term negative academic effects. There is a mounting concern for young children who live in socioeconomically challenged families and for ELLs as they struggle to gain basic math skills before entering kindergarten. This causal comparative study was implemented to determine the relationship between children participating in the daily instruction practice of calendar group time and preschool children's acquisition of basic math skills.

This study provides some evidence for North Carolina's private and government-sponsored prekindergarten programs of possible relationships between daily calendar group time participation and the mathematics skill achievement of young children. This causal comparative study serves as a model for larger scale efforts to improve early math curriculum and practice in the prekindergarten classroom and ultimately to prepare young learners for future success in mathematics.

Section 4: Data Presentation and Analysis

## Introduction

The purpose of this causal comparative quantitative study was to determine whether the early numeracy skills of prekindergarten children who participated in daily calendar time were significantly different from the skills of those who did not participate. This section presents the results of the statistical analysis of the data to address the study's research questions, specifically (a) whether there are statistically significant differences between the early numeracy skills of prekindergarten children who participate in daily calendar group time and the skills of those who do not participate, and (b) controlling for family SES and home language, whether there are statistically significant differences between the early numeracy skills of prekindergarten children who participate in daily calendar group time and the skills of those who do not participate.

If prekindergarten children who participated in daily calendar group time were found to be more likely to gain important mathematics skills by participating, then support for the practice should be considered. If prekindergarten children who participated in daily calendar group time were not found to gain statistically significant math skills compared with children who did not participate, then it would be important to question the practice. According to Vygosky (1962), if instruction is scaffolded within a young child's ZPD, then the child should attain the desired learning objectives. Vygotsky contended that a child's cognition develops at a minimum level when the child performs a task outside his or her ZPD and at a maximum level when the child can perform a task with assistance that is just beyond his or her current level of development. Thus, if daily calendar group time is scaffolded within young children's ZPD, then the children should

retain the calendar math skills taught throughout the school year. If the instructional math skill practices of daily calendar group time are not taught within the children's ZPD, then little or no math gains should be realized. Therefore, a causal comparative study to examine the math skills gained through the instructional practice of daily calendar group time was conducted.

## Data Collection

Archival data from the YCAT administered during the 2013–2014 and 2014–2015 school years were used in the study to evaluate the relationship between daily calendar group time and children's mathematical gains. As a standard procedure of the southeastern early childhood site selected, the YCAT is administered to all students using a pre- and posttest model to access children's achievement in five domains (general information, reading, mathematics, writing, and spoken language) over the course of a school year.

The YCAT is designed as a comprehensive early childhood assessment tool that examines academic achievement and can be used to measure a student's progress. Children respond to questions both orally and in writing in the mathematics and writing subtests; the other subtests do not contain a writing component. The total assessment takes 25–45 minutes to complete.

The YCAT test manual (Hresko et al., 2000) states that the instrument demonstrates high reliability and validity as a measurement of a young child's achievement on each of the five domains (general information, reading, mathematics, writing, and spoken language). The degree to which the items correlate with one another, the internal consistency, averaged over .85. The consistency of ratings by the same

examiner over a short period of time, test-retest reliability, was established at .98. The level of agreement among independent examiners' ratings of the same child, interrater reliability, averaged .98.

The YCAT test manual demonstrates that subscores and composite scores correlate as high as .99 with similar scores on other instruments, which include the Comprehensive Scale of Student Abilities, the Kaufman Survey of Early Academic and Language Skills, the Metropolitan Readiness Tests, and the Gates-MacGinitie Reading Tests (Hresko et al., 2000). This establishes high construct validity. According to Hresko et al. (2000), items on the YCAT were scrutinized to safeguard against bias relative to gender, disability, race, SES, and ethnic group. Potential bias was examined by differential item functioning techniques to ensure little or no bias. The math portion of the YCAT consists of 20 items that evaluate young children's counting skills, numeral identification, number comparison, numeral sequencing, and calculation skills. An overall mathematics achievement score is obtained by totaling the number of correct responses for the 20 items.

Archival copies of YCAT score sheets from the 2013–2014 and the 2014–2015 school years were released to me with only the mathematics achievement scores visible. The school personnel responsible for student records obscured the student name, teacher name, gender of child, and birthdate on each sheet. Each student's age, subscores, coded English language learner (ELL) or non-ELL status (as identified by the YCAT Spanish version, first language translator, or teacher), and low-SES/non-low-SES identifiers (as coded by participation in the government-sponsored NC Pre-K program, qualification for reduced or free meals through the Child and Adult Care Food Program, or both) remained

on the YCAT score sheets. Score sheets were delivered to me coded into classrooms of students who participated in daily calendar group time instruction and classrooms of students who did not participate, according to school year. It is important to note that the actual test sheets were not released to me.

Before data analysis, individual YCAT score sheets were checked for accuracy. More specifically, each YCAT score sheet was verified to be divided into proper classifications of prekindergarten status, school year attendance, daily calendar group time participation classrooms, SES standing, and ELL status. Furthermore, I verified that both the pretest and the posttest were administered to each child. Out of 112 sets of archival score sheets, the scores of eight students had to be eliminated, as either a pretest or a posttest score sheet was missing. Using the 104 remaining sets of YCAT score sheets and an Excel spreadsheet, I coded either 0 (*no*) or 1 (*yes*) for the categories of daily calendar group time participation, SES standing, and ELL status. Finally, I entered pre- and posttest raw math scores for each student.

## Data Analysis

A quantitative, comparative design was used in the study. In the design, the dependent variable was the posttest scores of the prekindergarten students. The independent variables were exposure to daily calendar group time (0 = *no calendar time*, 1 = *calendar time*), pretest mathematics achievement score, ELL status (0 = *non-ELL*, 1 = *ELL*), and SES status (0 = *not low SES*, 1 = *low SES*).

MLR was used to test the research hypotheses. MLR, a widely used method in educational research, evaluates the relationships among several independent variables and a continuous dependent or criterion variable (Cohen et al., 2013). The current study tested

the unique effects of hypothesized predictors (e.g., calendar exposure, ELL status, SES) on posttest mathematics achievement scores. In the statistical models, reference coding was for categorical variables. ELL and SES statuses were covariates. Three MLR models were fitted to the data. Model 1 shows the results of the MLR for testing Hypothesis 1. Table 2 corresponds to Research Question 1; Table 3 corresponds to Research Questions 2 and 3. The hypotheses and research questions are detailed below.

**Study Questions and Hypotheses**

The following section presents the statistical analysis and findings in relation to each research question.

RQ1: Are there statistically significant differences between the early numeracy skills of prekindergarten children who participated in daily calendar group time and the skills of those children who did not participate?

$H1_0$: When pretest scores are controlled for, there is no statistically significant difference between the early numeracy posttest scores of prekindergarten children who participated in daily calendar group time and those of children who did not participate.

$H1_a$: When pretest scores are controlled for, there is a statistically significant difference between the early numeracy posttest scores of prekindergarten children who participated in daily calendar group time and those of children who did not participate.

Results showed that when pretest scores, ELL status, and SES were controlled for, prekindergarten students who used the calendar did not have posttest scores that were significantly different from those of students with no calendar exposure, $R^2 = .54$, $t(99) = .25$, $p > .05$. Therefore, the null hypothesis was not rejected. Additionally, low-SES students had significantly lower posttest scores than did non-socioeconomically

disadvantaged students ($t(99) = 2.20$, $p < .05$), and ELL students had significantly lower posttest scores than non-ELL students ($t(99) = 2.02$, $p < .05$). The $R^2$ showed that this model explained 54% of the variance in posttest Y-CAT scores, with most of this due to the pretest, $t(99) = 6.88$, $p < .0001$. Table 2 shows results of the MLR for Hypothesis 1.

Table 2

*Descriptive Statistics for Testing Hypothesis 1*

| | Model 1, RQ1 ($n$ = 104) Mean ($SD$) | Model 2, RQ2 ($n$ = 70) Mean ($SD$) | Model 3, RQ3 ($n$ = 38) Mean ($SD$) |
|---|---|---|---|
| Calendar exposure | 66.35 | 50.00 | 52.63 |
| English language learner | 36.54 | 48.57 | 100.00 |
| Low socioeconomic status | 67.31 | 100.00 | 89.47 |
| Pre-YCAT score | 3.46 (3.31) | 2.63 (3.26) | 1.53 (2.53) |
| Post-YCAT score | 6.66 (4.04) | 5.40 (3.71) | 4.16 (3.34) |

*Note.* RQ = research question; YCAT = Young Children's Achievement Test.

RQ2: Are there statistically significant differences between the early numeracy skills of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and the skills of such children who did not participate?

$H2_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

$H2_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate.

Results showed that, for low-SES students, calendar exposure did not significantly predict posttest scores when pretest scores and ELL status were controlled for, $R^2 = .55$, $t(65) = 0.28$, $p > .05$. Therefore, the null hypothesis was not rejected. However, as noted in the discussion for RQ 1, when pretest scores, calendar exposure, and ELL status were controlled for, low-SES students had significantly lower posttest scores ($M = 5.40$, $SD = 3.71$) than non-socioeconomically disadvantaged children ($M = 9.26$, $SD = 3.45$). The adjusted mean posttest score for low-SES students was 1.6 units lower than that for non-socioeconomically disadvantaged children when pretest scores, calendar exposure, and ELL status were controlled for. This is a small to medium-sized effect (Cohen's $d = .4$). Table 3 shows results of the MLR for testing Hypotheses 2 and 3.

Table 3

*Results From the Multiple Linear Regression Models*

| | Model 1 – RQ1 Calendar exposure Overall ($n = 104$) | | | Model 2 – RQ2 Calendar exposure Low SES ($n = 70$) | | | Model 3 – RQ3 Calendar exposure ELL ($n = 38$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Est. (*SE*) | *t*-value | *p* | Est. (*SE*) | *t*-value | *p* | Est. (*SE*) | *t*-value | *p* |
| Intercept | 5.83 (1.00) | 5.83 | <.0001 | 4.09 (.67) | 6.09 | <.0001 | 5.80 (1.39) | 4.18 | 0.0002 |
| Pre-YCAT | 0.66 (.10) | 6.88 | <.0001 | 0.73 (.10) | 7.16 | <.0001 | 0.90 (.14) | 6.24 | <.0001 |
| Calendar (ref = no calendar) | 0.17 (.67) | 0.25 | .80 | 0.17 (.61) | 0.28 | .78 | −0.71 (.73) | −0.96 | .34 |
| Low SES (ref = not low SES) | −1.60 (.73) | -2.20 | .03 | — | — | — | −2.96 (1.24) | -2.39 | .02 |
| ELL (ref = non ELL) | −1.33 (.66) | -2.02 | .045 | −1.44 (.66) | −2.17 | .03 | — | — | — |
| $R^2$ | .54 | | | .55 | | | .62 | | |

*Note.* ELL = English language learner; RQ = research question; SES = socioeconomic status; YCAT = Young Children's Achievement Test.

RQ 3: Are there statistically significant differences in the early numeracy skills of prekindergarten ELLs who participated in daily calendar group time and the skills of such children who did not participate?

$H3_0$: When pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate.

$H3_a$: When pretest scores are controlled for, there is a statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate.

Results showed that, for ELL students, calendar exposure did not significantly predict posttest scores when pretest scores and SES status were controlled for ($R^2 = .62$, $t(33) = 0.96$, $p > .05$). Therefore, the null hypothesis was not rejected. However, among ELL students, low SES predicted significantly lower posttest scores ($t(33) = 2.39$, $p < .05$). In testing for RQ1, ELL students had significantly lower posttest scores ($M = 4.16$, $SD = 3.34$) than did non-ELL students ($M = 8.11$, $SD = 3.71$) when pretest scores, calendar exposure, and SES status were controlled for. Specifically, the adjusted mean posttest score for ELL students was 1.33 units lower than that for non-ELL children when pretest scores, calendar exposure, and SES were controlled for. This is a small to medium-sized effect (Cohen's $d = .34$).

There are no known inconsistencies in the analyses. Empirical evaluation of the model assumptions for MLR indicated that all assumptions were adequately met.

Multicollinearity among predictors was not problematic, residuals followed an approximately normal distribution, and residual-by-prediction as well as residual-by-predictor plots did not suggest concerns with nonlinearity or heteroscedasticity. There also were no overly influential or problematic cases.

## Conclusions

The purpose of this quantitative, causal comparative study was to determine whether daily calendar group time improved the mathematics skills of preschool children. Data were collected and analyzed using MLR, as deemed appropriate for each research question and hypothesis. The analysis results showed no significant difference between the posttest scores of children who participated in daily calendar group time and those who did not. Similarly, the mathematics posttest scores of socioeconomically disadvantaged students who participated in daily calendar group time were not significantly different from those of socioeconomically disadvantaged students who did not participate. Therefore, the null hypotheses for Hypothesis 1 and Hypothesis 2 were not rejected. Finally, no statistically significant difference was found between the mathematics achievement scores of ELL students who participated in daily calendar group time and those of the ELL students who did not participate. Therefore, the null hypothesis for Hypothesis 3 was also not rejected. Although this causal comparative study had a relatively small sample size and a specific population, the results of this study suggest that daily calendar group time may not significantly increase math skills in prekindergarten-aged children. The interpretations of the findings are discussed in detail in Section 5, along with recommendations for action and further study.

# Section 5: Interpretation of the Findings, Recommendations, and Conclusion

## Introduction

The purpose of this quantitative, causal comparative study was to determine the relationship between prekindergarten children's participation in daily calendar group time and early mathematics acquisition. This chapter presents the study findings and addresses the research questions:

RQ1: Are there statistically significant differences between the early numeracy skills of prekindergarten children who participated in daily calendar group time and the skills of those children who did not participate?

RQ2: Are there statistically significant differences between the early numeracy skills of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and the skills of such children who did not participate?

RQ3: Are there statistically significant differences in the early numeracy skills of prekindergarten ELLs who participated in daily calendar group time and the skills of such children who did not participate?

The study involved the examination of archival YCAT pre- and posttest data for 112 prekindergarten children 4 to 5 years of age who were enrolled in six prekindergarten classrooms in a private early childhood program during the school years 2013–2014 and 2014–2015. All children were 4 years of age at the beginning of each school year, and most children had turned 5 years of age by the end of the school year. Of those 112 children, 104 had both pre- and posttest scores. Of those 104 students, 72 participated in daily calendar group time while the remaining 32 children did not participate, 70 children

were considered socioeconomically disadvantaged, and 38 children were documented as ELLs.

As a routine procedure, the YCAT was administered to all prekindergarten students as both a pretest and a posttest. Pre- and posttest data were examined using MLR for prekindergarten students categorized into two groups: those who participated in daily calendar group time and those who did not. This design permitted the analysis of data between comparison groups to determine the effect of children's participating (or not) in daily calendar group time (independent variable) on math achievement posttest scores (dependent variable).

Controlling for pretest scores, this design permitted the analysis of data between all students who participated in daily calendar group time and those who did not, between socioeconomically disadvantaged and non-socioeconomically disadvantaged students who participated in daily calendar group time and those who did not, and between ELL students who participated in daily calendar group time and those who did not. Results indicated that there were no significant differences for calendar time participation versus no calendar time participation for students overall or for comparisons related to low SES or ELL status. Therefore, all three null hypotheses failed to be rejected: Conditional on the pretest, there was no significant difference between the math achievement posttest scores of students who participated in daily calendar group time and those who did not. An interpretation of these findings, with reference to the outcomes presented in Section 4, is discussed in this section. Additionally, Section 5 offers implications for social change, as well as recommendations for action and further study.

## Interpretation of the Findings

The purpose of this study was to determine whether daily calendar group time improved the mathematical abilities of prekindergarten children. When pretest scores were controlled for, the study revealed no statistically significant differences between the posttest scores of children who participated in daily calendar group time instruction and those of children who did not participate. Pre- to posttest comparisons of scores revealed that the children who participated in daily calendar group time did not learn more mathematics than the children in the comparison group. Therefore, these results suggest that participation in daily calendar group time does not significantly affect children's mathematical abilities.

There are several possible reasons that prekindergarten students who participated in daily calendar group time did not gain a significantly higher math score on posttests compared with the prekindergarten students who did not participate. Friedman (2000) argued that there is little evidence that calendar activities are meaningful to prekindergarten children. Some researchers contend that the instructional drill of daily calendar group time to teach young children math skills is not a developmentally appropriate practice and therefore is not effective in teaching preschoolers the math skills intended by early childhood educators (Beneke et al., 2008; Erikson Institute, 2014; Ethridge & King, 2005).

Researchers further caution that the time expended on daily calendar group time often does not accommodate a preschooler's short attention span. For example, Beneke et al. (2008) contended that daily calendar group time is often lengthy and results in little cognitive gain in the understanding of the calendar. Beneke and colleagues also stressed

that if preschool children are unable to understand the material and unable to attend to the activity presented, then daily calendar group time instruction is developmentally inappropriate for them. Zaghlawan and Ostrosky (2011) warned that group calendar instruction produced more behavior problems than other common circle-time activities, noting that, in fact, calendar routines are one of the top activities that lead to challenging behaviors among preschool-aged children.

This study also shows that, when pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of socioeconomically disadvantaged prekindergarten children who participated in daily calendar group time and those of such children who did not participate. (The study also revealed statistically significant differences between the math achievement posttest scores of socioeconomically disadvantaged students and students not considered economically disadvantaged, regardless of whether they were in the treatment or the control group.)

There are some possible reasons that low-SES prekindergarten children who participated in daily calendar group time did not gain a significantly higher math score on posttests compared with such children who did not participate. Young children who live in low-SES homes often struggle to gain standard core mathematics skills they will need to be successful in kindergarten and thus are at risk of future school failure (Claessens & Engel, 2011; Geist & Geist, 2009; Jordan et al., 2006; Son et al., 2013). Results from this study suggest that exposure to daily calendar group time is a practice that may not be beneficial in developing mathematical abilities for any children. Taking these two findings together may lead to the inference that daily calendar group time activities could

be even more ineffective in building math skills among socioeconomically disadvantaged preschoolers than in building math skills among their nondisadvantaged peers.

Results of the study showed that when pretest scores are controlled for, there is no statistically significant difference in the early numeracy posttest scores of prekindergarten ELLs who participated in daily calendar group time and those of such children who did not participate. Furthermore, ELL students had significantly lower posttest scores than did non-ELL students when pretest scores, calendar exposure, and SES status were controlled for. In fact, ELLs who are also socioeconomically disadvantaged had the least math gains of all the groups. This finding agrees with those of Frueh (2009), who stressed that children who are ELLs living in low-income households suffer the most from lack of effective math skill instruction.

There are several possible reasons that prekindergarten ELLs who participated in daily calendar group time did not gain significantly higher math scores on posttests compared with prekindergarten ELLs who did not participate. Researchers agree that ELLs lag considerably behind their English-proficient peers in gaining basic mathematics skills before entering kindergarten (Chang, 2008; Stein, 2011). Furthermore, researchers stress that most early childhood educators lack the knowledge needed to provide instructional methods to teach ELLs early math concepts effectively (Dillon & Wanjiru, 2013; Perry, 2011; Stein, 2011; Steinberg, 2013). Therefore, if daily calendar group time is ineffective in building preschool children's early math skills in general and researchers continue to suggest that ELLs already lag behind their English-proficient peers in math acquisition, then daily calendar group time activities would be significantly less effective in building ELLs' math skills.

Although there were limitations to this study, such as sample size and the fact that this was not a true experimental study, its findings showed no statistically significant differences between the posttest scores of children who participated in daily calendar group time and the scores of children who did not participate. The study concludes with a call to action for continued inquiry into the instructional practice of prekindergarten daily calendar group time and the gap between teacher intentions and student outcomes.

## Recommendations for Action

I examined whether daily calendar group time has a positive effect on prekindergarten students' mathematical abilities over the course of a school year. Although the study used children's assessment data from only one preschool setting, the findings from this study may be valuable. The lack of a statistically significant gain in math skills by young children who participated in daily calendar group time compared with those children who did not participate is an important piece of evidence for early educators that the practice of daily calendar group time may not provide the intended and desired math skill outcomes. Given that the instructional practice of daily calendar group time was shown to be ineffective, perhaps it should be questioned by NC Pre-K administrators and practitioners. Therefore, this study has important implications for social change.

Early childhood educators must continue to search for effective approaches, practices, and curricula that improve the math skills of the young children they serve. The results of this study show that daily calendar group time, a widely popular whole-group practice intended to build math skills in young children, may not be effective in improving such skills. Early childhood educators thus need to question the practice and

need to suggest more effective practices that do teach young children basic math skills. Further questioning the use of daily calendar group time as an instructional math practice, seeking effective classroom math curricula, and improving preservice and professional development opportunities for early childhood educators to build their knowledge of effective math practices will all help in attaining these goals.

## Recommendations for Further Study

This study should not serve as the sole basis on which to decide whether to remove daily group calendar time as an instructional practice in NC Pre-K classrooms. It can, however, offer insight into the effectiveness of this instructional practice for students' mathematics achievement. One might question whether these results would significantly differ in a center where the instructional practice of daily calendar group time was the major focus of daily math instruction.

Following are recommendations for further study regarding the use of daily group calendar math activities to build prekindergarten children's mathematical abilities:

1. Conduct a similar research study involving a larger sample size.
2. Conduct a similar research study that includes early childhood programs with greater focus on daily calendar group time.
3. Conduct a similar research study that examines other possible cognitive gains using the instructional practice of daily calendar group time in preschool classrooms.
4. Conduct a similar research study with a more rigorous methodology using randomized trials.

5. Combine various sources of qualitative and quantitative data, such as teacher surveys, interviews, and classroom video, to reach a broader understanding of the effect of the daily calendar group time on the math achievement of prekindergarten children.
6. Explore more developmentally appropriate and effective ways to implement the instructional calendar model for preschoolers. Focus on building children's skills of prediction and organization rather than on drilling numeracy skills or conveying passage-of-time concepts.
7. Examine prekindergarten teachers' early math professional development background as a potential factor in improving children's math achievement.

## Conclusions

By examining the effectiveness of daily calendar group time on the mathematical gains of prekindergarten students, this study contributes to the body of knowledge. The study failed to show a statistically significant difference in the math achievement posttest scores between children who participated in daily calendar group time and those who did not. There was also a lack of statistically significant difference between the math achievement posttest scores of children who were identified as socioeconomically disadvantaged who participated in daily calendar group time and the scores of such children who did not participate. According to the analysis of the data, ELL students who participated in daily calendar group time also did not perform significantly better than ELL students who did participate. Results from this study suggest that exposing prekindergarten children to daily calendar group time may not have a significant effect on children's math skills acquisition. Educators need to strive to build their content

knowledge and to effectively implement developmentally appropriate instructional practices that significantly assist in building basic math skills in prekindergarten-aged children.

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