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The Effect of Classroom Age Composition on Head Start Preschoolers' School Readiness

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By

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The current study examined the influence of classroom age composition (the variability in ages of children in the classroom) on low-income preschool children's rates of change in multiple domains of school readiness. The sample consisted of 4,417 preschool children enrolled in 207 classrooms in a large, diverse Head Start program. Children were assessed throughout the year on four school readiness domains: emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning. Multilevel modeling was employed to examine the main effect of classroom age composition as well as the interaction between classroom age composition and child's age as predictors of children's rates of change in these school readiness domains. Results showed that classroom age composition did not uniformly influence rates of change in school readiness for all children. Instead, a significant interaction between child's age and classroom age composition indicated that younger children developed skills in the domain of approaches to learning at an increased rate when placed in classrooms with a large age composition (i.e., in classrooms with a greater degree of age-mixing). This study extends literature focused on identifying classroom structures that promote positive development of school readiness skills, particularly for at-risk children.

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Introduction: Chapter 1

Children from low-income families are at risk for poor adjustment to formal schooling because of the multiple hazards associated with living in poverty (Duncan, Brooks-Gunn, & Klebanov, 1994). National attention has been paid to identifying and promoting emergent competencies that help protect these vulnerable children from experiencing difficulties upon entry into school (Kagan, Moore, & Bredekamp, 1995). These competencies, often referred to as school readiness skills, encompass multiple domains of development including cognitive and social development (Kagan et al., 1995). Early childhood experiences, particularly participation in quality early childhood education, are critical for the development of these school readiness competencies (Shonkoff & Phillips, 2000). Therefore, it is necessary to conduct research that identifies practices in early childhood education that best promote school readiness, particularly for low-income children (Bowman, Donovan, & Burns, 2001).

Head Start is the nation's largest federally-funded early childhood program serving predominantly low-income children. Head Start performance standards require that curricula be developmentally appropriate and encourage social interaction within the classroom as a way to promote children's readiness in multiple domains (1304.21 (c) (1) (ii); USDHHS, 1998, p.70; Zigler & Bishop-Josef, 2006). Head Start supports classrooms with mixed-age groups and places children as young as three years and as old as five years in the same classroom. Like many early childhood programs, Head Start follows guidelines sponsored by the National Association for the Education of Young Children (NAEYC), an organization that publishes information regarding developmentally appropriate practice in early childhood programs. NAEYC encourages the inclusion of mixed-age groups in the classroom (Katz, Evangelou, & Hartman, 1990). Katz and colleagues (1990) argue that mixed ages in the classroom enhance the socialization of young children. More specifically, they believe that this approach mimics family and neighborhood groupings, encourages positive social development (e.g., leadership) through peer tutoring, and promotes cognitive development by integrating children of different ability levels.

Despite support for the practice of mixed-age groups in early childhood classrooms, empirical research on the topic has produced conflicting results. Some research has indicated that age-mixing promotes many forms of positive development in children (e.g., Goldman, 1981; Field, 1982). In contrast, other research has highlighted some potential costs of age-mixing (e.g., Langlois, Gottfried, Barnes, & Hendricks, 1978; Lougee, Grueneich, & Hartup, 1977; Roopnarine et al., 1992). Thus far, the practical application of research on mixed-ages in the preschool classroom is impeded by these conflicting results as well as by methodological limitations. Most studies on this topic include small samples of predominantly Caucasian children from middle- to high-income families, thus reducing the ability to generalize results to the Head Start population.

The present study examined how age composition in Head Start classrooms influences children's rates of change across the school year in multiple domains of school readiness, including emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning. First, theoretical considerations about mixed-age groups will be discussed. Second, research examining mixed-age groups in the preschool classroom will be reviewed. Third, the school readiness domains of interest will be discussed with regard to their importance for children's future success. Finally, the rationale for the current study will be presented.

Theoretical Considerations for Mixed-Age Classrooms

The interaction between the child and his or her environment is considered an integral component of development. In fact, Bronfenbrenner and Morris (1998) state that proximal processes, interactions between the child and his or her environment, are the primary mechanisms through which children develop. For preschool children, key proximal processes affecting both social and cognitive development include their interactions with teachers and peers in the classroom (Hamre & Pianta, 2007). Mashburn and Pianta (2006) argue that children's school readiness competencies should be defined and understood as a direct result of the interactions between the preschooler and his or her teachers and peers.

While most theorists agree that exposure to peers is highly influential in children's development, there are differing viewpoints about peer characteristics, specifically age of peers, that provide the most appropriate stimulation for development. These differing viewpoints have generated a debate between the practices of same-age versus mixed-age groupings in early childhood classrooms. This debate has historically been framed within the perspectives of Piaget (1932) and Vygotsky (1978). Jean Piaget (1932) argued that children gain the most knowledge by interacting with peers of the same age. In contrast, Lev Vygotsky (1978) argued that interacting with peers of different ages is beneficial for both younger and older children.

Piaget's theory of cognitive development predominantly focuses on the interaction of the child and his physical, rather than social, environment (Tudge &

Rogoff, 1989). A child advances through the stages of cognitive development by reconciling his or her schemas about the world when a "cognitive conflict" occurs between his schemas and life experiences (Piaget, 1983). Usually these "cognitive conflicts" occur when the child acts upon his or her physical environment; however, Piaget also believed that it was possible for "cognitive conflicts" to occur during social interaction when two children hold different viewpoints about something (Piaget, 1932). When two children work together to reconcile these conflicting viewpoints, they are able to gain an understanding about the perspectives of others. Based on this idea, Piaget argued that cooperation is the ideal form of social interaction (Tudge & Rogoff, 1989). However, Piaget qualified this statement by arguing that this type of cooperation can only occur between children of the same age (Piaget, 1932). When children interact with an older child or adult, the younger child loses the power to resolve the conflict himself or herself (Piaget, 1959). Because Piaget downplays the importance of social interaction on children's cognitive development and does not see any benefit in the interaction between a child and a more competent peer, supporters of Piaget's theory disagree with the practice of mixed-age groupings in preschool classrooms.

Vygotsky's theory, on the other hand, was developed with social interaction as the central influence on children's cognitive development (Tudge & Rogoff, 1989). In fact, Vygotsky argued that the unit of analysis in developmental research should be the social interactions in which the child participates rather than characteristics of the individual child (Vygotsky, 1987). A key concept of Vygotsky's theory is the "zone of proximal development" in which children are pushed slightly beyond the limits of their knowledge by a more competent and experienced person. A more competent partner, such as an older peer or adult, is able to scaffold learning by allowing him or her to practice more advanced reasoning that he or she would not be able to do independently. Practicing more advanced cognitive thinking helps the child understand and master certain developmental milestones (Vygotsky, 1978). Vygotsky's concept of the "zone of proximal development" can be facilitated by an adult, such as a teacher, or an older peer. This concept leads many people invested in early childhood education to support the idea of mixed-age groups in the preschool classroom (Katz et al., 1990). When arguing in favor of the practice of mixed-age classrooms, early education specialists often cite Vygotsky's theory to support their position.

Review of the Literature on Mixed-Age Classrooms

Cross-Sectional Studies. The majority of research examining mixed-age classrooms has employed a cross-sectional design to compare same-age (SA) versus mixed-age (MA) preschool classrooms in relation to children's social behaviors. Several studies have found that children in MA classrooms have better social outcomes than children in SA classrooms. For example, Goldman (1981) observed how types of social participation (e.g., onlooker behavior, multiple forms of play, and interactions with peers and teachers) differed between SA and MA classrooms. She concluded that in MA classrooms, age did not affect children's choice of play partner and that all children engaged in more social participation in MA classrooms than in SA classrooms. These findings were consistent with a similar study by Field (1982) who found that children in MA classrooms spent less time engaged in sex-segregated play and more time engaged in more complex play, such as pretend play.

These studies find benefits for all children in MA classrooms regardless of age. Some research, however, has found benefits only for younger children in MA classrooms. Blasco, Bailey, and Burchinal (1993) observed play behaviors of one- to four-year-old children with and without developmental delays randomly assigned to four SA or four MA classrooms. The authors concluded that younger children, regardless of developmental delay, displayed higher levels of play mastery in MA classrooms than younger children in SA classrooms but that older children were not affected. In addition, Howes and Farver (1987) observed the complexity of social pretend play in dyads of young children paired with a same-age partner or with an older partner. They found that older children were not affected by age of partner but that younger children engaged in more complex pretend play when paired with an older partner than with an age-mate.

In contrast to research documenting the advantages of MA classrooms, some research has reported potential costs of MA classrooms. Lougee et al. (1977) examined positive and negative social interactions as well as the appropriateness and inappropriateness of child speech (e.g., participating in conversation versus unrelated speech) in same-age and mixed-age dyads. They found that older children displayed less positive social interactions and more inappropriate speech when interacting with a younger than with an older peer and concluded that older preschool children regressed in their social activity when placed in mixed-age dyads in order to match the behavior of their younger partner.

Similar to the research conducted by Lougee et al. (1977), a study conducted by Langlois et al. (1978) found that younger males in mixed-age dyads showed increases in aggression and that children in same-age dyads displayed more positive social behavior than children in mixed-age dyads. The authors concluded that older children were not effective in stimulating positive social participation in younger children, particularly younger boys. Urberg and Kaplan (1986) compared the effects of SA and MA classrooms on play and social behavior and found that younger children in MA classrooms engaged in more interactions with their peers, including positive play interactions as well as negative interactions. In addition, older children engaged in more onlooker behavior and lower levels of complex play in MA classrooms. They concluded that the benefits of MA classrooms are unclear and that there may be costs for older children in MA classrooms.

Longitudinal Studies. There are a few longitudinal studies that provide a more comprehensive examination of the influence of classroom age composition on children's outcomes. These studies find benefits for MA classrooms in terms of the overall social environment as well as specific benefits for younger but not older children. Roopnarine and colleagues (1992) observed play behaviors in SA and MA classrooms across one academic year. Similar to previous studies, they found that children in MA classrooms overall engaged in more social interaction than children in SA classrooms, particularly across age and sex. Winsler and colleagues (2002) examined social interaction and task behaviors in preschool children in SA and MA classrooms and followed these children for two preschool years. They identified benefits for younger children in MA classrooms who were more on-task than younger children in SA classrooms. In addition, all children in MA classrooms expressed more positive affect and greater social integration across age and sex than children in SA classrooms. Bailey, Burchinal, and McWilliam (1993) followed a sample of children assigned to SA or MA classrooms over a period of four years and compared child as well as group growth patterns of multiple domains of development. Children in MA classrooms as a group showed significantly faster rates of growth than children in SA classrooms in communication, cognitive, motor, and overall development. Also, younger children in MA classrooms tended to score higher than younger children in SA classrooms in multiple domains of development throughout the year.

Despite what appear to be substantial benefits for children in MA classrooms, these studies also show significant disadvantages of MA classrooms. Although they observed increased social activity in MA classrooms, Roopnarine et al. (1992) found that children in MA classrooms engaged in less complex forms of play than children in SA classrooms. In addition, younger and older children's play behaviors in MA classrooms were more similar to begin with and remained similar over time. The authors suggest that older children in MA classrooms engaged in less complex forms of play to match their younger peers which can account for both the increased social interaction in the classroom as well as the finding that older children in MA classrooms engaged in less complex play than older children in SA classrooms. While Winsler et al. (2002) found benefits for younger children in MA classrooms, they also found costs for older children who were less goal-directed and less on-task than older children in SA classrooms. Most notably and in contrast to the findings of Roopnarine and colleagues (1992), the authors found that the social environment of the preschool classroom changes throughout the school year as children become more familiar with one another and that the benefits of MA classrooms, particularly the higher levels of social integration, faded over the year. Finally, Bailey et al. (1993) found that the advantages for younger children in MA classrooms decreased over time, and by age five, they were reversed, such that older children in SA classrooms were outperforming older children in MA classrooms. Bailey et al. (1993) concluded that MA classrooms were beneficial for children three years and younger but that SA classrooms were more beneficial for four- and five-year-old children.

Research comparing SA and MA classrooms has demonstrated that the influence of classroom age composition is complex and warrants further examination. In addition, the research comparing SA and MA classrooms has used multiple forms of measurement for similar constructs as well as varying methodological designs. None of the research presented took into account the hierarchical structure of the data with children being nested within classrooms. In addition, some of the research examined children's behaviors when they were pulled out of the classroom and placed in dyads or small groups. Controlled environments such as these are difficult to generalize to routine classroom situations. These inconsistencies make it difficult to compare findings and make conclusions about MA classrooms. Most importantly, all of the research summarized on this topic thus far has included very small samples of predominantly Caucasian children from middle- to high-income families. Given the importance of high quality early education for low-income children, it is necessary to examine the influence of classroom age composition specifically in this population.

A recent study conducted by Moller, Forbes-Jones, and Hightower (2008) examined classroom age composition in urban preschools serving predominantly low-income children. Moller and colleagues (2008) operationalized classroom age composition in an innovative way. Using a large sample of primarily MA classrooms, they defined classroom age composition as the variability of ages within the classroom. Therefore, classroom age composition became a continuous rather than a dichotomous variable. They also utilized multilevel modeling to analyze the main effect of classroom age composition as well as differential effects for younger and older preschool children on developmental outcomes. While they did not find that classroom age composition influenced younger and older children differently, they did find a negative main effect of classroom age composition on all children's motor, social, and cognitive development. These findings indicate that as the age variability in the classroom increased (i.e., in classrooms with a greater degree of age-mixing), children's developmental outcomes decreased. Overall, this study employed a more informative methodological approach to examine MA classrooms by operationalizing age composition as a continuous variable and examining its influence in a sample of low-income children. However, this study was limited by its use of an ordinal level instrument when measuring children's development, making it difficult to compare children's abilities across the three types of development. In addition, children's development was measured at two time-points limiting the ability to examine rates of change in children's skills across time. The present study addressed these limitations to extend the work by Moller et al. (2008).

School Readiness

In response to the National Education Goals Panel's call for research to better understand the development of multiple domains of school readiness (Kagan et al., 1995), the present study examined the influence of classroom age composition on children's academic school readiness, social and emotional skills, and approaches to learning.

Two academic school readiness domains that consistently have been emphasized in early childhood are emergent literacy and numeracy. Because reading and math are critical areas for academic achievement, it is important to study skills that are considered precursors to learning in these domains. Emergent literacy involves multiple skills and knowledge such as phonological awareness, letter knowledge, and the use and understanding of language that are precursors to future achievement in reading and writing (Whitehurst & Lonigan, 1998). In preschool, early literacy skills are important predictors for children's future school achievement and can serve as protective factors for children at risk for poor academic outcomes (Burchinal, Roberts, Zeisel, Hennon, & Hooper, 2006; Burchinal, Roberts, Zeisel, & Rowley, 2008). Emergent numeracy skills are understood as a general knowledge of numbers including knowing the names of numbers as well as the cardinal and ordinal properties of numbers (Kagan et al., 1995). These skills have been strongly and directly linked to future mathematics achievement as well as achievement in other domains, such as reading (Jordan, Kaplan, Ramineni, & Locuniak, 2009; Duncan et al., 2007).

In addition to early academic readiness, social and emotional skills are considered essential for early positive adjustment to the classroom. Social and emotional development involves many skills necessary for children to succeed in classroom learning, such as the ability to engage with peers and teachers and to effectively regulate emotions (Denham, 2006; Ladd, Herald, & Kochel, 2006; Raver, 2002). Because learning is highly socially-mediated in preschool, children who are unable to engage with teachers and peers miss out on important learning opportunities that place them at risk for future social and academic difficulties (Singer, Golinkoff, & Hirsch-Pasek, 2006; Coolahan, Fantuzzo, Mendez, and McDermott, 2000; Fantuzzo, Sekino, & Cohen, 2004).

Approaches to learning is a relatively new domain of school readiness that has received increased attention in early childhood. Approaches to learning include a set of skills and behaviors in the classroom that provide children with the foundation for learning. They are considered "domain-general" skills that promote children's learning across multiple domains and contexts (McClelland & Morrison, 2003). Approaches to learning involve an array of skills and behaviors such as initiative, motivation, curiosity, and problem-solving abilities (Kagan et al., 1995). Approaches to learning have been found to predict children's future academic achievement in multiple domains and also serve as protective factors for children at risk for poor academic outcomes (Domínguez & Greenfield, 2009; Schaefer & McDermott, 1999).

Present Study

The purpose of the present study was to extend research examining the effect of classroom age composition on children's school readiness using data from a large Head Start program in Miami-Dade County. Based on the operationalization presented by Moller and colleagues (2008), classroom age composition was defined as a continuous variable and was examined in classrooms that were predominantly mixed-age. In contrast to Moller and colleagues (2008), school readiness was measured at multiple times across the academic year in order to examine rates of change in school readiness during one year of Head Start. The influence of age composition on rates of change was examined across multiple domains of school readiness, including emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning. Children were assessed using a tool that permits direct comparisons of children's abilities in different domains. Therefore, it was possible to examine whether classroom age composition influenced specific types of school readiness domains differently. Interactions between child's age and classroom age composition were tested to examine the differential influence of age composition for younger and older children in the classroom. In addition to classroom age composition, important child-level influences of school readiness, including age, sex, ethnicity, dual-language learner status, and special needs status were analyzed. Previous research has found that these child-level influences uniquely contribute to children's abilities in social and academic domains of school readiness (August & Shanahan, 2006; Bulotsky-Shearer, Domínguez, Bell, Rouse, & Fantuzzo, 2010; Fantuzzo, Bulotsky-Shearer, Frye, McDermott, McWayne, & Perlman, 2007; Fantuzzo, Bulotsky, McDermott, Mosca, & Lutz, 2003; Mantzicopoulos, 1999; Tabors & Snow, 2002). Specific research questions consisted of the following:

(1) How does classroom age composition, as well as other important child-level demographic variables, influence children's rates of change in school readiness?

(2) Is this influence moderated by child's age?

(3) Are there differential effects across domains of school readiness?

It was expected that children would improve in all school readiness domains across the year. Because Moller and colleagues (2008) provide the most methodologically-sound study examining the influence of classroom age composition in a sample of low-income children, the main hypothesis was based on their findings. It was expected that there would be a significant negative main effect of classroom age composition on children's rates of change in school readiness skills such that larger variability in ages within the classroom would predict lower rates of rates of change across the school year for all children in the classroom. Because of the inconsistencies in methodologies of the previous literature, testing interactions between child's age and age composition was exploratory, and no directions were predicted. Comparing the influence of classroom age composition across different domains of school readiness was also exploratory with no previous literature providing support for directional hypotheses.

Chapter 2: Method

Participants

Children in this study were selected based on their enrollment in the Miami-Dade County Head Start program for the 2008-2009 academic year. During the 2008-2009 school year, the Miami-Dade Head Start program served 7,301 children in 316 classrooms across 77 centers. Approximately half of the children were female (51.9%). Children in the program were predominantly Black or African American (57.1%) and Hispanic or Latino (42.1%) with a small percentage of children identified as White or Other (0.8%). The average age of children at the beginning of the school year was 47.7 months (SD = 7.12). In addition, there were a significant number of children who were identified as dual-language learners (43.0%). Approximately 7.2% of children in the program were identified with one or more special need.

Only classrooms in which the teacher filled out children's school readiness information online were examined because only school readiness information filled out online was available to researchers. In addition due to the nature of the programmatic data and the purpose of this study, children who dropped out of the program before October 1, 2008, and children who enrolled in the program after May 1, 2009 were excluded from analyses. This exclusion was applied to ensure that children spent at least one month in the classroom in order to appropriately examine the influence of the classroom composition variable on children's outcomes.

The final sample consisted of 4,417 children in 207 classrooms across 50 centers. This sample was very similar to the population of children in the Miami-Dade County Head Start program. Approximately half of the children were female (52.2%). Children were predominantly Black or African American (53.4%) and Hispanic or Latino (45.5%) with a small percentage of children identified as White or Other (1.1%). The average age of children at the beginning of the school year was 47.5 months (*SD* = 7.13). Approximately 46.4% of children were identified as dual-language learners, and 7.8% of children were identified with one or more special need. At least 90% of children met the federal income requirement for enrollment in Head Start indicating a sample of predominantly low-income children. Of the children in the final sample, 146 children (3.3%) were missing school readiness information.

Measures

Classroom Age Composition. In accordance with Moller et al. (2008), classroom age composition was calculated using two indices of variability within each classroom: the standard deviation and range of children's ages at the beginning of the school year. Age composition was calculated in two ways because both the standard deviation and the range provide unique information about the variability of ages in the classroom. First, age composition was calculated as the standard deviation of ages in months within each classroom. Each classroom received a score indicating the standard deviation of ages around the mean age of the classroom. Second, age composition was calculated as the classroom age range, the range of ages from the youngest child to the oldest child in the classroom. Each classroom received a score indicating the difference in months between the youngest child in the classroom and the oldest child in the classroom. Therefore, every classroom was given two scores representing age composition.

School Readiness. Children's school readiness scores were assessed using the Galileo System for the Electronic Management of Learning (Galileo; Bergan et al., 2003). The Galileo is a teacher measure used to track children's rates of change in multiple school readiness domains. The Galileo consists of eight scales each representing a unique school readiness domain. Each scale contains a series of skills divided into sub-skills. Each sub-skill includes a set of items for which the teacher indicates if the skill is "learned" or "not learned" for every child in the classroom. Teachers enter children's skills into a web-based system a minimum of three times per year. Based on an item response theory (IRT) model (Thissen & Steinberg, 1986), children are given interval-level ability scores for each school readiness domain. The developers of the Galileo standardized the scales on a large sample of ethnically diverse preschool children attending early childhood programs in multiple states. The mean of the ability distribution is 500 with a standard deviation of 50 for all eight readiness domains allowing for direct comparisons across domains. The Galileo has demonstrated high internal consistency indicated by a Cronbach's alpha coefficient of .94 (Bergan, Burnham, Feld, & Bergan, 2009).

Four of the eight Galileo scales were used for this study: Language & Literacy, Early Math, Social & Emotional Skills, and Approaches to Learning. Emergent literacy was measured using the Language & Literacy scale which includes skills such as knowledge of receptive and expressive vocabulary, early reading abilities, and alphabet knowledge. Emergent numeracy was measured using the Early Math scale which includes skills such as counting, sorting, and identifying shapes and patterns. Social and emotional skills were measured using the Social & Emotional Skills scale which assesses children's engagement in social relationships including their skills in cooperation, conflict resolution, and self-control. Approaches to learning was measured using the Approaches to Learning scale which includes learning-related behaviors such as initiative, curiosity, attention, and persistence. Each subscale demonstrates high internal consistency with Cronbach's alpha coefficients of .97, .95, .97, and .94 for the Language & Literacy, Early Math, Social & Emotional Skills, and Approaches to Learning scales, respectively (Bergan et al, 2009). Factor analytic studies conducted by the developers of the Galileo support the structure of the scales. All subscales within each scale were found to reflect a single underlying factor with subscale loadings for all four scales ranging from .38 to 1.00 (Bergan et al., 2009).

Procedure

Data from this study were obtained through a larger data integration project in collaboration with the Miami-Dade County Head Start program. The purpose of the larger project was to integrate three large databases of information programmatically collected by Miami-Dade County Head Start. The three large databases included a child and family information database consisting of child and family demographic information (date of birth, gender, ethnicity, primary and secondary home language, special needs status, etc.), a database containing results from the program-wide behavioral screener as assessed by the Devereux Early Childhood Assessment (DECA; LeBuffe & Naglieri, 1999), and a database consisting of children's school readiness information as assessed by the Galileo. Children's information were linked across the three databases to create an integrated database housing demographic information and data from the DECA and the

Galileo for all children in the Miami-Dade County Head Start program during the 2008-2009 academic year.

The present study used linked data from the child and family information database as well as the school readiness assessment database. According to procedure for the Miami-Dade County Head Start program, parents or guardians report on child and family demographic information which is then entered into the database by Head Start administrative staff upon a child's entry into the program. Information is updated when a child's enrollment information changes. For the school readiness assessment data, teachers are trained to observe children in their classrooms and complete the Galileo for each child at least three times throughout the school year. Once data between these two databases were linked, all identifying information was stripped from the file prior to conducting analyses.

Data Analytic Plan

Multilevel modeling (MLM) was used to examine both child-level and classroom-level variables and how they influenced children's rates of change in school readiness scores. A series of three-level models were conducted using HLM6 (Raudenbush, Bryk, Cheong & Congdon, 2004). First, a fully unconditional model for each of the four school readiness outcomes was analyzed to ensure that there was a significant proportion of variance within children, between children, and between classrooms. Second, children's rates of change were examined to determine if children's school readiness scores grew across the academic year. Finally, the child- and classroom-level variables were entered as predictors of children's baseline scores and their rates of change in school readiness over the year. Missing data were handled using Full Information Maximum Likelihood

(FIML) which uses all available data when estimating parameters (Hancock & Mueller, 2006; Kline, 2005). FIML is recommended for use in developmental research (McCartney, Burchinal, & Bub, 2006).

Level 1. Within-child variance represents the intra-individual variability in children's school readiness scores. The variable examined at this level was time (the number of days that have passed since the beginning of the school year). Examining the effect of time on children's school readiness scores determined if their scores changed significantly across the school year.

Level 2. Between-children variance represents the variability between children's scores within each classroom. The variables examined at this level included age, sex, ethnicity, dual-language learner status, and special needs status. Age was calculated as children's ages in months at the beginning of the school year. Sex (0 = male, 1 = female), dual-language learner status (0 = primary language is English, 1 = primary language is something other than English), and special needs status (0 = no special needs, 1 = one or more identified special needs) were dummy-coded. For ethnicity, Black/African American was set as the reference group, and Hispanic (0 = Black/African American, 1 = Hispanic) and Other ethnicity (0 = Black/African American, 1 = White, Asian or other ethnicity) were included as predictors. Level 2 predictor variables were entered sequentially in the following order: age, sex, ethnicity, dual language learner status, and special needs status. All Level 2 predictors were centered at the group mean as recommended by Enders and Tofighi (2007). If the variance terms associated with the random effects of the child-level variables were not significant, the effect of this variable on school readiness did not vary at the classroom level. Therefore, non-significant variance components were fixed to zero in order to create a more parsimonious model.

Level 3. Between-classrooms variance represents the variability in children's scores that is associated with differences between classrooms. The variable examined at this level was classroom age composition. The main effect of classroom age composition was tested on children's baseline scores as well as their rates of change. In addition, the cross-level interactions between child's age and classroom age composition were tested on baseline scores and rates of change to determine if classroom age composition influenced younger and older children differently. Separate models were analyzed for classroom age standard deviation and classroom age range.

The final model was analyzed to incorporate the two operationalizations of classroom age composition and the four school readiness outcomes of interest:

Level 1: $\textit{School Readiness}_{ti} = \pi_{0i} + \pi_{1i}\,(\textit{Time}_{ti}) + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + \beta_{01}\,(\textit{Age}) + \beta_{02}\,(\textit{Sex}) + \beta_{03}\,(\textit{Hispanic}) + \beta_{04}\,(\textit{Other})$

$+ \beta_{05}\,(\textit{Dual-language Learner}) + \beta_{06}\,(\textit{Special Needs})\; r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}\,(\textit{Age}) + \beta_{12}\,(\textit{Sex}) + \beta_{13}\,(\textit{Hispanic}) + \beta_{14}\,(\textit{Other})$

$+ \beta_{15}\,(\textit{Dual-language Learner}) + \beta_{16}\,(\textit{Special Needs}) + r_{1i}$

Level 3: $\beta_{00} = \gamma_{000} + \gamma_{001}\,(\textit{Classroom Age Composition}) + u_{00i}$

$\beta_{01} = \gamma_{010} + \gamma_{011}\,(\textit{Classroom Age Composition}) + u_{01i}$

$\beta_{02} = \gamma_{020} + u_{02i}$

$\beta_{03} = \gamma_{030} + u_{03i}$

$\beta_{04} = \gamma_{040} + u_{04i}$

$\beta_{05} = \gamma_{050} + u_{05i}$

$\beta_{06} = \gamma_{060} + u_{06i}$

$\beta_{10} = \gamma_{100} + \gamma_{101}$ (*Classroom Age Composition*) $+ u_{10i}$

$\beta_{11} = \gamma_{110} + \gamma_{111}$ (*Classroom Age Composition*) $+ u_{11i}$

$\beta_{12} = \gamma_{120} + u_{12i}$

$\beta_{13} = \gamma_{130} + u_{13i}$

$\beta_{14} = \gamma_{140} + u_{14i}$

$\beta_{15} = \gamma_{150} + u_{15i}$

$\beta_{16} = \gamma_{160} + u_{16i}$

Chapter 3: Results

Descriptive Statistics

Descriptive statistics for child- and classroom-level variables can be found in Table 1. The grand mean developmental level scores across all time points throughout the year for emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning were 492.19 (*SD* = 67.142), 501.14 (*SD* = 62.302), 483.71 (*SD* = 60.237), and 539.85 (*SD* = 57.118), respectively. The number of time-points for which each child was given a score on the four school readiness domains ranged from 1 to 48. The average number of time-points for each domain was 8.06 for emergent literacy, 4.96 for emergent numeracy, 9.38 for social and emotional skills, and 8.97 for approaches to learning. For each domain, multilevel models were built in a series of steps as described previously.

Multilevel Modeling Results

First, a fully unconditional model was analyzed to determine the distribution of variance in children's school readiness at each of the three levels. For emergent literacy, 40% of the variance in children's scores was attributable to differences within children (Level 1), 32% of the variance was attributable to differences between children (Level 2), and 29% was attributable to differences between classrooms (Level 3). For emergent numeracy, 41% of the variance in children's scores was at Level 1, 34% of the variance was at Level 2, and 25% was at Level 3. For social and emotional skills, 38% of the variance in children's scores was at Level 1, 34% of the variance was at Level 2, and 28% was at Level 3. For approaches to learning, 40% of the variance in children's scores was at Level 1, 38% of the variance was at Level 2, and 23% was at Level 3. Tables 2 and 3 include results from the multilevel models. Because these models were built in steps starting with the first level, Level 1 and 2 findings are equivalent across the two tables. Level 3 results differ between the two tables based on the operationalization of classroom age composition. Table 2 includes results from classroom age standard deviation, and Table 3 includes results from classroom age range.

Level 1. Next, an unconditional growth model was analyzed by including the variable of time as a predictor at Level 1. For the unconditional growth model, the intercept is interpreted as the mean of teacher's ratings of children's school readiness at the beginning of the school year (baseline score), and the slope is interpreted as the daily average rate of change in school readiness across the year. For all school readiness domains, the intercept was significant, and the slope was both significant and positive. These models demonstrated that children experienced significant improvement in emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning across the year. The addition of the time variable accounted for 80.0% of the variance within children for emergent literacy, 81.5% of the variance in emergent numeracy, 73.5% of variance in social and emotional skills, and 76.4% of the variance in approaches to learning. The random effects associated with the intercept and slope were significant for all models, indicating the appropriateness of entering predictors at Level 2 and Level 3.

Level 2. Child-level variables (age, sex, ethnicity, dual language learner status, and special needs status) were added at the intercept and slope and were centered at the group-mean. The intercept (γ_{000}) is interpreted as the average baseline school readiness score for children at the mean age in classrooms with an average ratio of gender, ethnicities, dual-language learners, and children with special needs. Age and sex were significant predictors of baseline scores for all school readiness domains, with older children and girls rated as having higher scores in all domains at the beginning of the year, in comparison to younger children and boys.

The slope (γ_{100}) is interpreted as the daily average rate of change in school readiness for children at the mean age in classrooms with an average ratio of gender, ethnicities, dual-language learners, and children with special needs. For emergent literacy, ethnicity and special needs status were predictors of rates of change with Hispanic children showing higher rates of change in emergent literacy as compared to Black children and children with special needs showing lower rates of change in emergent literacy as compared to children without special needs. For emergent numeracy, age and special needs status were predictors of rates of change with older children showing higher rates of change in emergent numeracy as compared to younger children and children with special needs showing lower rates of change in emergent numeracy as compared to children without special needs.

For social and emotional skills, age, ethnicity, and special needs status were predictors of rates of change with older children and children with special needs showing lower rates of change in social and emotional skills as compared to younger children and children without special needs, and Hispanic children showing higher in rates of change in social and emotional skills as compared to Black children. Age and special needs status were predictors of rates of change in social and emotional skills with older children and children with special needs showing higher rates of change in social and emotional skills as compared to younger children and children without special needs.

The variance terms associated with age at the intercept and slope were significant in all models indicating that the effect of age on baseline scores and rates of change in school readiness varied at the classroom level. Additionally, the variance term associated with Other ethnicity was significant for social and emotional skills and approaches to learning, and the variance term associated with special needs status was significant for emergent numeracy. All other variance terms were not significant and were fixed to zero. The addition of the Level 2 variables accounted for 34.0% of the variance between children for emergent literacy, 36.2% of the variance in emergent numeracy, 31.8% of the variance in social and emotional skills, and 31.8% of the variance in approaches to learning.

Level 3. Finally, classroom age composition was entered as a predictor of children's baseline scores and rates of change in school readiness. In addition, cross-level interactions between classroom age composition and child's age were specified at the intercept and the slope. Separate models were analyzed for classroom age standard deviation and classroom age range. Level 2 results did not change with the inclusion of the Level 3 variables.

For the three-level model, the intercept (γ_{000}) is interpreted as the average baseline score in school readiness for children at the mean age in classrooms with an average ratio of gender, ethnicities, dual language learners, and children with special needs as well as in classrooms with an average classroom age composition. The slope (γ_{100}) is interpreted as the average rate of change in school readiness for children at the mean age in classrooms with an average ratio of gender, ethnicities, dual language learners, and children with special needs as well as in classrooms with an average classroom age composition. The slopes for emergent literacy and emergent numeracy ($\gamma_{100} = 0.364$, $SE = 0.02$, $p < 0.001$; $\gamma_{100} = 0.364$, $SE = 0.02$, $p < 0.001$) were equivalent to a rate of change of 11.1 points (almost a quarter of a standard deviation) per month. The slope for social and emotional skills ($\gamma_{100} = 0.316$, $SE = 0.01$, $p < 0.001$) was equivalent to a rate of change of 9.6 points (approximately a fifth of a standard deviation) per month. Finally, the slope for approaches to learning ($\gamma_{100} = 0.337$, $SE = 0.01$, $p < 0.001$) was equivalent to a rate of change of 10.3 points (approximately a fifth of a standard deviation) per month.

For emergent literacy, emergent numeracy, and social and emotional skills, neither classroom age standard deviation nor classroom age range was a significant predictor of the intercept or the slope, and there were no significant cross-level interactions between child's age and classroom age composition. For approaches to learning, there were no main effects associated with classroom age standard deviation or classroom age range, and there were no cross-level interactions associated with classroom age range. However, there were significant cross-level interactions between child's age and classroom age standard deviation at the intercept ($\gamma_{011} = 0.395$, $SE = 0.19$, $p = 0.04$) and at the slope ($\gamma_{111} = 0.001$, $SE < 0.01$, $p = 0.04$). These interactions are displayed in Figure 1. The interaction at the intercept (where Time = 0) indicates that teachers rated older children in classrooms with a larger age composition as having better approaches to learning at baseline as compared to older children in classrooms with a smaller age composition. The interaction at the slope can also be interpreted as a three-way interaction between time, child's age, and classroom age composition. As displayed in Figure 1, it appears that younger children in classrooms with a larger age composition showed higher rates of change over time in approaches to learning as compared to younger children in classrooms with a smaller age composition; specifically, younger children in classrooms with a larger age composition experienced a monthly increase of 0.03 points above the average rate of change. For the final model with classroom age standard deviation and approaches to learning, the addition of classroom age composition explained 0.20% of the variance between classrooms.

Chapter 4: Discussion

The present study examined the influence of classroom age composition on children's rates of change in multiple domains of school readiness in a sample of preschoolers from a large, urban Head Start program. Consistent with hypotheses, the results show that children experienced significant improvement in emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning across one academic year. Age and sex influenced children's abilities in these domains at the beginning of the year, and age, ethnicity, and special needs status influence children's rates of change across the year. Contrary to hypotheses, classroom age composition did not directly influence children's rates of change in school readiness. However, significant cross-level interactions between child's age and classroom age composition indicate that classroom age composition influenced younger and older children's approaches to learning differently.

This is the second study to examine the influence of classroom age composition, as defined by the standard deviation and range of ages in the classroom, in low-income preschool classrooms. It is the first study to examine this variable as it influenced rates of change in the specific domains of emergent literacy, emergent numeracy, social and emotional skills, and approaches to learning. Previous findings that a greater degree of age-mixing in low-income preschool classrooms negatively influenced children's competencies were not replicated. Instead, a positive influence of a larger classroom age composition was found for younger children. These results contribute to a controversial literature attempting to disentangle the effects of age-mixing in preschool classrooms.

Child-Level Influences

The results for age and sex are consistent with previous research findings indicating that older children and girls have better school readiness skills across academic and social domains (Bulotsky-Shearer, Fantuzzo, & McDermott, 2008; Mendez, McDermott, & Fantuzzo, 2002; Coolahan et al., 2000). At the beginning of the year, older children and girls were rated as having better skills in all domains of school readiness. However, for social and emotional skills and approaches to learning, younger children developed these skills at a faster rate than older children throughout the year. This is encouraging given that social and emotional skills and approaches to learning are important prerequisites for more academic learning in preschool, such as in emergent literacy or numeracy (Bulotsky-Shearer et al., 2008; Coolahan et al., 2000; Domínguez & Greenfield, 2009; McClelland, Morrison, & Holmes, 2000; Mendez et al., 2002; Schaefer & McDermott, 1999).

Age did not predict rates of change in emergent literacy, indicating that older children maintained the advantage they had in this area throughout the year. For emergent numeracy, older children began the year with higher scores and grew at faster rates as compared to younger children. Teachers may be directing instruction in early reading and math toward older children because they have already developed the ability to socially interact and pay attention during learning situations. In addition, preschool teachers may be focusing literacy and numeracy instruction on children who are in their final year of preschool in order to prepare them for Kindergarten. It is also possible that rates of change in the domains of social and emotional skills and approaches to learning are more important for younger children before they progress into more cognitivelydemanding domains of learning, such as emergent literacy and numeracy (Layzer, Goodsen, & Moss, 1993); however, future research is needed to support this conclusion. For all domains of school readiness, sex did not predict rates of change indicating that boys do not catch up with girls who start out the year with more school readiness skills. Sex differences in school readiness have been consistently documented (Bulotsky-Shearer, et al., 2010; Qi, Kaiser, & Milan, 2006; Ponitz et al., 2008; Stowe, Arnold, & Ortiz, 2000); future research is necessary to examine why boys lag behind girls in school readiness outcomes in early childhood.

The findings for ethnicity and dual language learner status are not as clear. While there were no differences between ethnicities at the beginning of the year, Hispanic children experience higher rates of change in the domains of emergent literacy and social and emotional skills. Research attempting to explain differences across cultural groups has been restricted by methodological limitations, such as lack of valid measures for particular cultural groups (Fantuzzo, Coolahan, Mendez, McDermott, & Sutton-Smith, 1998). One potential explanation for why Hispanic children are growing at a faster rate, particularly in the domains of early literacy and social and emotional skills, is that many Hispanic children speak Spanish as their primary home language and are acquiring English-speaking skills simultaneously as they are acquiring other school readiness skills (Butler & Hakuta, 2004; Oller & Eilers, 2002). However, in the present study, dual language learner status did not predict baseline scores or rates of change in school readiness. Children’s dual language learner status was based on parent report of primary and secondary language. It is likely that this indicator has a degree of unreliability to it, and that more direct measurement of dual language learner status or English language ability would provide more accurate information. Therefore, future research is needed to better understand these findings.

Children with special needs did not start out the year below their non-special-needs peers, but they did develop school readiness skills at a slower rate. This finding is consistent with federal regulations emphasizing the importance of identifying children with special needs as early as possible in their schooling and is consistent with research finding that many children with special needs are not being identified at an early enough age (Fantuzzo, et al., 1999; IDEA, 1997; Yoshikawa & Knitzer, 1997). Children from low-income families who are also identified with special needs are at disproportionate risk for poor outcomes early on and later in life (Lavigne et al., 1996). Head Start is the largest provider of services to low-income children with special needs in the United States (Schwartz & Brand, 2001). Therefore, it is critical for future work to examine how assessment tools used by teachers in Head Start classrooms can help them identify the needs of these children, particularly related to school readiness domains, and how they can support their improvement in these domains across the school year.

Classroom Age Composition

Contrary to previous research (Bailey et al., 1993; Field, 1982; Goldman, 1981; Moller et al., 2008; Roopnarine et al., 1992; Winsler et al., 2002), classroom age composition did not uniformly influence school readiness for all children. Instead, classroom age composition influenced children's school readiness, specifically their approaches to learning skills, differently based on child's age. However, for the domains of emergent literacy and numeracy and social and emotional skills, classroom age composition was not influential at all. Because significant findings for classroom age composition were found only for one school readiness domain, the influence of classroom age composition cannot be compared across domains. However, differential effects of classroom age composition for children of different ages for approaches to learning can be explored.

A significant and positive interaction between child's age and classroom age composition for approaches to learning scores at the beginning of the year indicated that older children in classrooms with a larger age composition were rated as having better approaches to learning skills than older children in classrooms with a smaller age composition. It was slightly unexpected that classroom age composition would affect children at the beginning of the school year because children should be exposed to classroom-level variables for a period of time in order for them to be influential. However, Roopnarine and colleagues (1992) found that the benefits of being in a mixed-age classroom were apparent at the beginning of the school year as children were adjusting to the classroom, but this influence changed throughout the year as children became more familiar with each other. Another explanation is that teachers in classrooms with a larger age composition are exposed to a wider range of ability levels. Therefore, they may perceive the older children in their classroom as more skilled in contrast to the younger children in their classrooms than would teachers in classrooms with a more narrow range of ability levels.

The most interesting finding of the present study was a significant interaction between child's age and classroom age composition on rates of change in approaches to learning. Younger children in classrooms with a larger age composition were rated as having higher rates of change in approaches to learning as compared to younger children in classrooms with a smaller age composition. While this is the first study examining the influence of classroom age composition on rates of change in approaches to learning, the finding that younger children benefit from age-mixing in the classroom is consistent with previous research (Bailey et al., 1993; Blasco et al., 1993; Howes & Farver, 1987; Urberg & Kaplan, 1986; Winsler et al., 2002). In addition, other research has examined the influence of other classroom-level variables (i.e., classroom quality) on rates of change in approaches to learning (Domínguez, Vitiello, Maier, & Greenfield, 2010). This research found that classroom quality, specifically classroom organization (e.g., behavior management strategies and classroom productivity), uniquely influences rates of change in approaches to learning (Domínguez, et al., 2010). While classroom quality predominantly refers to the teacher's role in the classroom, classroom age composition provides a way to examine the composition of peers in the classroom as an index of the role played by social interactions in the classroom. The current study extends previous research on rates of change in approaches to learning by examining the role of classroom age composition as well as differential influences of classroom age composition based on children's age.

Results show that older children start out the year with better approaches to learning skills. However, younger children in classrooms with a large age composition appear to benefit throughout the year from exposure to older peers in terms of their development of learning-related behaviors such as initiative, curiosity, attention, and persistence. In accordance with Vygotsky's theory, older children may be scaffolding younger children's development of the skills associated with approaches to learning (Vygotsky, 1978). Approaches to learning are characterized by skills that are easily observable in classroom learning situations (Barnett, Bauer, Ehrhardt, Lentz, & Stollar, 1996; Schaefer & McDermott, 1999). Therefore, it is likely that younger children are observing their older peers model these behaviors in the classroom and are more quickly able to engage in these behaviors themselves. Approaches to learning are not only malleable in preschool children but also serve as a protective factor for children at risk for poor academic outcomes (Domínguez & Greenfield, 2009; Schaefer & McDermott, 1999; McWayne & Cheung, 2009). Therefore, this finding has important implications for educators who are interested in intervention with low-income children.

Limitations and Future Directions

The present study contributes to the literature on classroom age composition by using a large sample of children and classrooms from a large, urban Head Start program in the Southeast. In addition, this study utilized multilevel modeling to examine the influence of child- and classroom-level variables on baseline scores and rates of change in multiple domains of school readiness. Despite these strengths, there are some limitations to the study that need to be addressed. First, because our sample came from one Head Start program, the generalizability of the findings are limited to populations of predominantly African-American and Hispanic children from low-income families living in urban areas. Future research should examine these findings in samples of children from other diverse groups and geographic areas.

In addition, the school readiness domains were measured using teachers reports of children's skills in these domains. Therefore, children's scores in school readiness reflect teacher's perceptions of their abilities. Research has shown that teachers may take into account their own characteristics and perspectives when assessing children's competencies, which can bias the scores (Mashburn, Hamre, Downer, & Pianta, 2006). However, the Galileo is designed to measure teacher's direct observations of children's skills in the classroom and does not ask the teacher to make inferences or judgments about children's abilities. In addition, the Galileo is used as the program-wide school readiness assessment for the Miami-Dade Head Start program. Research has shown that teachers are the most efficient source of information on children's school readiness when gathered on a large scale (McDermott, 1986). However, future research would benefit from incorporating multiple methods of measuring children's school readiness skills, such as direct assessment and observation.

Another limitation is that other important classroom-level variables that may influence children's school readiness were unavailable in the current study. While classroom age composition provides information on the peer characteristics in the classroom, it does not provide information on what is happening in the classroom on a daily basis. The same degree of age-mixing in the classroom could manifest itself differently based on the structure of the classroom, the social environment of the classroom, and many other factors. In addition, there are numerous other classroom-level influences that should be examined. For example, the influence of classroom age composition on children's outcomes may be dependent on other factors such as classroom quality as well as teacher experience and education level. In addition, children's school readiness may be influenced by other classroom composition variables or peer characteristics, such as the composition of gender, ethnicities, dual-language learners, children with special needs, as well as the level of problem behavior or positive social interaction in the classroom. Future research should examine the influence of classroom age composition in relation to other important classroom-level variables.

Finally, it is important to note that although the interaction between child's age and classroom age composition on approaches to learning was statistically significant, the effect size of classroom age composition (i.e., the variance explained by classroom age composition) was relatively small. As mentioned previously, there may be numerous other classroom-level influences that are not accounted for in the current models. It is likely that the influence of classroom age composition could be greater if more information on the classroom context is included in analyses. For example, classroom quality is likely a key contributor to this relationship. It is possible that a combination between high classroom quality and a large age composition would significantly influence children's school readiness. However, classroom quality is not being controlled for in the current study; therefore, low quality classrooms with a large age composition may encumber the findings. It is also important to note that many highly influential child-level variables are controlled for in this study, meaning that classroom age composition is uniquely contributing to school readiness above and beyond these child-level influences.

Conclusions and Implications

Despite the limitations, the results of the current study pave the way for important conclusions and implications for classroom age composition. It is necessary for future researchers to move beyond calculating classroom age composition and to observe classroom age composition in context. There may be some characteristics of classrooms that enhance the benefits of mixed-age classrooms and some that do not. Approaches to learning is a critical domain of school readiness particularly for low-income children. Therefore, it is important to structure classrooms in a manner that promotes the early development of these skills considered to be foundational for future learning. Age-mixing in the classroom, through its influence on improvement in approaches to learning, may provide an opportunity to mitigate the negative effects of poverty on children's academic outcomes.

Past research has demonstrated that the influence of classroom age composition on preschool children's outcomes is complex. The current study extends this research and provides evidence for the benefits of age-mixing in Head Start classrooms, particularly for younger children in the classroom. However, prior to making policy decisions regarding the future of age-mixing in Head Start, further research is necessary to examine the mechanisms through which classroom age composition influences rates of change in approaches to learning as well as how classroom age composition interacts with other important classroom-level variables. This research highlights the need to identify potential professional development and curricular strategies that capitalize on the unique opportunities that a mixed-age classroom provides, particularly in classrooms serving at-risk children.

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Table 1.

Descriptive Statistics for Child- and Classroom-Level Variables.

	n	*Mean*	*SD*
Child-level Variables			
Age	4417	47.54	7.13
Sex	4417	0.52	0.50
Black/African American	4417	0.53	0.50
Hispanic/Latino	4417	0.46	0.50
Other	4417	0.01	0.10
Dual Language Learner Status	4347	0.46	0.50
Special Needs Status	4415	0.08	0.27
Classroom-level Variables			
Age Standard Deviation	207	6.80	0.98
Age Range	207	22.29	2.57

Note. Age is provided in months. Sex (1 = Female), Black/African American (1 = Black/African American), Hispanic/Latino (1 = Hispanic/Latino), and Other (1 = Other) are dummy-coded.

Table 2.

Final Models for Age Standard Deviation.

Fixed Effects	Emergent Literacy	Emergent Numeracy	Social Emotional	Approaches to Learning
Parameter	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept (γ_{000})	439.4739 (2.77)*	459.6700 (2.28)*	438.6821 (2.77)*	491.2384 (2.53)*
Age Composition (γ_{001})	1.7237 (2.86)	1.1687 (2.33)	1.5858 (2.85)	1.5350 (2.59)
Age (γ_{010})	3.8526 (0.18)*	3.3650 (0.17)*	3.6262 (0.19)*	4.1416 (0.17)*
Age x Age Composition (γ_{011})	0.3448 (0.20)	0.2039 (0.19)	0.2296 (0.20)	0.3950 (0.19)*
Sex (γ_{020})	7.2392 (1.55)*	4.9512 (1.35)*	6.7629 (1.55)*	5.7370 (1.55)*
Hispanic (γ_{030})	-3.4514 (3.19)	-1.8755 (2.78)	-4.1771 (3.17)	-1.6251 (3.16)
Other (γ_{040})	-4.4052 (7.68)	0.4496 (6.67)	-10.1598 (11.83)	-4.3531 (10.35)
Dual Language Learner (γ_{050})	-0.8921 (2.82)	-1.2397 (2.45)	-0.7079 (2.82)	-2.9903 (2.82)
Special Needs (γ_{060})	-0.3263 (2.90)	0.4720 (2.83)	3.2231 (2.90)	4.1256 (2.91)
Slope (γ_{100})	0.3640 (0.02)*	0.3639 (0.02)*	0.3164 (0.01)*	0.3369 (0.01)*
Age Composition (γ_{101})	0.0107 (0.02)	0.0091 (0.02)	0.0026 (0.02)	0.0032 (0.01)
Age (γ_{110})	-0.0011 (0.00)	0.0026 (0.00)*	-0.0040 (0.00)*	-0.0065 (0.00)*
Age x Age Composition (γ_{111})	-0.0011 (0.00)	-0.0003 (0.00)	-0.0005 (0.00)	-0.0015 (0.00)*
Sex (γ_{120})	-0.0056 (0.01)	0.0005 (0.01)	-0.0085 (0.01)	-0.0075 (0.01)
Hispanic (γ_{130})	0.0258 (0.01)*	0.0213 (0.01)	0.0302 (0.01)*	0.0144 (0.01)
Other (γ_{140})	-0.0005 (0.03)	-0.0008 (0.03)	0.0236 (0.04)	0.0272 (0.03)

Dual Language Learner (γ_{150})	-0.0095 (0.01)	0.0054 (0.01)	-0.0154 (0.01)	0.0036 (0.01)
Special Needs (γ_{160})	-0.0468 (0.01)*	-0.0291 (0.01)*	-0.0387 (0.01)*	-0.0364 (0.01)*
Random Effects				
Level 1 (σ^2)	360.5959	295.5038	361.4710	306.0367
Level 2				
Intercept ($\tau_{\pi00}$)	1820.9076*	1313.0884*	1878.2119*	1931.8461*
Slope ($\tau_{\pi11}$)	0.0191*	0.0155*	0.0187*	0.0186*
Level 3				
Intercept ($\tau_{\beta00}$)	1439.6414*	963.4903*	1447.4993*	1198.7428*
Intercept/Age ($\tau_{\beta01}$)	3.5990*	3.8661*	4.0427*	3.2117*
Intercept/Other ($\tau_{\beta04}$)	--	--	2986.94132*	2199.4068*
Intercept/Special Needs ($\tau_{\beta04}$)	--	200.6564*	--	--
Slope ($\tau_{\beta10}$)	0.0470*	0.0452*	0.0421*	0.0247*
Slope/Age ($\tau_{\beta11}$)	0.0001*	0.0001*	0.0001*	0.0001*
Slope/Other ($\tau_{\beta14}$)	--	--	0.0182*	0.0176*
Slope/Special Needs ($\tau_{\beta13}$)	--	0.0061*	--	--

Note. Age represents chidren's age in months. Sex, Black/African American, Hispanic/Latino, Other, Dual Language Learner, and Special Needs are dummy-coded. Approaches to Learning, Social Emotional, Early Math, and Language & Literacy are developmental level scores ($M = 500$, $SD = 50$).

*$p = .05$.

Table 3.

Final Models for Age Range.

Fixed Effects	Emergent Literacy	Emergent Numeracy	Social Emotional	Approaches to Learning
Parameter	Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
Intercept (γ_{000})	439.4856 (2.77)*	459.6833 (2.28)*	438.6814 (2.76)*	491.2516 (2.53)*
Age Composition (γ_{001})	0.9437 (1.09)	0.5446 (0.90)	0.7656 (1.08)	0.6766 (0.99)
Age (γ_{010})	3.8906 (0.18)*	3.3845 (0.17)*	3.6526 (0.18)*	4.1705 (0.17)*
Age x Age Composition (γ_{011})	-0.0010 (0.08)	-0.0535 (0.07)	0.0112 (0.08)	0.1091 (0.07)
Sex (γ_{020})	7.2349 (1.55)*	4.9508 (1.35)*	6.7509 (1.55)*	5.7113(1.55)*
Hispanic (γ_{030})	-3.3786 (3.19)	-1.8496 (2.78)	-4.1278 (3.17)	-1.5746 (3.16)
Other (γ_{040})	-4.3350 (7.69)	0.4658 (6.66)	-10.3953 (11.86)	-4.6171 (10.43)
Dual Language Learner (γ_{050})	-0.8777 (2.82)	-1.2145 (2.45)	-0.7063 (2.82)	-2.9830 (2.82)
Special Needs (γ_{060})	0.3226 (2.90)	0.4381 (2.82)	3.2111 (2.90)	4.1012 (2.91)
Slope (γ_{100})	0.3639 (0.02)*	0.3369 (0.01)*	0.3164 (0.01)*	0.3369 (0.02)*
Age Composition (γ_{101})	-0.0034 (0.01)	-0.0054 (0.01)	-0.0023 (0.01)	-0.0024 (0.00)
Age (γ_{110})	-0.0012 (0.00)	0.0026 (0.00)*	-0.0041 (0.00)*	-0.0066 (0.00)*
Age x Age Composition (γ_{111})	-0.0001 (0.00)	-0.0000 (0.00)	-0.0001 (0.00)	-0.0003 (0.00)
Sex (γ_{120})	-0.0056 (0.01)	-0.0005 (0.01)	-0.0085 (0.01)	-0.0074 (0.01)
Hispanic (γ_{130})	0.0256 (0.01)*	0.0212 (0.01)	0.0301 (0.01)*	0.0142 (0.01)
Other (γ_{140})	-0.0008 (0.03)	-0.0009 (0.03)	0.0244 (0.04)	0.0282 (0.03)

Dual Language Learner (γ_{150})	-0.0096 (0.01)	0.0053 (0.01)	-0.0154 (0.01)	0.0036 (0.01)
Special Needs (γ_{160})	-0.0468 (0.01)*	-0.0290 (0.01)*	-0.0387 (0.01)*	-0.0363 (0.01)*
Random Effects				
Level 1 (σ^2)	360.5966	295.5108	361.4704	306.0355
Level 2				
Intercept ($\tau_{\pi 00}$)	1821.3328*	1313.4310*	1878.2503*	1931.8885*
Slope ($\tau_{\pi 11}$)	0.0191*	0.0155*	0.0187*	0.0186*
Level 3				
Intercept ($\tau_{\beta 00}$)	1437.6487*	961.6329*	1445.8123*	1197.0896*
Intercept/Age ($\tau_{\beta 01}$)	3.6595*	3.8560*	4.0797*	3.2503*
Intercept/Other ($\tau_{\beta 04}$)	--	--	3014.5412*	2178.1186*
Intercept/Special Needs ($\tau_{\beta 04}$)	--	195.3450*	--	--
Slope ($\tau_{\beta 10}$)	0.0471*	0.0448*	0.0420*	0.0247*
Slope/Age ($\tau_{\beta 11}$)	0.0001*	0.0001*	0.0001*	0.0001*
Slope/Other ($\tau_{\beta 14}$)	--	--	0.0184*	0.0174*
Slope/Special Needs ($\tau_{\beta 13}$)	--	0.0061*	--	--

Note. Age represents chidren's age in months. Sex, Black/African American, Hispanic/Latino, Other, Dual Language Learner, and Special Needs are dummy-coded. Approaches to Learning, Social Emotional, Early Math, and Language & Literacy are developmental level scores ($M = 500$, $SD = 50$).
*$p = .05$.

Figure 1.

Interaction between Classroom Age Composition and Child's Age