5-1-2011

Do our children add up? A meta-analysis of the longitudinal effects of kindergarten schedule and mathematic achievement

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Recommended Citation
Hill, Anita, "Do our children add up? A meta-analysis of the longitudinal effects of kindergarten schedule and mathematic achievement" (2011). *Dissertations*. 156.
https://digscholarship.unco.edu/dissertations/156

University of Northern Colorado

Greeley, Colorado

The Graduate School

DO OUR CHILDREN ADD UP? A META-ANALYSIS OF THE LONGITUDINAL EFFECTS OF KINDERGARTEN SCHEDULE AND MATHEMATIC ACHIEVEMENT

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

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College of Education and Behavioral Sciences
School of Psychological Sciences
Educational Psychology

May 2011

This Dissertation by: Anita Hill

Entitled: *Do Our Children Add Up? A Meta-Analysis of the Longitudinal Effects of Kindergarten Schedule and Mathematic Achievement*

has been approved as meeting the requirements for the Degree of Philosophy in the College of Education and Behavioral Sciences in the School of Psychological Sciences, Educational Psychology.

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Date of Dissertation Defense   April 6, 2011

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ABSTRACT

Hill, Anita. *Do Our Children Add Up? A Meta-Analysis of the Longitudinal Effects of Kindergarten Schedule and Mathematic Achievement.* Published Doctor of Philosophy dissertation, University of Northern Colorado, 2011

From an early age, children are exposed to mathematical experiences. These experiences influence the child's thinking about his or her abilities to do mathematics. Children who participate in early childhood programs may have experiences that develop positive attitudes toward mathematics. However, not all children have that opportunity. Children who struggle with mathematics may not have developed a strong foundation to support future skills. One approach for early intervention is participation in full-day kindergarten. Considerable research has been conducted on the effectiveness of half-day vs. full-day kindergarten. While there have been attempts to synthesize this research through meta-analysis and narrative reviews, none of the previous studies have focused exclusively on mathematics. Rather, they have focused on general academic or literacy effects of the schedules. The purpose of the proposed study was to investigate whether students who participate in full-day kindergarten have a long-term advantage over half-day kindergarten in mathematic achievement during Grades 1-4, and to examine some of the moderator variables that may influence the effect. The method**,** which was employed, was a meta- analysis of existing research. These studies showed a statistically significant difference in children's mathematical achievement when they attended full-day kindergarten. Unfortunately, the difference is not long term. Attendance at full-day kindergarten makes a difference in mathematical achievement during kindergarten and first grade. More studies need to be done to investigate reasons why the decline in mathematic achievement occurs after the first grade. Potential areas for future research include teacher training, the mathematics curriculum, and philosophical approaches to teaching.

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CHAPTER 1

INTRODUCTION

Mathematic difficulties are widespread in the United States (U.S.; Jordan, Kaplan, Olah, & Locuniak, 2006). In the U.S., nationally representative data on student achievement come primarily from two sources: The National Assessment of Educational Progress (NAEP) and U.S. participation in international assessments, such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA; National Center for Education Statistics [NCES], 2009b). The NAEP is used to measure fourth, eighth, and twelfth grade students' performance in mathematics and science, among other subjects, with assessments designed specifically for national and state information. The TIMSS is the major source for internationally comparative information on mathematics and science achievement of students in the fourth and eighth grades, and PISA is the primary source of students in the upper grades at an age that is near the end of compulsory schooling (NCES).

The PISA (NCES, 2009b) is an international assessment that is used to measure the performance of 15-year-olds in reading literacy, mathematics literacy, and science literacy every 3 years. It was partnered with the Organization for Economic Cooperation and Development (OECD), an intergovernmental organization of 34 member countries, in the 2009 assessment, and the results showed that the average score of 487 of U.S. 15-

year-olds was lower than the OECD average of 496 (NCES, 2009b). Of the 34 participant countries, 17 had higher scores than the U.S., 5 had lower scores, and 11 had average scores not measurably different from the U.S.

A report conducted by NCES (2009a) demonstrated that the NAEP results for Grades 4 and 8 showed no significant changes from 2007 to 2009 at Grade 4; however, Grade 8 scores showed an upward trend with a 2 point increase. The NCES staff reported that only five states and jurisdictions made gains at both Grades 4 and 8 (e.g., District of Columbia, Nevada, New Hampshire, Rhode Island, and Vermont). Colorado, Kentucky, and Maryland made gains in Grade 4 only, and 10 states (e.g., Connecticut, Georgia, Hawaii, Idaho, Missouri, Montana, New Jersey, South Dakota, Utah, and Washington) made gains in Grade 8 only**.** Even though the scores for these states showed improvement, there seemed to be a huge discrepancy in scores from state to state. The percentage of children who performed below Basic levels (i.e., Basic level is different in each state) ranged from 31% in Mississippi and 30% in Alabama to 8% in Massachusetts (NAEP, 2005). States with the highest number of students performing in the Advanced category were Massachusetts (12%), Minnesota (11%), and New Hampshire (10%; NCES, 2009a). This posed a strong case that students in the U.S. can be competitive in mathematics internationally, state wide, and individually.

The increase in scores may be attributed to the No Child Left Behind Act of 2001: Improving the Academic Achievement of the Disadvantaged, 20 U.S.C. § 6301-6578 (2008; NCLB). The purpose of the NCLB is to support standards-based educational reform, which is based on the belief that setting high standards and establishing measurable goals can improve individual outcomes in education. The purpose of the NCLB is “to ensure that all children have a fair, equal, and significant opportunity to obtain a high quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments” (NCLB § 6301). It “requires states to develop assessments in basic skills to be given to all students in certain grades, if those states are to receive federal funding for schools” (U.S. Department of Education, 2003, p. 1). The assessments required in certain grades provides an opportunity to examine mathematics achievement over time.

Of the 12 countries that participated in all three international assessment, the staff of the American Institute for Research (AIR; 2005) found that the U.S. mathematics scores ranked: (a) 8th on the TIMSS-4, (b) 9th on the TIMSS-8, and (c) 9th on the PISA. Their conclusion was that the initial Grade 4 international performance of a country is likely to be where that country ends up performing internationally for 15 year-olds; thus, countries that want to improve their mathematics performance should start by building a strong mathematics foundation in the early grades.

Justification for the Study

One source of individual differences in mathematic performance in elementary school is the mathematical knowledge children have at the beginning of the first grade. Aunola, Leskinen, Lerkkanen, and Nurni (2004), Duncan et al. (2007), and Hannula, Lepola, and Lehtinen (2010) suggested that attendance at a full-day kindergarten may lead to greater mathematical knowledge at the end of kindergarten than attendance at a half-day kindergarten, especially for children from a less privileged background. At the current time, it is not known if this advantage persists past kindergarten. In this current study, the author examined whether the greater mathematical knowledge continues through Grades 1-4.

The beneficial effect of kindergarten on mathematical knowledge appears to stem from general enrichment of the whole child, rather than only to mathematical instruction (Ray & Smith, 2010). In building a foundation for the development of number sense, number relationships in problem-solving situations and communicating their reasoning, young children need interactive experiences with everyday objects, materials, and their environment (Allen-Young et al., 2003). Children are exposed to mathematics in their daily lives through play, conversation, and exploration. Wishon, Crabtree, and Jones (1998) stated, “Investigating and thinking mathematically are more a function of the interest children show in things ordinarily and naturally, not things that take place only when children interrupt their childhoods, as it were, to take time to study math” (p. 223). Students start building beliefs about their abilities to do mathematics. These beliefs influence their thinking about, performance in, and attitudes toward, mathematics and decisions related to studying mathematics in later years (NCTM, 2000). Some support for mathematical learning is intuitive, comes from real life experiences and play, and begins before children enter school (Allen-Young et al.). Infants spontaneously recognize and discriminate among small numbers of objects, and many preschool children possess a substantial body of informal mathematical knowledge (NCTM). From the day they notice their environment, children are learning about distance, size, shape, and weight (Allen-Young et al.).

Children develop mathematical understanding and mathematical relationships when tactile and visual opportunities are provided with the use of manipulative materials.

(Wishon et al., 1998). When children are given materials to play with and time to explore, they have opportunities to construct their knowledge about mathematics. This opportunity to play and explore with mathematical materials becomes connected with enjoyable play, and children will tend to develop positive attitudes toward mathematics (Johnson, Christie, & Yawkey, 1999). This play supports cognitive development as the child works symbolically with art materials, dramatic improvisation, and other modes of representation in order to construct patterns of meaning from interactions with things and people (Armstrong, 2006). To help support cognitive development during play, teachers can choose materials and activities that enhance children's mathematical curiosity. This is seen as the opportunity for children to construct knowledge, develop self-regulation skills, acquire content knowledge, and deepen their intellectual understanding of various concepts with the help of teachers and peers (Frede & Ackerman, 2007).

Children who participate in early childhood programs may have experiences that develop positiive attitudes toward mathematics. However, not all children have that opportunity. Most children receive little to no exposure to mathematical thinking, language, and concepts before they enter formal schooling environments (Balfanz, Ginsburg, Greenes, Sarama, & Clements, 2003). Children with weaknesses in basic arithmetic may not develop the conceptual structures required to support the learning of advanced mathematics (Jordan et al., 2006). If children's learning needs can be identified in the early elementary grades, educators may be able to design interventions that prevent failure in mathematics.

One approach for early intervention is participation in full-day kindergarten. Children benefit from a developmentally appropriate, full-day program, most notably in terms of early academic achievement (WestEd, 2005). Full-day kindergarten can afford children the academic learning time needed to prepare for mastery of primary-grade reading and mathematical skills, in doing so, such programs help circumvent subsequent needs for remediation or grade retention (WestEd). In previous meta-analyses, Fusaro (1997), Hill (2010), Jones (2002), and Karweit (1987) found that children do benefit academically from full-day kindergarten programs. Can this explain part of the growth stated in the NAEP (2005) report? Will this benefit continue in later years? The current study is a meta-analysis of longitudinal studies measuring the effect of full-day kindergarten vs. half-day kindergarten on mathematics achievement.

Theoretical Background

The founder of the kindergarten system was a German Educational reformer, named Friedrich Froebel (Ross, 1986). His system was a preschool curriculum for 3-7 year-old children that aimed at unfolding the child’s physical, intellectual, and moral nature with balanced emphasis on each of them. Ross reported that three areas were used in developing the child’s nature: (a) the gifts or play things; (b) the handiwork activities; and (c) songs, games, stories, and gardening. Froebel believed one phase of education must build on the child’s previous development. He put an emphasis on a child’s natural activities and its use of those activities for constructive purposes. By combining observation with actual doing through play, a child was allowed to develop his or her abilities and express his or her own creative impulses. Froebel’s goal for the kindergarten system was to link the joy the child felt in playing to his or her attitudes toward work and the rest of school activities.

Staff of the National Mathematics Advisory Panel (2008) reported that most children acquire considerable knowledge of numbers and other aspects of mathematics before entering kindergarten. This is important, because the mathematical knowledge that kindergarteners bring to school is related to their mathematics learning for years thereafter in elementary school, middle school, and even high school.

According to Magnuson, Lahaie, and Waldfogel (2006), a majority of U.S. kindergartners have attended some form of preschool in the year before kindergarten. They reported that children who attended preschool enter school with higher levels of academic skills, compared with children who attended only informal child care or were at home with their parents. Unlike years ago, when kindergarten was a place to learn to discover, socialize, and play within a festive like atmosphere, today, kindergarten provides children with the pre-academic skills necessary for the formal academic work of first grade (Pagani, Jalbert, & Girard, 2006).

Most children come to kindergarten with some degree of number sense, although there are wide individual differences (Jordan, Kaplan, Locuniak, & Ramineni, 2007). Poor achievement in mathematics is a national concern, and early screening in kindergarten and first grade can identify children in need of educational support or intervention before failure occurs.

Purpose of the Study

Considerable research has been conducted on the effectiveness of half-day vs full-day kindergarten. Some studies found a significant difference in favor of full-day kindergarten (Adcock, Hess, & Mitchell, 1980; Brierley, 1987; Holmes & McConnell, 1990; Hough & Bryde, 1996) while others found no significant difference (Evans &

Marken, 1983; Hildebrand, 1997). Although there has been an attempt to synthesize this research through meta-analysis and narrative reviews, none of the previous studies have focused exclusively on mathematics. Rather, they have focused on general academic or literacy effects of the schedules.

The purpose of this study was to investigate the longitudinal differences in student mathematical outcomes for children in a full-day kindergarten program in comparison to children in a half-day program. This author investigated whether full-day kindergarten has a long-term advantage over half-day kindergarten in mathematic achievement during Grades 1-4, and to examine some of the moderator variables that may influence the effect. The method employed was a meta-analysis of existing research.

Meta-analysis is the preferred mode to assess the differences in the effects of the schedules (Fusaro, 1997; Jones, 2002; Karweit, 1987). A meta-analysis is a systematic procedure for statistically combining the results from many different studies. They may contrast with narrative reviews, which are likely to suffer from subjective factors such as the: (a) selective inclusion of studies, (b) selective weighting of certain studies, as well as (c) misrepresentation of findings and other factors (Borenstein, Hedges, Higgins, & Rothstein, 2009). The need to provide synthesis of research and the accompanying difficulties in providing accurate and unbiased summaries of research was the impetus for the inception and rapid growth of meta-analysis (Hunt, 1997).

In previous meta-analysis conducted on the effect of half-day vs. full-day kindergarten (Fusaro, 1997; Jones, 2002; Karweit, 1987), the focus was on kindergarten scores from standardized assessments, teacher assessments, and parent surveys, and they had a number of limitations. First, they combined literacy and mathematic scores rather than a separation of the mathematics effects. Second, they are somewhat dated. Thirdly, they have at least two major methodological faults. Each of them employed measures of effect sizes that were biased on smaller sample sizes (Hedges & Olkin, 1985). Two of them employed Cohen’s d, and one employed Glass’s delta. In addition, all three meta-analyses applied a fixed-effect model rather than the more appropriate random effect model.

One of the primary goals of a meta-analysis is to calculate an average effect size and establish confidence for the set of individual studies in the analysis. An effect size is calculated for each study, and each effect size is weighted by a function of its standard error or sample size. Two models may be used to accomplish these processes, fixed-effects and random-effects (Borenstein et al., 2009). In the fixed effect model, it is assumed that there is one effect size for the population, and the studies differ only due to sampling error. In the random effect model, the variability between the estimated effect sizes are not only due to sampling error, but also to true variance among the studies. This true variance may be due to different aspects of the studies. For example, in the current study, such variations could be: (a) the demographic characteristics of students attending kindergarten, (b) the curriculum, (c) formal training of the staff, (d) number of staff, (e) length of the session, as well as (f) additional variables. Since the random effect model is generally considered more realistic, it is generally recommended (Kisamore & Brannick, 2008) except when the numbers of studies in the meta-analysis are few (Borenstein et al.). For the purpose of this meta-analysis, five or more studies were required at each grade level to be considered in the analysis.

Significance of the Study

Reports from the National Mathematics Advisory Panel (2008) and the American Institute for Research (2005) described policy implications and suggestions to help improve U.S. mathematics systems. Staff of the American Institute for Research observed that the U.S. must do a better job of establishing a strong foundation of students' initial mathematics knowledge in the early grades. This meta-analysis is an effort to help school districts build those foundations by determining which kindergarten program is most effective. School districts can use the research to consider the advantages and disadvantages of each program.

There are multiple reasons for participating in a full-day kindergarten program. First, children benefit academically and socially, especially children from low socioeconomic or educationally disadvantaged backgrounds (Housden & Kam, 1992). Second, full-day programs provide more time for a variety of experiences, which allows teachers and children time to explore topics in depth (Rothenberg, 1984). It provides more time for individualization and fewer children per teacher, so children's individual needs can be accommodated (Gullo & Maxwell, 1997). Full-day programs also reduce the ratio of transition time to class time and provide an environment that favors a child centered, developmentally appropriate approach (Rothenberg, 1995).

Critics of full-day kindergarten point out some of the disadvantages. An increase of stress can arise due to inappropriate curricular approaches, and a child may become overly tired due to longer days (Elicker & Mathur, 1997). The added expense of teaching staff, aides, and finding more classroom space may also cause difficulty (Rothenberg, 1984).

Advocates for half-day kindergarten programs believe that a half-day schedule is ample time in school for the attention span of a 5-year-old span. The extra time at home allows for children to experience less structured interactions with adults in their own home setting (Rothenberg, 1984).

The mid-day disruption is the most obvious disadvantage for the half-day kindergarten program. If busing is not provided by the school, parents are imposed upon to make transportation arrangements (Rothenberg, 1984). The students of half-day programs also miss some of the opportunities for field trips, enrichments, or assemblies.

In this current study, the author investigated whether an academic benefit of full-day kindergarten exists for mathematical scores and for how long. This should provide needed information to help school districts justify their decisions for the most effective program.

Research Questions

The following specific research questions were used in this investigation.

Q 1 Does full-day kindergarten have a long-term advantage over half-day kindergarten in mathematic achievement during Grades 1 through 4?

Q 2 Does the effect vary as a function of the moderator variables investigated in this study?

Limitations of the Study

Many studies have been conducted to examine the advantages of full-day kindergarten in comparison to half-day kindergarten. However, the studies were not focused on the same variables. Some studies were focused on literacy (Bassett, 2008; DeCosta, 2005; Tatum, 1999), others were on alternate day schedules (Cleminshaw & Guidubaldi, 1979; Mouw, 1976), and others on multiple variables including mathematics

(Baldus, 2001; Thompson, 1990; Wolgemuth, Perie, Grigg, & Dion, 2006). Due to the inconsistency of information provided, studies were chosen to meet specific criteria. Each study in this meta-analysis must have been an empirical comparison of full-day and half-day schedules (e.g., parent surveys, teacher surveys and alternate kindergarten schedules were not explored), reported results on mathematic achievement in grades past kindergarten, and used a standardized test to measure mathematic achievement (i.e., not one developed by the teacher). Through this selection process, some studies may have been eliminated that could potentially alter the outcomes.

Studies based on the data from the Early Childhood Longitudinal Study (ECLS) were not used in this meta-analysis. Multiple studies used the same data base, the data sets were not always broken down by schools or districts, and the information provided in some of the studies was not sufficient. In addition, studies using this data base reported multiple results which may alter or bias the results of a meta-analysis. The ECLS program provides national data on early education programs, school, and children’s experiences and growth through the eighth grade (NCES, 2009a).

Definition of Terms

Kindergarten has been in the U.S. for over 100 years (Walkowiak, 2007). During that time, the kindergarten schedules have changed many times. It went from full day in the beginning to half days during World War II, then back to full days again. In an attempt to address overcrowding, other schedules were introduced, alternate days, and extended days are also options. The following schedules have been identified in the literature:

1. Full-Day Kindergarten – 5 days a week, approximately 6 hours a day;
2. Half-Day Kindergarten – 5 days a week, approximately 2.5 hours a day;
3. Alternate-Day Kindergarten – 3 days one week, 2 days the next, approximately 6 hours a day;
4. Extended-Day Kindergarten – half-day kindergarten with an after school program of some type;
5. Modified Kindergarten – a schedule that is a hybrid between half-day and full-day kindergarten. A student will attend a half-day session 2 days each week, and the other 3 days are full-day sessions; and
6. Cohort - a collection of students within a study who started kindergarten in the same year.

Effect Size: the magnitude of the difference between full-day and half-day in mathematics achievement. It is equivalent to the magnitude of the treatment effect of full-day kindergarten. Effect size is measured by Hedge's g (Borenstein et al., 2009).

p-value: for any study, the p-value is a function of the observed effect size and the sample size (Borenstein et al.).

CHAPTER 2

REVIEW OF LITERATURE

Children who participate in early childhood education find more success in later schooling (Hildebrand, 1997). Early childhood education ages range from infants a few weeks old to children around age 6, and kindergartens are the most universal early childhood service (Hildebrand). In a study conducted by Howard (1986), students who attended kindergarten performed at higher levels of achievement in the elementary grades of 1-3 than the students who did not attend kindergarten. Other studies also show kindergarten has a significant and positive effect on academic outcomes (Cage & Emerson, 1973; Dhuey, 2011; Prince, Hare, & Howard, 2001). While kindergarten appears to have a long term effect in comparison to no kindergarten, there is little consensus about whether certain schedules or curricula are more effective than others.

Curriculum

Kindergarten was developed by German educator Friedrich Froebel. Froebel made a case for the importance of music, nature study, stories, and play as well as symbolic ideas like children sitting together in the kindergarten circle (Berg, 2008). Kindergartens were child-centered and emphasized learning-by-doing, natural experiences, and development of the whole child through free play (Bartolini & Wasem, 1985). This curriculum, characterized as having experiential/social/play orientation, is rooted in the principles of child development and is generally referred to as a developmentally oriented curriculum (Bartolini & Wasem).

Egertson (1987) reported that kindergarten programs derived from a child development orientation do not base activities on the learning of discrete skills, but rather follows the mission of moving each child as far forward in his or her development as possible. The classroom environment is designed so children can self-select activities; materials are logically organized, usually into several interest areas containing many options ranging from easy to difficult, so that a wide range of abilities is accommodated.

Members of the National Association for the Education of Young Children (Copple & Bredekamp, 2009) identified developmentally appropriate practices in five areas, which are important in the teacher's role: (a) creating a caring community of learners, (b) teaching to enhance development and learning, (c) planning curriculum to achieve important goals, (d) assessing children's development and learning, and (e) establishing reciprocal relationships with families. Examples of creating a community of learners include teachers: (a) being warm, caring, and responsive; (b) model positive interaction with others; (c) actively involve children in conflict resolution; and (d) give all children a chance to participate and work with partners as well as in small and whole group situations.

Teaching to enhance development and learning examples include: (a) fostering a learning environment that encourages exploration, initiative, positive peer interaction, and cognitive growth; (b) provide a variety of engaging learning experiences and hands-on materials; and (c) allow time each day for child-guided experiences, including play (Copple & Bredekamp, 2009). Kindergarten children are able to work together in special ways by sharing expertise and ideas and expressing their concerns and accomplishments with each other (Pitcher, Feinburg, & Alexander, 1989).

Bartolini and Wasem (1985) described the traditional kindergarten curriculum as a program which focuses upon the social, emotional, and physical development of children. Copple and Bredekamp (2009) added the factors of cognitive, physical education and health, language and literacy, mathematics, science, social studies, and creative arts as key goals for curriculum to address. Teachers are to: (a) plan and implement experiences to help children achieve important developmental and learning goals; (b) value children's input and let them shape curriculum as appropriate; and (c) connect curricular topics with children's interests and with what children already know and can do.

Assessing children's development and learning should be strategic and purposeful. Armstrong (2006) reported that over half a million 4-year-olds sit for a 20- to 30-minute standardized test that covers their achievement in literacy and number skills. These standardized tests and others are used to assess program quality, conduct research, and evaluate the progress of children on a regular basis. Copple and Bredekamp (2009) identified four specific, beneficial reasons for assessment: planning and adapting curriculum to: (a) meet each child's developmental and learning needs, (b) help teachers and families monitor children's progress, (c) evaluate and improve teaching effectiveness, and (d) screen and diagnose children with disabilities or special learning or developmental needs.

Copple and Bredekamp (2009) identified the fifth area for the teachers' role in developmentally appropriate practice is to establish reciprocal relationships with families.

One way this is done is by soliciting parents' knowledge about their children and input about their goals and concerns, and then uses this information in ongoing assessment, evaluation, and planning. Families are also welcome to visit the classroom, participate in various activities such as volunteering in the classroom, accompanying children on field trips and attending school events. The connection between the child's home and classroom can foster strong supportive relationships that will last throughout the school year.

Bartolini and Wasem (1985) claimed that approaches to kindergarten education have changed in the last decade or two. By the 1980s, kindergartens in the United States had moved away from play based chil-centered education toward academic preparation for first grade (Berg, 2008). Egertson (1987) explained that kindergarten is characterized by the direct teaching of specific discrete skills, particularly in reading and math. Children are expected to master these skills before going to first grade. Other characteristics include limited availability of concrete materials; pencil-and-paper oriented work; and little opportunity for conversation among children and between children and adults (Egertson). Spodek (1981) reported that, with the addition of instruction in academics in the kindergarten, the losses have been in terms of those activities that traditionally have been highly prized: art, music, science as well as opportunities for expression and play. Children exposed to curriculum that blends child-initiated and teacher-directed activities within a comprehensive program model are found to have the highest levels of school readiness and early school achievement (Reynolds, Magnuson, & Ou, 2010).

Developmentally appropriate practice for teaching mathematics encourages the teacher to provide focused math time that is interesting to children, using various instructional contexts and find opportunities to integrate mathematics learning with other curriculum areas (Copple & Bredekamp, 2009). Teachers build on children's current knowledge, making sure that children consolidate their understanding of a concept before moving ahead. Teachers use a variety of strategies to engage children in reasoning, problem solving, and communicating about mathematics. The three most important content areas for kindergartners are: (a) number and operations, (b) geometry, and (c) measurement. According to Copple and Bredekamp, covering too many topics interferes with children's gaining deep understanding of the concepts and skills important to prepare them for the next steps in their mathematics learning.

Teacher Training

Well educated teachers should be able to teach and instruct mathematics within the early childhood environment; however, dramatic differences exist in the training and skills of teachers working with young children (Rudd, Lambert, Satterwhite, & Zaier, 2008). The Colorado Department of Education (2010) reported that student achievement is connected to teacher quality. No Child Left Behind aims to ensure that children are taught by *highly qualified* teachers with strong content knowledge (NCLB § 6311(b)(8)(C)). Highly qualified teachers must have a bachelor's degree, full state certification or licensure, and be able to demonstrate subject matter competency in each core content are in which they are assigned (Colorado Department of Education; U.S. Department of Education, 2003).

According to Copple and Bredekamp (2009), many teachers lack the current knowledge and skills needed to provide high-quality care and education to young children. Research suggests that teacher ability, teacher education, and teacher experience show very strong relations with student achievement (Greenwald, Hedges, & Laine, 1996; Kauerz, 2005). However, a mismatch between the teaching qualifications expected of professionals lie between those who teach children 5 years old and older and those who teach in early childhood programs (Kauerz). Factors that can contribute to a lack of teacher knowledge include the lack of a standard entry-level credential, wide variation in program settings and auspices, low compensation, and high turnover (Copple & Bredekamp). Teachers with elementary education certificates were considered highly qualified to teach kindergarten even though they had little or no training in early childhood education (Bartolini & Wasem, 1985). Rudd et al. (2008) suggested that teachers of early childhood students develop methods for teaching young children, and have an understanding, a plan, and a method for teaching children what they need to know about the world around them, including mathematics and other content areas. Children benefit most when teachers utilize skills, knowledge, and judgement to make good decisions (Copple & Bredekamp).

Socioeconomic Status

Jones (1998) identified children, who are earmarked for failure, as those who cannot sit still, cannot listen, cannot concentrate, and cannot follow directions. The children do not know colors, cannot name seasons, and they hold picture books upside down. Slavin and Madden (1989) suggested that every child can learn; however, many students fail, which reflects the incapacity of school staff to meet the needs of the child.

A child in danger of failing to complete his or her education with an adequate level of skills is *at-risk* (Slavin & Madden). The staff of the No Child Left Behind Act (2001) defined the at-risk child as a school aged individual who is at-risk of academic failure, is at least 1 year behind the expected grade level for the age of the individual, has limited English proficiency, or has a high absenteeism rate at school. Poor families dealing with their own academic failures might experience more stress and have negative relationships with the schools. They read less with their children, offer less enriching environments, and engage in less cognitively stimulating activities during early childhood (Pagani, Jalbert, & Girard, 2006).

The staff of the North Central Regional Educational Laboratory (NCREL; n.d.) reported that a family's socioeconomic status is based on family income, parental education level, parental occupation, and social status in the community. Also, the NCREL staff made the following observation about socioeconomic status:

> Families with high socioeconomic status often have more success in prepaing their young children for school because they typically have access to a wide range of resources to promote and support young children's development. They often seek out information to help them better prepare their young children for school. Families with low socioeconomic status often lack the financial, social, and educational supports that characterize families with high socioeconomic status. Poor families also may have inadequate or limited access to community resources that promote and support children's development and school readiness. Parents may have inadequate skills for such activities as reading to with their children. Having inadequate resources and limited access to available resources can negatively affect families' decisions regarding their young children's development and learning. As a result, children from families with low socioeconomic status are at greater risk of entering kindergarten unprepared than their peers from families with median or high socioeconomic status. (p. 1)

The Elementary and Secondary Education Act went through fundamental changes as President Bush redefined the federal role in K-12 education to close the achievement gap between disadvantaged and minority students and their peers (U.S. Department of Education, 2003). As a result , the NCLB was initiated. Some of the fundamental reforms address options for parents of children from disadvantaged backgrounds, strengthening teacher quality, and improving the academic achievement of the disadvantaged:

1. Parents of children from disadvantaged backgrounds whose children are trapped in failing schools would be allowed to transfer their child to a better performing public or charter school immediately after a school is identified as failing.
2. Federal Title 1 funds can
    a. be used to provide supplemental educational services – including tutoring, after school services, and summer school programs – for children in failing schools.
    b. States are to put a highly-qualified teacher in every public school classroom by 2005.
    c. Title 1 – Improving the academic achievement of the disadvantaged can be accomplished by:
        (1) ensuring that high-quality academic assessments, accountability systems, teacher preparation and training, curriculum, and instructional materials are aligned with challenging State academic standards so that students, teachers, parents, and administrators can measure progress against common expectations for student academic achievement;
        (2) meeting the educational needs of low-achieving children in our Nation's highest-poverty schools, limited English proficient children, migratory children, children with disabilities, Indian children, neglected or delinquent children, and young children in need of reading assistance;
        (3) closing the achievement gap between high- and low-performing children, especially the achievement gaps between minority and nonminority students, and between disadvantaged children and their more advantaged peers.
3. Risk factors identified by Slavin and Madden (1989) include low achievement, retention in grade, behavior problems, poor attendance, low socioeconomic status, and attendance at schools with large numbers of poor students. Classes in high-poverty schools were less likely to be staffed by a highly qualified teacher than classes in low-poverty schools (U.S.D.E., 2010). Examples of results from a summary of highly qualified teachers by the U.S. Department of Education include:
    a. In the majority of states (45 for secondary and 36 for elementary), high-poverty schools were less likely to have classes taught by highly qualified teachers than low-poverty schools.

b. In high-poverty schools, the percentage of classes taught by highly qualified teachers ranged from 100 percent (North Dakota) to 74 percent (District of Columbia) for elementary and from 100 percent (North Dakota) to 58 percent (Hawaii) for secondary.

c. In low-poverty schools, the percentage of classes taught by highly qualified teachers ranged from 72 percent (District of Columbia) to 100 percent (North Dakota) in elementary classes and from 66 percent (District of Columbia) to 99.9 percent (North Dakota) in secondary classes. (U.S. Department of Education)

In order for children to achieve success at each level of schooling, the schools must be organized differently. Slavin and Madden (1989) outlined the principles of a school plan devised for all grades. They noted that it is the responsibility of the school to see that everyone succeeds, recognize that success for everyone will not be cheap, emphasize prevention, emphasize classroom change, and use remedial programs as a last resort. Preschool, extended-day kindergarten, and first grade tutoring preventive programs have strong effects for a few years; however, they do not guarantee lasting success for all children (Slavin & Madden).

Current Research

The literature is inconsistent in answering the question: “Does full-day kindergarten make a difference?” Considerable research has been conducted on the effectiveness of half-day vs. full-day kindergarten. In an attempt to make sense of the research, multiple meta-analyses have been conducted (Fusaro, 1997; Hill, 2010; Jones, 2002; Karweit, 1987). Meta-analysis is the preferred mode to assess the differences in effects of the schedules and is a systematic procedure for statistically combining the results from many different studies.

In the meta-analysis conducted by Fusaro (1997), 23 studies were identified. Twenty-one of them used achievement-test results as the outcome measure, and the other

2 used teacher ratings as outcome measures. Ultimately, 21 studies were used for the meta-analysis. The results confirmed the research hypothesis that children who attend every-day full-day kindergarten achieved statistically higher scores (i.e., the mean effect size of .77 with a 95% confidence interval from .97-1.87) than did children who attended a half-day kindergarten.

Twenty-six studies were used in a meta-analysis conducted by Hill (2010). This analysis focused on the mathematic achievement of children participating in full day kindergarten compared to half day kindergarten. Most of the studies were unpublished, being either evaluation reports in ERIC or dissertations; only 2 were peer reviewed publications. All of the studies used standardized assessments as measures, reported scores, compared half-day to full-day schedules, and offered enough data to compute effect size. The average effect size was comparable to a difference on an achievement test between a mean on the 50th percentile for the half day and a mean on the 65th percentile for full day. These studies showed a statistically significant difference (i.e., a mean effect size .380 with a 95% confidence interval from .223-.533) in children's mathematical achievement when they attended full-day kindergarten.

Jones (2002) identified 25 studies to include in a meta-analysis. Upon further analysis, only 22 of the studies compared academic achievement of full-day every-day kindergarten to half-day kindergarten students, therefore, meeting the additional criteria for inclusion. The studies used in the meta-analysis supported the findings that students do benefit from all-day kindergarten programs (i.e., mean effect size for study .56; for math .37, reading .51, and language .58).

Karweit (1987) found different results in a study examining effects on students attending either full-day or half-day kindergartens. Findings from the 20 studies used in this analysis indicated that under-achieving and disadvantaged students benefitted from the additional instruction provided in full-day programs, but the benefits were found only on short-term measures. Disadvantaged students receiving additional instruction were the primary source of positive effects. No long-term effects were demonstrated. The added time gained in a full-day program may be valuable to disadvantaged students, but the type of instructional program provided may be even more important.

Research Favoring Short-Term Gains In Full-Day Kindergarten

The previous meta-analyses results focused on the immediate effects of full-day or half-day kindergarten programs. All showed a positive effect of full-day kindergarten programs, however, does that effect last? The following studies showed early gains; however, the achievement did not last past first grade (Baldus, 2001; Entwisle, Alexander, Cadigan, & Pallas, 1987; Minor, 2001; Walkowiak, 2007; Wolgemuth et al., 2006).

Baldus (2001) showed there was no statistical interaction between gender, number of parents in the home, absenteeism, and the type of kindergarten program on reading achievement for three cohort groups for Grades 1, 2, and 3. A significant difference was evident for math at Grade 1.

Entwisle et al. (1987) found that more kindergarten leads to some early positive effects on cognitive status during first grade performance for a sample of Baltimore students. African American children participating in full day kindergarten scored higher on the California Achievement Test in reading and mathematics than Anglo American children. They also determined that more kindergarten experience does not affect children's deportment, their personal maturity, expectation for their own performance, or their parent's expectations for them.

Minor (2001) had a double purpose for the study. The first was to determine a relationship between academic achievements of students who attended full-day or half-day kindergarten. The second was to determine if there was a relationship between kindergarten schedule and academic achievement of at-risk students and their non-at-risk peers. The results showed that students in full-day kindergarten performed better academically in reading and math than their peers in half-day. The results also showed that at-risk students in full-day kindergarten performed better academically than at-risk peers in half-day settings.

Walkowiak (2007) worked with 85 subjects from two district schools that qualified for a state grant providing full-day kindergarten to schools where the concentration of poverty exceeded the state average for the treatment group. The comparison group consisted of randomly selected subjects with similar pretest scores enrolled in 10 other district schools offering the traditional half-day program. The findings indicated that while the full-day schedule led to higher achievement by the end of kindergarten, the difference was explained by the higher scores of the Anglo American and non-poverty students. There was no difference by kindergarten schedule in the reading and math scores by the beginning of Grade 3.

Wolgemuth et al. (2006) compared the academic achievement of children enrolled in full-day kindergarten to children enrolled in half-day kindergarten on mathematic and reading in Grades 2, 3, and 4. The results showed that students in the full-day kindergarten demonstrated significantly higher achievement at the end of kindergarten than their half-day counterparts, but that advantage disappeared by the end of first grade.

Research Indicating Long-Term Academic Effects

Data on studies with long-term results were collected. Three of the studies showed results through Grade 2 (Gullo, 2000; Jarvis & Schulman, 1988; Oliver, 2008). Humphrey (1988), Lewis (2000), Schroeder (2007), and Truss (2001) looked at third grade scores. Duffy (1996), McIntosh (2006), Ohio State Department of Education (1992), and Thompson (1990) showed gains lasting to fourth grade.

Gullo (2000) indicated that 974 second grade children from a large Midwestern school district were subjects for the study. Seven hundred thirty of them participated in the full-day kindergarten program and scored significantly higher on both math and reading on a standardized achievement test.

Jarvis and Schulman (1988) found no consistent differences in mean reading achievement of half-day and all-day kindergarten children by the third grade. A small significant difference was evident for mathematical achievement in Grade 2.

Koopman’s (1991) evaluation of the long-term effect of attending an all-day kindergarten program on academic achievement found that students in Grade 1 who had attended the all-day program had a significant advantage over students who had attended a traditional half-day program. Two cohort groups were assessed, one that started Grade 1 in 1987 and the other in 1988. Both studies found a significant advantage of the full-day program over the half-day program. The mathematic achievement difference between the groups lost significance after the second year for the 1988 cohort and after the third year for the 1987 cohort.

Oliver (2008) conducted a study to determine the relationship between students who attended full-day kindergarten or half-day kindergarten and their second grade literacy and math achievement. The data showed no statistical difference between the two groups in relation to their second grade literacy, and there was only a small statistical difference in regard to their mathematic achievement.

Humphrey (1988) looked at test scores for Grades 3 and 7. The CTBS was administered to children in the experimental and control groups for all 3 years. The two groups were compared a total of 42 times. The mean scores of students, who attended full-day kindergarten, were higher on every test in all three grades and significantly so on 27 of the 42 comparisons. The scores for the total battery were significantly higher in favor of the full-day kindergarten students all 3 years.

Lewis (2000) found it difficult to reach conclusions or make valid generalizations regarding the advantages or disadvantages in academic achievement of at-risk students in a full-day kindergarten program. However, a significant difference was found in mathematical achievement through Grade 3.

Schroeder (2007) worked with 4,411 students in full-day and half-day kindergarten programs throughout the U.S.. The results showed that students of poverty in full-day kindergarten programs achieved significantly higher test scores in both Language Arts and Mathematics than students who participated in half-day kindergarten programs. This difference lasted until Grade 3.

Truss (2001) looked at the effects of half-day kindergarten vs. full-day kindergarten on third grade scores from students in seven schools in North Central Texas. One hundred fifty-four students from full-day kindergarten and 282 students from half-day kindergarten participated. The results showed no significant difference in reading scores between the two groups, however, students in full-day kindergarten scored significantly higher on the math section of the Texas Assessment of Academic Skills test than students in half-day kindergarten.

Full day kindergarten was compared to a modified kindergarten program in a dissertation done by Duffy (1996). Tracking 602 students in a certain school district on the Iowa Test of Basic Skills scores over an 8 year period showed a distinct advantage in mean scores for full day kindergarten students.

McIntosh (2006) investigated two Ohio school districts with similar demographics to explore the academic and social effects of a half-day kindergarten experience when compared to a full-day kindergarten experience. One of the school districts offered full-day kindergarten, and the other offered half-day kindergarten. The results showed a clear academic advantage for students in kindergarten and first grade who had received a full-day experience. The academic measures administered in second and third grade were not statistically significant; however, a small significant difference occurred in Grade 4 for mathematic achievement, which favored full day kindergarten.

Staff of the Ohio State Department of Education (1992) conducted a longitudinal study to examine the effects on children of three kindergarten schedules: (a) half day, (b) full day, and (c) alternate day. The effect was investigated from kindergarten through Grade 4. Participation in full day kindergarten was positively related to school performance through Grade 2. The results showed that children who attended preschool prior to kindergarten experienced greater success in elementary school than those who did not attend. It also showed that the child that, who is most likely to succeed in the elementary grades, is a girl who attended preschool, turned 5 in January before kindergarten entrance, and attended a full-day kindergarten program.

Thompson (1990) also found gains, which lasted through fourth grade for a specific group. The students were compared by use of the reading and mathematics scores from the Iowa Test of Basic Skills for Grades 1-4. The findings indicated significant differences between groups for those attending school through fourth grade for low-SES and ESL students. Marginal effects or no statistically significant effects were discovered for students attending through the third and second grades.

Research Favoring Half-Day Kindergarten

Bowman (1992), Pawk (2003), and Pope (1995) reported results in favor of the half-day kindergarten program. Bowman found statistically significant differences between full-day kindergarten and half-day kindergarten groups in reading and mathematics scores on the Basic Skills Assessment Program. Students who attended prekindergarten and subsequently kindergarten for a half day had significantly higher scores in Grades 1, 2, and 3 and were retained fewer times than students who attended prekindergarten and subsequently full-day kindergarten.

A study done by Pawk (2003) indicated that the half-day kindergarten group did significantly better on the Iowa Test of Basic Skills subtests including: (a) Kindergarten Vocabulary, (b) Kindergarten Listening, (c) Kindergarten Math, and (d) Kindergarten

Total. The study conducted by Pope (1995) was designed to assess mathematics and reading scores at the end of the third grade for students who attended all-day and half-day kindergarten programs as well as students without kindergarten. The results indicated that half-day students achieved higher mathematics scores than students who attended full-day programs at the end of third grade. Results also indicated that students who attend either full-day or half-day kindergarten programs obtain higher reading and mathematics scores than students without kindergarten experience (Pope).

Research Showing No Differences

Saam and Nowak (2005), Stofflet (1998), and Williams (2000) found no significant differences between full-day and half-day kindergarten programs. Saam and Nowak looked at the effects of kindergarten program on achievement of students with low/moderate income status. The results of the study indicated that there were no significant difference between students recorded as free meal code and students enrolled in Title 1 schools in either full-day or half-day kindergarten.

Stofflet (1998) found no major long-term effect from the type of kindergarten program students attended. There did seem to be a short term effect with full-day kindergarten students from Title 1 schools, who were better prepared for first grade than were their counterparts from half-day kindergarten.

Williams (1999) investigated the differences in the effects of kindergarten enrollment on the academic achievement of children within one school district. The participants were 241 first and second grade students. The findings of the study revealed no statistical difference in the achievement scores of students in the full-day and the half-day kindergarten program.

In this current study, the author investigated whether an academic benefit of full day kindergarten existed for mathematical scores in Grades 1-4 and whether the effect varied as a function of moderator variables. The findings from the current study provided needed information to help school districts justify decisions for the most effective program.

CHAPTER 3

METHODS

Retrieval Strategy

The retrieval strategy utilized in the current study followed recent guidelines (Reed & Baxter, 2009; Rothstein & Hopewell, 2009; White, 2009). The first step in a meta-analysis is to locate the research studies. The following data bases were searched: (a) *ERIC*, (b) *PsychInfo*, (c) *Wilson Education Web*, (d) *Education Research Complete*, (e) *Academic Search Premier*, (f) *Scirus*, (g) *Scopus,* (i) *ProQuest Dissertations & Theses,* and (j) *Google Scholar*. Whenever a document, was found, all references were searched for additional studies. The process of locating relevant studies started by searching for the terms: (a) full day, (b) all day, (c) partial day, (d) complete day, (e) extended day, (f) half-day, which were paired with the term, (g) kindergarten. Once found, these studies were searched for references to: (a) mathematics, (b) mathematic, (c) mathematical, and (d) arithmetic. The resulting subset was then searched for longitudinal studies.

In order to focus on the mathematical achievement of children participating in full day kindergarten compared to half day kindergarten, the studies met the following eligibility criteria: (a) the study must have been an empirical comparison between the two schedules, (b) the study must have reported results on mathematics achievement in the grades following kindergarten, (c) the measure of mathematics achievement was based upon a standardized test and not upon a teacher or project developed test, and (d) the study provided sufficient information to compute effect size. When multiple publications based on the same independent study were found, only one was included.

Coding

The coding procedure was based upon the guidelines for systematic coding (Lipsey, 2009; Wilson, 2009). In addition to effect and sample size, information on the characteristics of each study was coded. The characteristics were included as possible moderator variables. Moderator variables are variables that may influence the strength of the relations between type of kindergarten schedule and mathematics achievement. The initial coding included: (a) age of students; (b) percent male; (c) socioeconomic class; (d) mathematics curriculum; (e) amount of time on math instruction; (f) preschool experience; (g) design I (i.e., Random Assignment vs. Quasi-Experimental); (h) Design II (pre/post design vs. post only design); (i) teacher training; (j) percent of English Language Learners; (k) location; (l) cohort (i.e., year in which kindergarten was attended); (m) percent special needs; and (n) other risk factors for student underperformance. If a study or cohort included more than one measure of mathematics achievement, the average effect size was computed and included.

Analysis

The meta-analysis utilized in this study consisted of four separate analyses: (a) kindergarten to first grade, (b) kindergarten to second grade, (c) kindergarten to third grade, and (d) kindergarten to fourth grade. Consequently, analyses at different grade levels were based on different studies. Analysis was conducted with the Comprehensive Meta-Analysis Software (Borenstein & Rothstein, 1999) following the statistical procedures outlined by Borenstein, Hedges, Higgins, and Rothstein (2009), and Lipsey and Wilson (2001). When multiple cohorts (e.g., the year in which kindergarten was attended) were reported within a report, each cohort was treated as a separate study.

Global Effect Size

A random effect model was used to calculate mean effect sizes (Borenstein et al., 2009). The analysis employed a random-effect model rather than a fixed-effect model. In the fixed-effect model, it is assumed that the effect sizes are samples from a population with a common effect size. The staff of the National Research Council (1992) has concluded that this is, in fact, a rare phenomenon as different study methodologies and sample characteristics often introduce sizable sources of between study variance. In contrast, in the random-effects model, it is assumed that the effects observed in a meta-analysis are a sample from a larger population of effect sizes. For example, the effect size of full-day kindergarten is not assumed to be constant, as suggested by the fixed effect model. Rather the effect size is assumed to be a combination of sub-populations based upon the: (a) type of curriculum, (b) type of kindergarten, and (c) type of student. Moderator variables were examined to account for the between study effect variance.

Moderator Variables

Moderator variables were examined to account for the between study effect variance. Moderator variables are any characteristics of the studies that are associated with differences in effect size (Hunt, 1997). When the moderator variables are dichotomous or polychotomous, a technique analogous to the analysis of variance was employed to examine for differences in effect size. When moderator variables are continuous, a meta regression was employed. A graphical analysis of moderator variables and effect size relationships was also examined.

Publication Bias

In any meta-analysis, there is always the risk of a publication bias. That is a results bias that occurs when authors are more likely to submit, or editors accept, positive rather than null (e.g., negative or inconclusive) results. Studies with negative or inconclusive results are more likely to end up in a *file drawer*. When a significant global effect size is found, this possibility was investigated in several ways (Sutton, 2009).

First, Hunt (1997) suggested that, when a search is not thorough, the best way to handle it is with a file drawer test. In the file drawer test, one looks at the number of studies not found that would reduce the overall significance to insignificance (Rosenberg, 2005).

Second, the file drawer for effect size was also examined. Orwin (1983) adapted Rosenthal's fail-safe *n* for significance level to represent a fail-safe *n* required to bring a mean effect size down to a certain magnitude.

The remaining procedures are based upon the assumption that small studies will be published or submitted for publication only when the results are significant, while studies with larger sample sizes will be submitted or published without statistical significance (Borenstein et al, 2009). Consequently, if a publication bias exists, then smaller effect sizes will be seen with larger samples and larger effect size with smaller samples.

One way to examine the effect size of publication bias is to look at this effect through a funnel plot. A funnel plot is a scatter plot of the effect of the standard error. If symmetric, an inverted funnel shape arises from the data, and a publication bias is unlikely.

Second, Begg and Mazumdar (1994) developed a statistical test to detect publication bias based on the rank correlation (Kendall's tau) between the standardized effect size and the variances. Kendall's tau is interpreted as any correlation, with a value of zero signifying no relationship, and departures from zero are indicative of the presence of a relationship. A significant negative correlation suggests that bias may exist. If publication bias exists, then it is expected that high standard errors (i.e., small studies) will be associated with larger effect sizes

Third, a regression analysis was examined. In a procedure developed by Egger, Davey, Schneider, and Minder (1997), the actual values of the effect sizes and their precision, rather than ranks, were used.

CHAPTER 4

RESULTS

Retrieval Strategy

The first step in a meta-analysis is the retrieval of the research studies. Numerous data bases were searched in an effort to locate longitudinal studies with information about mathematic scores on half-day and full-day kindergarten. Search terms included: (a) full day, (b) all day, (c) partial day, (d) complete day, (e) extended day, and (f) half day paired with the term, kindergarten. Then the studies were searched for longitudinal data resulting in 126 studies which included: (a) 25 dissertations, (b) 31 ECLS studies, (c) 28 had inadequate information, (d) 17 were focused on literacy, and (e) 25 were math studies that did not compare schedules.

The remaining studies were then reviewed in order to meet the following eligibility criteria: (a) the study must have been an empirical comparison of half-day to full-day kindergarten schedules, (b) the study must have reported results on mathematics achievement in grades following kindergarten, (c) the study must measure mathematics achievement based upon a standardized test and not upon a teacher or project developed test, and (d) the study provided sufficient information to compute effect size. If a study reported more than one independent cohort, each cohort was reported.

Of the studies found, 24 met the criteria and were used with a total of 63 cohorts and 24,892 subjects. Sample size varied across studies from 16 (Lewis, 2000) to 10,583

(Stofflet, 1998). Only 5 of the studies were from peer reviewed journals (Entwisle, 1987; Gullo, 2000; Saam & Nowak, 2005; Schroeder, 2007; Wolgemuth et al., 2006), the others were dissertations or evaluation reports in ERIC.

Analysis

The results consist of four separate analyses: (a) first grade, (b) second grade, (c) third grade, and (d) fourth grade. Each grade level has different studies and a different number of studies. The results were calculated with a random effect model and a fixed effect model. The results appeared to fit the random effect model. The variability across each analysis did not exceed that predicted from the random aeffect model. In contrast, the results did not fit the fixed effect model at all. The results are presented in Figure 1.

Table 1. *Effect sizes by grade*

Grade	Hedges's g	Standard Error	Lower limit	upper limit	z-value	p-value
		Random Effect Model				
1	0.020	0.100	0.010	0.400	1.999	0.046
2	-0.060	0.084	-0.220	0.100	-0.719	0.472
3	-0.080	0.058	-0.200	0.030	-1.440	0.151
4	-0.220	0.163	-0.540	0.100	-1.370	0.170
		Fixed Effect Model				
1	0.130	0.040	0.050	0.210	3.315	0.001
2	0.001	0.026	-0.049	0.052	0.057	0.954
3	-0.045	0.019	-0.085	-0.014	-2.470	0.014
4	-0.295	0.030	-0.350	-0.240	-9.920	0.000

The first grade analysis consisted of 15 studies with a total of 4,305 subjects. Of the 15 studies, 1 was from a peer reviewed publication, 5 were evaluation reports in ERIC, and 9 were dissertations. The effect size ranged from -0.394 to 1.08. The weighted mean effect, based on the random effect model, was .20 (standard error = .10 with a 95% confidence interval from 0.01 to 0.40). The average effect size in the first grade was comparable to a difference on an achievement test between a mean on the 50th percentile for students who were in half day kindergarten and a mean on the 56th percentile for students who were in full day kindergarten. The results are presented in Figure 1.

Study name	Statistics for each study						
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Baldus c1 1	0.407	0.454	0.206	-0.483	1.297	0.897	0.370
Baldus c3 1	-0.394	0.432	0.187	-1.242	0.454	-0.911	0.362
Bowman 1	-0.263	0.145	0.021	-0.547	0.021	-1.815	0.070
Duffy 1	0.140	0.084	0.007	-0.024	0.304	1.673	0.094
Entwisle 1	-0.215	0.095	0.009	-0.401	-0.029	-2.266	0.023
Koopmans c1 1	0.175	0.219	0.048	-0.254	0.604	0.799	0.424
Koopmans c2 1	0.709	0.155	0.024	0.405	1.013	4.577	0.000
Lewis 1	1.080	0.228	0.052	0.633	1.527	4.736	0.000
MacRae 1	-0.260	0.355	0.126	-0.956	0.436	-0.732	0.464
Minor 1	0.455	0.158	0.025	0.145	0.765	2.878	0.004
Pope 1	-0.259	0.141	0.020	-0.536	0.018	-1.831	0.067
Robin et al 1	0.342	0.202	0.041	-0.055	0.739	1.689	0.091
Thompson 1	0.100	0.126	0.016	-0.148	0.348	0.791	0.429
	0.162	0.109	0.012	-0.052	0.375	1.487	0.137

Hedges's g and 95% CI

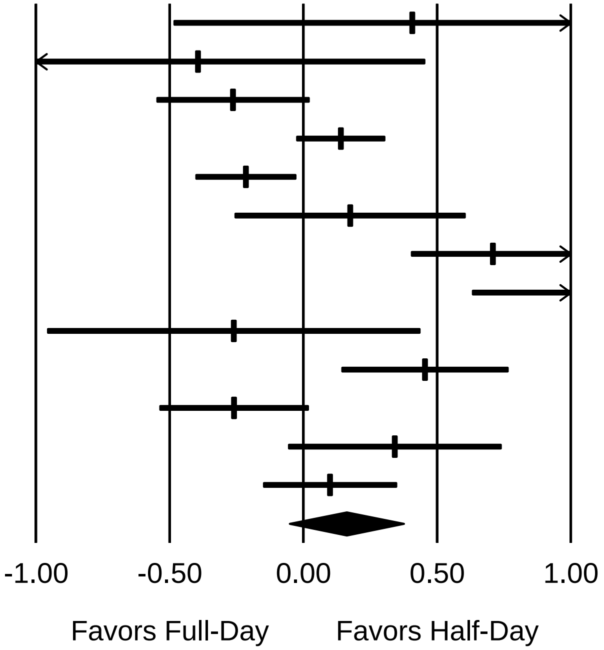

Figure 1. Effect sizes and Forrest plot for Grade 1.

The second grade analysis consisted of 19 studies with a total of 7,990 subjects. Of the 19 studies, 2 were from a peer reviewed publication, 6 were evaluation reports in ERIC, and 11 were dissertations. The effect size ranged from -1.816 to 0.710. The weighted mean effect, based on the random effect model, was -0.06 (standard error = .084 with a 95% confidence interval from -0.22 to 0.10). The average effect size in the second grade was comparable to a difference on an achievement test between a mean on the 50th percentile for students who were in full day kindergarten and a mean on the 54th percentile for students who were in half day kindergarten. The results are presented in Figure 2.

Study name	Statistics for each study						
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Baldus c2 2	-0.836	0.470	0.221	-1.757	0.085	-1.778	0.075
Bowman 2	-0.469	0.148	0.022	-0.760	-0.178	-3.162	0.002
Duffy 2	0.312	0.084	0.007	0.148	0.476	3.729	0.000
Gullo 2	0.185	0.077	0.006	0.033	0.337	2.388	0.017
Jarvis & Schulman b 2	0.147	0.155	0.024	-0.157	0.451	0.949	0.343
Jarvis & Schulman m 2	-0.097	0.071	0.005	-0.236	0.042	-1.372	0.170
Koopmans c1 2	0.162	0.219	0.048	-0.267	0.591	0.739	0.460
Koopmans c2 2	0.710	0.155	0.024	0.406	1.014	4.583	0.000
Lewis 2	-1.816	0.387	0.150	-2.575	-1.057	-4.689	0.000
Oliver 2	0.185	0.241	0.058	-0.287	0.657	0.768	0.442
Pawk 2	-0.182	0.089	0.008	-0.357	-0.007	-2.035	0.042
Pope 2	-1.080	0.148	0.022	-1.371	-0.789	-7.281	0.000
Reenders 2	-0.028	0.257	0.066	-0.532	0.476	-0.109	0.913
Thompson 2	0.158	0.063	0.004	0.034	0.282	2.498	0.012
Williams 2	-0.015	0.148	0.022	-0.306	0.276	-0.101	0.919
Wolgemuth 2	-0.056	0.126	0.016	-0.304	0.192	-0.443	0.658
	-0.092	0.097	0.009	-0.281	0.097	-0.954	0.340

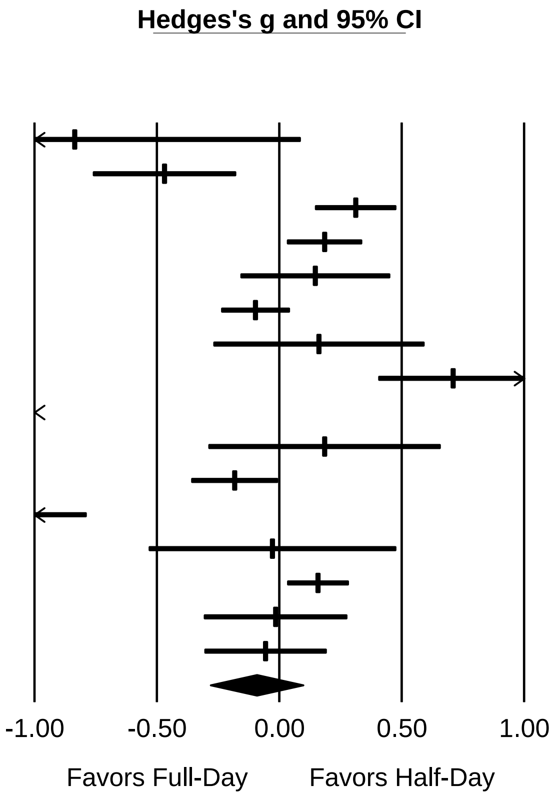

Figure 2. Effect sizes and Forrest plot for Grade 2.

The third grade analysis consisted of 21 studies with a total of 11,823 subjects. Of the 21 studies, 3 were from a peer reviewed publication, 8 were evaluation reports in ERIC, and 10 were dissertations. The effect size ranged from -0.931 to 0.728. The weighted mean effect, based on the random effect model, was -.08 (standard error = .058 with a 95% confidence interval from -0.20 to 0.03). The average effect size in the third grade was comparable to a difference on an achievement test between a mean on the 50th percentile for students who were in full day kindergarten and a mean on the 53rd percentile for students who were in half day kindergarten. The results are presented in Figure 3.

Study name	Statistics for each study						
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Baldus c1 3	-0.345	0.453	0.205	-1.232	0.542	-0.762	0.446
Bowman 3	-0.426	0.148	0.022	-0.717	-0.135	-2.872	0.004
Duffy 3	0.188	0.084	0.007	0.024	0.352	2.247	0.025
Humphreys 3	0.460	0.158	0.025	0.150	0.770	2.909	0.004
Jarvis & Schulman b 3	-0.058	0.155	0.024	-0.362	0.246	-0.374	0.708
Jarvis & Schulman,m 3	-0.170	0.071	0.005	-0.309	-0.031	-2.404	0.016
Koopmans c1 3	0.265	0.219	0.048	-0.164	0.694	1.210	0.226
Lewia 3	0.728	0.494	0.244	-0.240	1.696	1.474	0.141
McIntosh 3	-0.211	0.118	0.014	-0.443	0.021	-1.783	0.075
Pope 3	-0.931	0.148	0.022	-1.222	-0.640	-6.277	0.000
Reenders 3	-0.149	0.257	0.066	-0.653	0.355	-0.580	0.562
Saam & Nowak 3	0.000	0.032	0.001	-0.062	0.062	0.000	1.000
Schroeder 3	0.034	0.055	0.003	-0.073	0.141	0.621	0.535
Stofflet c1 3	0.000	0.122	0.015	-0.240	0.240	0.000	1.000
Stofflet c2 3	-0.617	0.089	0.008	-0.792	-0.442	-6.898	0.000
Stofflet c3 3	-0.332	0.100	0.010	-0.528	-0.136	-3.320	0.001
Thompson 3	0.048	0.063	0.004	-0.076	0.172	0.759	0.448
Truss 3	0.201	0.100	0.010	0.005	0.397	2.010	0.044
Walkowiak 3	-0.064	0.134	0.018	-0.327	0.199	-0.477	0.633
Wolgemuth 3	0.085	0.152	0.023	-0.212	0.382	0.560	0.575
	-0.089	0.060	0.004	-0.206	0.029	-1.479	0.139

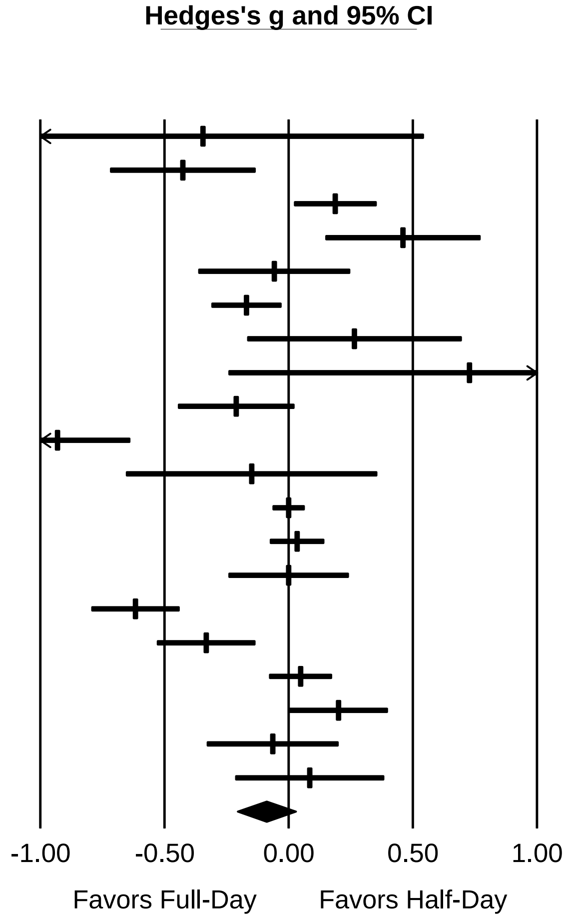

Figure 3. Effect sizes and Forrest plot for Grade 3.

The fourth grade analysis consisted of 8 studies with a total of 774 subjects. Of the 8 studies one was from a peer reviewed publication, 3 were evaluation reports in ERIC, and 4 were dissertations. The effect size ranged from -0.902 to 0.156. The weighted mean effect, based on the random effect model, was -.22 (standard error = .163 with a 95% confidence interval from -0.54 to 0.10). The average effect size in the fourth grade was comparable to a difference on an achievement test between a mean on the 50th percentile for students who were in full day kindergarten and a mean on the 59th percentile for students who were in half day kindergarten (see Figure 4).

Study name	Statistics for each study						
	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Duffy 4	0.148	0.084	0.007	-0.016	0.312	1.769	0.077
McIntosh 4	0.156	0.110	0.012	-0.059	0.371	1.424	0.154
Stofflet c1 4	-0.522	0.077	0.006	-0.674	-0.370	-6.739	0.000
Stofflet c2 4	-0.617	0.071	0.005	-0.756	-0.478	-8.726	0.000
Stofflet c3 4	-0.902	0.071	0.005	-1.041	-0.763	-12.756	0.000
Thompson 4	0.135	0.063	0.004	0.011	0.259	2.135	0.033
Walkowiak 4	-0.201	0.134	0.018	-0.464	0.062	-1.498	0.134
Wolgemuth 4	0.063	0.195	0.038	-0.319	0.445	0.323	0.747
	-0.224	0.163	0.027	-0.544	0.096	-1.373	0.170

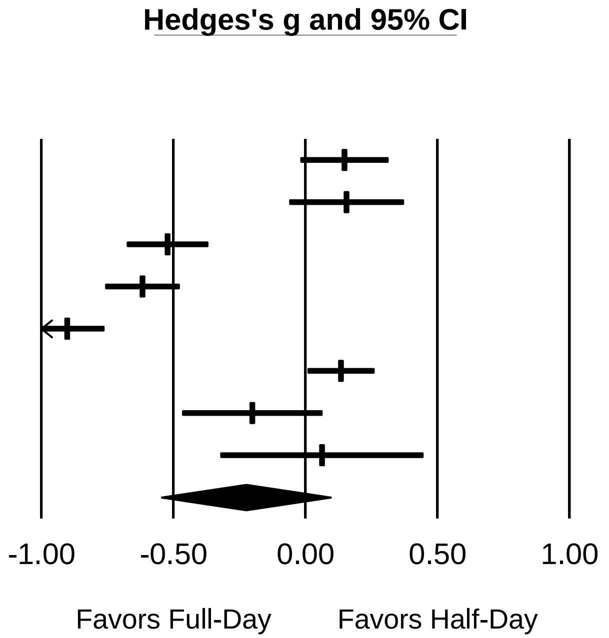

Figure 4. Effect sizes and Forrest plot for Grade 4

The trend across grade in effect size is negative monotonic function. As can be seen in Figure 6 with each grade beyond kindergarten, the effect was smaller than the grade before. Any positive effect of full day kindergarten appeared to disappear after the first grade (see Figure 5).

Solid Lines are Mean Effect Size
Dashes are the 95% Confidence Interval

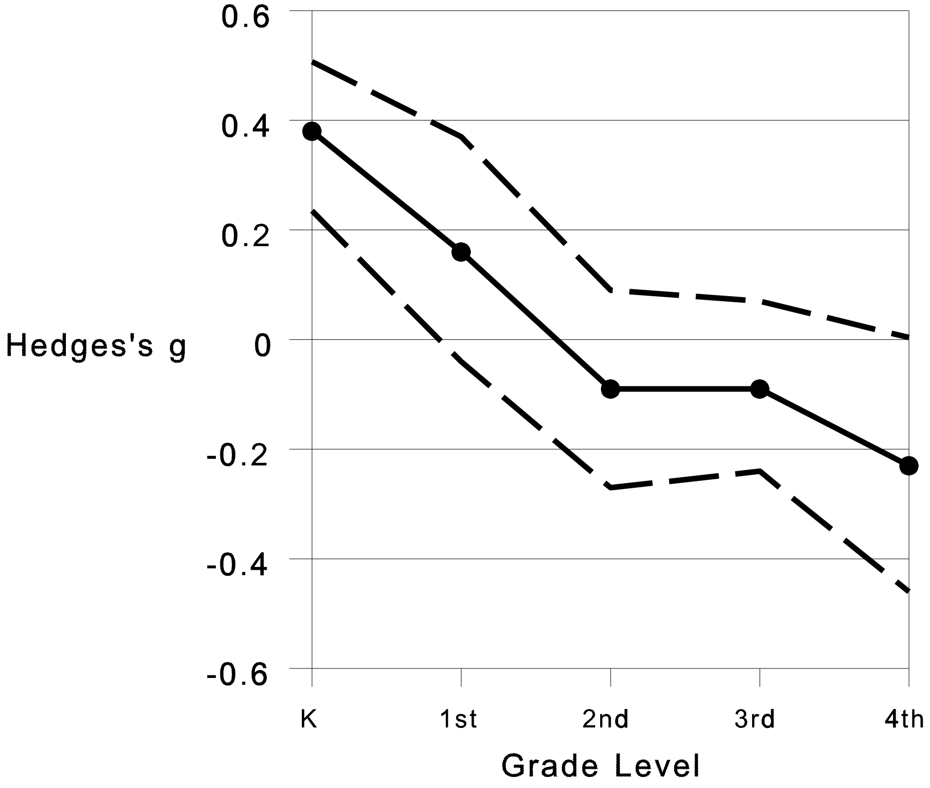

Figure 5. Random effect size at each grade.

In many meta-analyses, there is risk of publication bias. Publication bias is a results bias that occurs when authors are more likely to submit, or editors accept, positive rathyer than null (i.e., negative or inconclusive) results. In this study, there appeared to be little evidence that the effect was significantly different from zero at any grade level. Consequently, the risk of publication bias was not likely to be a problem in the current study. In addition, given that most of the studies were not publications, the lack of publication bias is important.

Moderator Variables

In order to examine the effect of moderator variables, they must be reported in the study. Unfortunately, most of the moderator variables were not reported frequently enough to investigate them. Few studies (i.e., less than 5) reported any information about: (a) the age of the students, (b) the amount of time on math instruction, (c) preschool experience, or (d) teacher training. Socioeconomic status was presented in 9 of the studies. However, not enough of them were reported in the same grade level to evaluate. Demographic information was typically presented for the district, school, or in vague terms. The lack of consistent reporting of variables made it difficult to identify where correlations and/or effects truly existed.

There was no substantive variation in design. All studies employed a cross sectional design. Cross sectional designs are studies in which data are collected at one point in time (Rossi, Freeman, & Lipsey, 1999). None of the studies were based upon a random assignment at kindergarten. None of the studies were a longitudinal study following the same group of students from kindergarten on. The studies selected students at the post-kindergarten grades who were either in full day or half day kindergarten.

The only moderator variable that could be examined was the year of the study. The results were mixed. There was a significant ($p < .001$) increase in effect size of the studies in the first grade with the year in the study. There was no significant regression for the second and third grade. The fourth grade had a significant negative regression ($p < .001$); more recent studies had a less positive relation than earlier studies.

The results of this meta-analysis showed that children participating in full day kindergarten show an advantage on mathematical achievement over their half day counterparts. This advantage lasted only through Grade 1. However, the reasons for the decreasing effects were unclear. Moderator variables may have been a contributing factor for the decline in math scores. Unfortunately, not enough studies reported the variables for evaluation.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There appears to be strong evidence that children's mathematics achievement benefits from their participation in full-day kindergarten programs during kindergarten and first grade (Baldus, 2001; Fusaro, 1997; Hill, 2010; Jones, 2002; Karweit, 1987; McIntosh, 2006; Minor, 2001; Walkowiak, 2007). These studies also demonstrate that the benefits do not last. This is not necessarily a reflection of fault from the full-day program, but it could be from a larger systemic problem. If school district staff are going to able to evaluate the full day kindergarten schedule effectively, they need to address the entire school community. What happens to the mathematic curriculum during the elementary grades? Are teachers appropriately prepared to teach mathematics? Do the schools in the poorer neighborhoods have the resources needed for children to succeed?

Little research exists to compare the academically oriented kindergarten with developmentally appropriate curriculum on student outcomes; nevertheless, developmentally appropriate kindergartens tend to be more appropriate for most children and an academic curriculum, if emphasized, before children are ready, could be harmful (Bartolini & Wasem, 1985). Teachers need to be trained in mathematics and early childhood education to be considered qualified to teach the early grades. If an academic curriculum is to be used, it must be at a developmentally appropriate level.

When a developmentally appropriate curriculum is used, children have the ability to play individually or in small groups. This curriculum engages the child in reasoning, problem solving, and communicating about mathematics (Bartolini & Wasem, 1985; Copple & Bredekamp, 2009). With a focus on accountability, an increase in standardized assessments, an increase in number of students attending preschool, and the lack of training in early childhood education, there has been an emphasis on an academically oriented curriculum (Bartolini & Wasem). In addition to a shift of more academics, teachers are also responsible to teach curriculum that addresses a broad range of topics instead of fewer topics more in depth. This shift is a potential reason for why the mathematical effects of full-day kindergarten do not last.

In a report by Ruddock (1998), the mathematics curriculum was assessed in 16 countries. The countries are divided into two groups: centralized government and federal government. The centralized government countries consist of England, France, Hungary, Italy, Japan, Korea, The Netherlands, New Zealand, Singapore, Spain, and Sweden. The federal government countries include Australia, Canada, Germany, Switzerland, and the United States. The 11 centralized countries have some form of compulsory national curriculum for mathematics (Ruddock). Of those countries, 10 participated in the 2009 PISA (Copple & Bredekamp, 2009) international assessment. Eight of the countries (i.e., Singapore, Korea, Japan, Netherlands, New Zealand, France, Sweden, and Hungary) have higher mathematic averages than the U.S.(NCES, 2009a). The averages for Sweden and Hungary averages were higher, but not measurably different from the U.S. average.

In a study conducted by the American Institute for Research (AIR; 2005) to compare the U.S. mathematic curriculum to the Singapore mathematic curriculum, the

U.S. lacks a centrally identified core of mathematical content that provides a focus for the rest of the system. Singapore students ranked first in the world in mathematics while the U.S. students were among the lowest of all industrialized countries. Major differences exist between these two national mathematics systems. Singapore has a uniform national framework that covers a relatively small number of topics in-depth, and it is sequenced grade-by-grade, while the U.S. has no official framework (AIR). The other major differences exist between textbooks, assessments, and teacher training. Singapore textbooks build deep understanding of mathematical concepts, while the traditional U.S. textbooks rarely get beyond definitions and formulas. In addition, the Singapore assessments are more challenging; and the teachers in Singapore receive better instruction both in mathematics content and in mathematics pedagogy (AIR).

Singapore teachers are required to demonstrate strong mathematics skills and take a stringent examination before they are accepted into the teacher education school; in contrast, U.S. elementary teachers have the lowest SAT mathematics scores of all college students (AIR, 2005). Teachers must know a great deal in order to create and choose appropriate educational activities, however, U.S. education majors take fewer formal mathematics courses than the average college graduate (AIR; Spodek, 1981). In an effort to ensure that students are taught by highly qualified teachers, the No Child Left Behind Act of 2001 requires teachers to have a Bachelors degree, demonstrate competency in the subject matter, and be fully licensed (U.S. Department of Education, 2009). However, teachers trained in elementary education are considered competent to teach kindergarten, even without training in early childhood education (Spodek). The lack of teacher knowledge base and training is a second potential reason that mathematical benefits from the full-day kindergarten programs decrease over time.

Staff of the International Association for the Evaluation of Educational Achievement (IEA, 2009) provided information about teacher education and recruitment, teacher salaries, and teacher labor force for 20 countries. Sixteen of these countries participated in the PISA 2009 (Copple & Bredekamp, 2009) international assessment. The average for 10 countries (i.e., Singapore, Hong Kong, Korea, Chinese Taipei, Finland, Switzerland, Australia, Germany, Norway, France) was higher than the U.S. average in mathematics. The United Kingdom, Spain, and Italy are not measurably different from the U.S. and Bulgaria and Thailand have a lower mathematic average than the U.S. (PISA). In order to teach in Korea, the candidate must earn 140 credits in both teacher education and a major subject (i.e., 21 subject credits for elementary and 42 subject credits for secondary levels). The candidate must also pass a national employment exam. In Chinese Taipei, teachers are required to participate in 2 years of teacher education classes concurrently with 40 units in professional education subjects. These courses are then followed with 6 months of practicum. Finland requires teachers to earn a Master’s degree with at least 160-180 credits. Fifty-five credits must be in the subject area, 35 credits in a second subject, and 35 credits in pedagogical classes (IEA, 2009).

The U.S. teacher certification requirements are set by individual states and vary greatly. Some states have provisions for emergency certification to allow people who have not met their state requirements to teach (IEA, 2009). All states require a Bachelor’s degree that includes subject matter and pedagogical studies.

In a report from the U.S. Department of Education (2009), the staff noted that teachers in high-poverty and high-minority schools were more likely to report that they were not highly qualified, and the teachers highly qualified in high-poverty schools had less experience and were less likely to have a degree in the subject they taught. Although teachers reported participating in content-focused professional development only 6%, they received more than 24 hours of professional development on the in-depth study of topics in mathematics (U.S. Department of Education). In contrast, Singapore teachers are encouraged to continue to improve their knowledge through 100 hours of required annual professional development (AIR, 2005). Not having highly qualified teachers in high-poverty schools is yet another reason that mathematic achievement scores would level off.

Recommendations

With the strong evidence that full-day kindergarten makes a difference in mathematic achievement, more studies should be conducted to examine why these differences fade. Reports from the U.S. Department of Education (2008) and the AIR (2005) describe policy implications and suggestions to help improve U.S. mathematics systems. First, the AIR staff emphasized that there is a necessity to build a strong mathematic foundation starting in the early years. Second, U.S. educators can learn from the Singapore curriculum, and they need to become more stringent with the mathematics curriculum and strengthen the implementation of reforms for highly qualified teachers in order to ensure that teachers actually demonstrate that they understand mathematics content and how to teach it (AIR). Thirdly, in the Final Report of the National Mathematics Advisory Panel, the U.S. Department of Education (2008), the staff suggested that mathematics curriculum in the early grades should be streamlined, and the emphasis should be placed on a well-defined set of the most critical topics. Finally, more research needs to be conducted to investigate the public school system as a whole. Academic gains are made in mathematics by participation in full-day kindergarten. An injustice is done to these students, if there is no evaluation of why those gains disappear. School districts now need to spend more time evaluating mathematic curriculum, teacher training, appropriate assessments, and other variables that affect the evident gains from full-day kindergarten in order to help the U.S. become more competitive internationally. Achieving and maintaining mathematical literacy is truly a lifelong quest in this world of ever advancing technology (Copple & Bredekamp, 2003).

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