INFLUENCES OF INSTRUCTIONAL AND EMOTIONAL CLASSROOM ENVIRONMENTS AND LEARNING ENGAGEMENT ON LOW-INCOME CHILDREN'S ACHIEVEMENT IN THE PREKINDERGARTEN YEAR

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CHAPTER I

Introduction

Statement of the Problem

Public pre-kindergarten programs, specifically designed to improve at-risk children's school readiness skills, have become a principal context in which many young children live and learn. There are two types of such programs; one program is affiliated with a public school system, and the other program, Head Start, is affiliated with the federal government. State programs are rapidly expanding, and, as a result increasing numbers of children are in pre-kindergarten classrooms. For example, in 2009–2010, more than 1.3 million children ages three to four were in state funded programs (Barnett et al., 2010), and almost 984 thousand children ages three to five were in Head Start programs (National Head Start Association, n.d.). While these numbers are impressive, they include a small portion of young children in the country. The number of children in public pre-kindergarten programs will almost certainly continue to grow as more states offer programs, and states with programs expand them. (Head Start funding has been capped; thus this program has remained stable in terms of children served for the past few years.) This rapid expansion of state programs occurs at a time when all early childhood programs are being held accountable for demonstrating learning gains among their children.

Identification of program characteristics related to children's progress above and beyond what the child brings to school, both developmentally and in terms of family

background, is of considerable importance for ensuring that these pre-kindergarten programs enhance school readiness, particularly for children from disadvantaged backgrounds. Results from studies examining aspects of teacher behaviors at the global level depict two central elements: an instructional and an emotional element (National Institute of Child Health and Human Development Early Child Care Research Network [NICHD ECCRN], 2002; Pianta, La Paro, & Hamre, 2005; Pianta, La Paro, Payne, Cox, & Bradley, 2002). The instructional aspect refers to the extent to which instructional activity and child engagement are directed by the teacher or the child (Morrison & Connor, 2002), and the extent to which instructional focus is on the improvement of basic skills or on analytic-inferential thinking in children (Hamre & Pianta, 2007). The emotional aspect of the classroom climate refers to how warm, sensitive, and responsive the teacher is to children in his/her classroom (La Paro, Pianta, & Stuhlman, 2004).

Empirical evidence repeatedly indicates the importance of these classroom components in the prediction of children's gains in academic skills. Indeed, instructional and emotional aspects of the classroom are independently (Curby, Rimm-Kaufman, & Ponitz, 2009; Howes et al., 2008; Mashburn et al., 2008; Pianta, Belsky, Vandergrift, Houts, & Morrison, 2008) and in combination (Perry, Donohue, & Weinstein, 2007; Stipek et al., 1998; Stipek, Feiler, Daniels, & Milbum, 1995) predictive of children's gains in academic skills, particularly as their effects are moderated by certain risk factors for poor achievement (Connor, Morrison, & Katch, 2004a; Connor, Morrison, & Petrella, 2004b; Curby et al., 2009; Hamre & Pianta, 2005).

It is important to note that the observed effects of instructional and emotional aspects of the classroom on children's gains in academic skills are small in general. One

reason for this is that only a few classrooms provide high-level instructional and emotional support for children (Howes et al., 2008). Indeed, across 4,000 classrooms extending from pre-kindergarten to fifth grade, on average, the level of instructional support ranges from low to medium levels, while that of emotional support is relatively high ranging from medium to high levels (identified on the basis of absolute scores on *Classroom Assessment Scoring System* [CLASS]) (Hamre, Pianta, Mashburn, & Downer, 2007). Despite the weak nature of the instructional and emotional classroom climates, quite small increases in levels of instructional and emotional support can produce significant gains in academic skills of young children (Hamre & Pianta, 2005).

Many studies have been conducted to investigate the characteristics of an instructionally supportive classroom environment that fosters children's academic achievement. Researchers have reported conflicting results. More specifically, studies have shown that instruction focusing on analysis and inferential thinking in teacher-directed or child-centered classroom activities (Burts et al., 1993; Connor et al., 2004b; NICHD ECCRN, 2004) and also that emphasizing basic skills development under the teacher's direction (Gersten, Darch, & Gleason, 1988; Stallings, 1974) are positively related to children's academic achievement. It is important to take into account the limitations of these studies while interpreting the results; most of the studies attempting to relate instructional practices to children's academic achievement did not control for children's prior achievement. Also, the findings of these studies appear to vary as a consequence of the backgrounds of the students -- with one group reporting a positive effect of cognitively rich instruction on a diverse group of children, while the other

finding a positive effect of teacher-directed basic skills instruction for children from socioeconomically disadvantage backgrounds.

Studies examining instructional and emotional support together have found differential effects for these classroom components. Indeed, instructional support is a relatively stronger predictor of children's academic achievement in the pre-kindergarten year (Howes et al., 2008; Mashburn et al., 2008), while emotional support has a relatively stronger effect on children's academic skills in the elementary school years (Curby et al., 2009; Pianta et al., 2008). On the other hand, studies testing the collective effect of instructional and emotional classroom environments reported the significant impact of such support on children's achievement in prekindergarten through first grade (Perry, et al., 2007; Stipek et al., 1998, 1995).

Emotional support is related to other classroom characteristics such as the degree to which children control their own learning, i.e., child-centered learning. A blend of teacher direction and child-centered learning has been characterized as a supportive learning environment. More supportive classrooms create an emotional climate that involves warm, sensitive, and responsive interactions between the teacher and the children (Connor, Morrison, Fishman, Schatschneider, & Underwood, 2007; Crosnoe et al., 2010). In addition to these study findings, evidence has indicated that early childhood classrooms employing child-centered, cognitively rich instruction and providing positive emotional support can facilitate children's future academic outcomes (Stipek et al., 1998).

In addition to results from studies examining classroom environments on the basis of observed behaviors of the teacher, studies have examined children's classroom

experiences on the basis of behaviors of individual children. Those studies indicate that children's engagement with the teacher, peers, and materials within the context of a classroom is another program characteristic that influences children's learning outcomes (Chien et al., 2010; Ridley, McWilliam, & Oate, 2000). Investigation of child behavior provides information on individual children's mastery of skills, as well as on classroom environment that is not otherwise captured in the measures of instructional and emotional aspects of the classroom delivered by the teacher.

Several investigations have suggested children's engagement in learning activities as a proximal mechanism that promotes learning and therefore should be fostered in children (Alexander, Entwisle, & Dauber, 1993; DiPerna, Volpe, & Elliott, 2005; Hughes & Kwok, 2007; Ladd, Birch, & Buhs, 1999). Relatively little is known, however, about the classroom practices that facilitate children's engagement. Investigating instructional and emotional aspects of the classroom that lead children to be more engaged could provide valuable information related to children's achievement.

Empirical evidence derived primarily from studies of older students indicates that children in classrooms with higher level instructional and/or emotional support tend to be more engaged in learning-related activities (e.g., Dolezal, Welsh, Pressley, & Vincent, 2003; Downer, Rimm-Kaufman, & Pianta, 2007; Pakarinen et al., 2011; Ridley et al., 2000). Also, findings of another extensive body of empirical work on elementary school children collectively suggest engagement as a salient predictor of not only children's short-term (Alexander et al., 1993; DiPerna et al., 2005; Hughes & Kwok, 2007; Ladd et al., 1999), but also long-term academic achievement (Alexander et al., 1993; Hughes & Kwok, 2007; Ladd & Dinella, 2009). Furthermore, the *lack* of engagement in secondary

school also appears to be a key factor in why students report that they decide to leave high school prior to graduation (Alexander, Entwisle, & Horsey, 1997; Connell, Spencer, & Aber, 1994; Janosz, Archambault, Morizot, & Pagani, 2008). It is important to note that studies investigating the influence of engagement on academic achievement have used teacher reports to measure level of engagement. There is need in this body of work for investigations of the relations between direct measures of engagement and achievement.

A further consideration in understanding the impact of the individual's engagement in learning is the general level of learning engagement shared among the class members. Above and beyond the level of learning engagement individual children display, the learning engagement of a classroom as a whole is significantly associated with the average level of at least math achievement (Pakarinen et al., 2011). Replication of this finding with a diverse sample of classrooms and other subject matter areas is needed.

Research on learning engagement has also examined the mediating role of engagement on the relationship between classroom environments and academic achievement (Pakarinen et al., 2011; Ponitz, Rimm-Kaufman, Grimm, & Curby, 2009), but without strong results. There is need in the early childhood literature for investigations of the classroom aspects that lead children to be more engaged, to determine if their engagement relates to improved achievement and to examine the contextual effects of classroom composition on these outcomes.

Objectives

The purpose of this study was to investigate the associations between instructional and emotional classroom components, classroom engagement in learning, and gains in academic skills in urban pre-kindergarten classrooms serving a fairly homogeneous sample of children from socioeconomically disadvantaged backgrounds. First, the study tested whether the instructional classroom practices and the emotional tone of the classroom had significant effects on children's academic gains from fall to spring of the prekindergarten year. Second, the study examined whether the amount and the complexity of classroom engagement in learning predicted children's academic gains. Third, this study investigated the mediating role of the complexity of classroom learning engagement on the relationship between instructional and emotional classroom environments and children's gains. The study also explored whether children's initial academic skills moderated the relationship between instructional and emotional classroom environments and children's academic gains. This study sought to add to the growing body of work by providing empirical evidence for the early childhood research community on the ways in which specific classroom experiences facilitate young children's academic development.

CHAPTER II

Review of the Literature

The process of learning and the factors that aid or do not adequately support this process are topics that have motivated much research in education. Theorists acknowledging the complex nature of human development describe learning as a product of repeated reciprocal interactions between human beings and the persons, objects, and symbols in their external environment (i.e., family, school, community, society) (Bronfenbrenner & Morris, 1998). Bronfenbrenner and Morris specify these particular forms of interaction between person and environment as "proximal processes," the primary engine of development. Proximal processes are interactions or activities in which a child routinely engages and by which the child learns to make sense of the world. Examples of proximal processes are the child's habitual engagement with academic materials in a complex task and his/her engagement in classroom activities designed by the teacher. Thus, both the individual and the environment contribute to the learning process, and the magnitude of learning varies as a function of the characteristics of developing individuals and context. The next sections summarize research demonstrating the significance of individual characteristics of a child and the features of classroom environment in explaining differences among children in both developmental status and rates of change in skill acquisition.

Child Characteristics

There are a number of child-level factors that research indicates may influence children's academic achievement. Background factors including race or ethnicity, socioeconomic status, gender, and academic skills of children at school entry are highlighted as important predictors of achievement. These factors are included in studies to test their effects on child outcomes or to control for their effects while investigating the relationships between other child factors or environmental factors and outcomes.

There appear to be substantial differences in academic achievement across ethnic and racial groups. Minority children tend to do less well compare to majority children in a variety of academic areas and across the early through later school years (Lavin-Loucks, 2006; Lee, 2002, 2004; Perez-Johnson & Maynard, 2007). A number of factors may contribute to these performance differences. For instance, minority children are more likely to be in schools with teachers with less educational training (Darling-Hammond, 1999). Also, minority children are disproportionally represented among the lower income groups (Child Welfare League of America, 2004).

Research consistently shows that children from families of low socioeconomic status do less well on reading and mathematics achievement tests (e.g., Biddle, 1997; Chall, 1996; Crosnoe et al., 2010; Darling-Hammond, 1999; Sander, 2001). As noted, race and ethnicity are closely related to socioeconomic status. Although both SES and ethnicity appear to be associated with achievement, the independent effects of each are difficult to untangle. The research in this area is contradictory with some suggesting that race or ethnicity as compared to socioeconomic status is more highly related to academic

achievement (Bankston & Caldas, 1998) and others suggesting that socioeconomic status is more highly related to academic achievement (Harkreader & Weathersby, 1998).

There also appears to be an association between gender and child achievement. Gender differences in mathematical skills have been investigated by several researchers. Some findings indicated significant, but small gender differences favoring males emerging in the middle/high school years (e.g., Baharudin & Luster, 1998; Maccoby & Jacklin, 1974; National Center for Education Statistics, 2011a; U.S. Department of Education, 2001), while others provided no evidence for such differences (Geist & King, 2008; Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Long ago, Dwyer (1973) pointed out that gender differences in verbal skills were evident early in development and that reading skill differences unfolded from the start of school. Disaggregation of the 2011 National Assessment of Educational Progress (NAEP) reading results by gender revealed that females outperformed males (National Center for Education Statistics, 2011b).

Of interest is *when* gender differences appear and to what experiences they can be attributed. For example, gender differences in mathematics achievement may not appear until middle childhood; in Baharudin and Luster's study (1998) of six-to-eight-year olds, girls scored significantly higher in mathematics as compared to boys. Earlier, Coates (1974) suggested that girls may outperform boys in the pre-kindergarten years. By middle and high school, boys consistently appear to outperform girls on math on standardized achievement tests (e.g., U.S. Department of Education, 2001). If the school experience itself is a contributor to these gender differences, it would be of concern if the provision of prekindergarten accelerated the emergence of gender differences. It is

important to note, however, as the 2011 NAEP reports on reading and mathematics pointed out, the magnitude of the differences found is quite small.

Another child characteristic associated with later academic outcomes involves children's academic skills at school entry, sometimes referred to as cognitive maturity in the research. Many studies suggest that children with stronger pre-academic skills have higher levels of subsequent academic performance (e.g., Connor, Son, Hindman, & Morrison, 2005; Curby et al., 2009; Lazar & Darlington, 1982; Reynolds, 1991; Reynolds & Bezruczko, 1993). Children's cognitive maturity at school entry is a particularly important background factor to study and understand because it appears to exert somewhat stronger effects on children's subsequent achievement as compared to children's demographic characteristics (Ladd et al., 1999). In fact, the explicit goal of prekindergarten programs for children from low SES backgrounds is remediation of poor readiness for school. The next section focuses on the associations among instructional and emotional aspects of the classroom environment and children's academic achievement.

Instructional and Emotional Aspects of Classroom Environment

Children's adjustment to the early academic demands of school forecasts academic progress (Alexander et al., 1997; Finn, 1989; Stevenson & Newman, 1986) throughout their school years and into early adulthood. Given the importance of children's early school adjustment, many researchers have examined factors that aid or do not adequately support children's school readiness skills and early academic trajectories (for reviews, see Perry & Weinstein, 1998). In this line of work, some

researchers have investigated the effects of aspects of the classroom and school context on children's achievement (e.g., Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; NICHD ECCRN, 2004; Rimm-Kaufman & Pianta, 2000; Roeser, Eccles, & Freedman-Doan, 1999). This section reviews study findings on classroom aspects that are found to associate with children's academic success.

The research in the early education literature seeks to identify elements of classroom environments that are important for predicting children's early school adjustment and to characterize different types of classroom environments. Empirical evidence repeatedly indicates the significance of two distinct, but related, components of classroom environments, namely the instructional and the emotional (NICHD ECCRN, 2002; Pianta et al., 2005; Pianta et al., 2002). It is important to note that this research assesses the environment at the classroom level by global measures focusing on teacher behaviors. The following sections present literature describing the characteristics of instructionally and emotionally supportive classrooms, to what extent classrooms differ in levels of instructional and emotional support provided to children, and in turn, how varying classroom environments relate to children's academic achievement. It is important to note that not all researchers investigate instructional and emotional components of the classroom environment simultaneously in their studies. Some researchers have focused on either the instructional or the emotional aspect of a classroom, while others have examined both of these aspects together.

Researchers have also investigated whether the effects of the two elements of the classroom environment on children's academic development differ based on children's entry characteristics. In response to extant research, this review will first present

evidence on the association between instructional practices and children's academic achievement, and then discuss evidence on the relationship between emotional climate and academic achievement. Next, the issue of the independent and collective effects of instructional and emotional classroom components on children's learning outcomes will be discussed. Finally, the interactions between children's characteristics and instructional and emotional aspects of the classroom and their effects on children's academic outcomes will be presented.

Instructional environment. Instructional elements of the classroom environment involve two dimensions (among others): (1) the structure of instructional activities, and (2) the foci of instruction. One way the first dimension can be characterized is as "teacher-directed vs. child-centered." This dimension refers to the extent to which instructional activity and child engagement are under the direction of the teacher (e.g., when the teacher is reading a book to the whole group of children) or under the child's control to some extent (e.g., when a small group of children is interacting with materials during a structured hands-on activity or during an unstructured free play activity) (Morrison & Connor, 2002). In teacher-directed activities, the teacher is the center of attention and instructs the entire group of children. In child-centered activities, the teacher is not directly instructing children. Instead, the teacher designs learning activities in which children are engaged independently or with some guidance from the teacher. A key element is that there is a choice of activities in child-centered activities. The former structure is uniform and meets the teacher's goals, as the latter is differentiated and individualized by the teacher and meets individual children's needs (Perry et al., 2007).

The second dimension of instructional practices can be contrasted as "basic-skills instruction vs. analysis-inference instruction." This dimension refers to the extent to which the instructional focus involves explicit teaching of basic skills or instead more process-oriented implicit teaching of analytical and inferential thinking (Perry et al., 2007). Basic-skills instruction requires children to memorize and master facts, so that they can successfully recall information. In contrast, analysis-inference instruction enables children to develop higher-order thinking skills so that they can better understand and apply concepts in the real world outside the classroom (Hamre & Pianta, 2007).

On the basis of these two dimensions of instructional practices, empirical evidence indicates that the characteristics of a high-level instructional support involve frequent teacher interactions with children. Also, the classroom activities include both teacher-directed and child-centered activities that emphasize inference and critical thinking. Furthermore, basic skills supplements were provided for children who enter school with low skill levels (Connor et al., 2007; Crosnoe et al., 2010).

Among early elementary classrooms, there is considerable variability in the amount of time spent on different types of instructional activities (Morrison & Connor, 2002; NICHD ECCRN, 2002; Pianta et al., 2002), as well as in the focus of instruction provided to children (Downer et al., 2007). For example, evidence from observations in kindergarten classrooms indicated that in the average classroom, children were exposed to structured teacher-directed group activities or seatwork for 61% of all intervals, while they were engaged in centers or free play for 26% of the intervals over the course of a morning-long observation (Pianta et al., 2002). However, there was wide variation across classrooms in the occurrence of these activities.

Also, the reports of recent large-scale observational studies indicated that children were far more likely to experience basic skills instruction than analysis-inference instruction in early elementary classrooms and there was a substantial amount of variability in levels of children's exposure to these types of instruction (Curby et al., 2009; NICHD ECCRN, 2005). Furthermore, a report based on observational studies that included a national sample of over 4,000 classrooms extending from pre-kindergarten to fifth grade showed that children generally experienced low to medium levels of instructional support in elementary schools (identified on the basis of absolute scores on *Classroom Assessment Scoring System* [CLASS]). Teachers often provided a low level instructional support, even in classrooms that were rated relatively higher (Hamre et al., 2007). Given this observed variability in instructional classroom practices, many researchers have been interested in exploring the contribution of classroom experiences to the prediction of differences between classrooms in children's academic development above and beyond what the child brings to school, both developmentally and in terms of family background.

There is empirical support for the link between variations in instructional classroom practices and children's achievement. More specifically, studies including ethnically and socio-economically diverse populations of young children have reported that children perform better in classrooms with the emphasis on cognitively rich instruction led by the teacher (Connor et al., 2004b; NICHD ECCRN, 2004) or the child (Burts et al., 1993). For instance, a study by the NICHD research network investigated the extent to which children's achievement in literacy and math in first grade was related to the level of instructional support observed in the spring of first grade (NICHD

ECCRN, 2004). The Classroom Observation System for First Grade (COS-1) was used to measure instructional support and consisted of ratings of literacy instruction, evaluative feedback, instructional conversation, and encouragement of child responsibility. A composite score was created to measure the variability between classrooms in level of instructional support. The study controlled for language and social skills at fifty-four months, gender, maternal education, the quality of parenting, and early child care context. Children's academic skills were assessed by the *Woodcock Johnson* (WJ) *Letter-Word Identification* and *Applied Problems* subtests in the spring of first grade.

The findings revealed that classrooms in which teachers more frequently read and taught phonics and comprehension, provided more feedback to children that had an evaluative aspect and the goal of improving performance, asked more open-ended questions, more often encouraged children to engage in instructional conversations, and promoted their willingness to take responsibility had children with higher literacy scores. However, there was no significant relationship between level of instructional support and first-grade math outcomes. The results of the NICHD research network's study need to be interpreted in the context of study limitations. Since children's prior academic performance in literacy and mathematics was not measured with standardized tests that paralleled those administered in the spring of first grade, there might be some confounding factors involved in study findings. Also, the use of a measure of classroom instruction that more specifically focused on literacy instruction might diminish the possibility of finding a significant relationship between the level of instructional support and first-grade math outcomes. Furthermore, classrooms were observed only in the

spring of the first grade year. The results would be more reliable if observations had been conducted more frequently.

Cognitively rich instruction that allows child initiation and freedom is also related to better academic performance. Concerned with differential effects of two types of instructional programs (i.e., child-centered versus teacher-directed) on children's later academic performance, Burts et al. (1993) observed instructional practices in kindergarten classrooms. Cluster analysis revealed two types of instructional practices: (1) teacher-directed skill-oriented instruction, and (2) child-centered analysis-inference instruction. Children's grades from the first-grade report cards were used as academic outcomes. Subject area average grades were calculated for reading, language, spelling, math, science, and social studies. The findings showed that children from child-centered kindergarten classrooms had significantly higher average grades in reading in the following year than did children from teacher-directed kindergarten classrooms. Similar to the NICHD research network's study, Burts et al.'s study is limited in terms of isolating confounding factors, since they did not control for children's level of achievement prior to first grade. Also, this study did not use a standardized measure of achievement. To provide a stronger basis for inferring predictive roles for the cognitively rich instruction on children's academic achievement, studies that investigate changes in children's academic achievement associated with teachers' instructional support after controlling for entering achievement are needed.

On the other hand, reports of earlier quasi-experimental studies focusing on socio-economically disadvantaged children have shown benefits of highly structured teacher-directed instruction focusing on skills development after controlling for prior

achievement (Gersten et al., 1988; Stallings, 1974). For example, Gersten et al. examined the long-term effects of children's exposure to highly structured teacher-directed instruction in classrooms from kindergarten or first-grade through third grade involved in Direct Instruction Project Follow Through. Their findings indicated that children in teacher-directed instruction program outperformed those in a demographically matched comparison group experiencing practice-as-usual instruction on standardized assessments of reading, math, and language outcomes six years after having received the program. Given the homogenous sample, the findings of the Gersten et al. study in contrast to earlier cited work may imply that the teacher-directed skills-oriented instruction can be beneficial for children coming from low-income families.

Children's learning is not only influenced by the instructional aspects of teaching practices. The emotional atmosphere of the classroom is also important in understanding the impact of classroom environment on children's academic development. In the following section, emotional aspects of classrooms will be discussed.

Emotional environment. The emotional tone of a classroom refers to the way in which teachers' affective behaviors contribute to classroom climate. The extent to which the teacher displays positive (warm and respectful) or negative (anger, sarcasm, and irritability) emotions toward children, how sensitive he/she is to children's levels of academic and social functioning, as well as how responsive he/she is to the needs of children in these areas of functioning determine the level of emotional support provided to children (La Paro et al., 2004; Pianta et al., 2005). Teachers who offer high levels of emotional support are warm and respectful towards children. Emotionally supportive

teachers also tend to be aware of children's level of academic and social functioning and are responsive to their needs in these areas (Hamre & Pianta, 2007).

The presumption is that high emotional support fosters children's learning. Emotionally supportive classrooms are supposed to promote the development of a sense of security and confidence in children who are challenged by social and academic demands of schooling. Such an environment may serve as a resource that permits children to actively engage with their environments and to cope more effectively with novel academic and social demands. That, in turn, may help children develop skills that are required for success in school (Hamre & Pianta, 2007). Results of large scale observational studies have indicated that children generally experience medium to high levels of emotional support in elementary schools (Hamre et al., 2007). Also, this report shows that on average, the level of emotional support observed in classrooms is higher relative to the observed level of instructional support.

Empirical evidence on the association between the emotional aspect of a classroom and child achievement has presented contradictory results. Using a subsample of the NICHD SECCYD data, Rudasill, Gallagher, and White (2010) investigated the contribution of emotional classroom environment in third grade to children's reading and math achievement at the end of that year. Classrooms were observed once in the spring semester. The observers rated the level of teacher detachment, positive and negative classroom climate, productive use of instructional time, and teacher sensitivity on a 7-point scale. Children's reading and math achievement were tested with the subtests of the WJ III Tests of Achievement. Controlling for children's reading and math achievement at the age of $4^{1/2}$, and mother-reported temperamental attention and activity

level, the emotional support observed in third grade classrooms was found to be related only to children's reading achievement at the end of third grade. On the other hand, the level of emotional support was not related to children's math achievement.

Investigating the effect of emotional climate only on math skills, Pakarinen et al. (2011) also found a non-significant association between emotional support observed in kindergarten classrooms and children's math achievement. The results of these studies need to be interpreted in the context of study limitations. The Pakarinen et al. study was conducted in Finland so its sample did not represent the U.S. population.

Other studies have investigated the contribution of emotional tone of a classroom to children's academic development in conjunction with instructional classroom practices. Findings of such studies will be presented in the following section.

Instructional and emotional environments. In this body of literature, some researchers have investigated individual effects of instructional and emotional classroom environments on children's academic achievement in the same model (Curby et al., 2009; Howes et al., 2008; Pianta et al., 2008), while others have examined the combined effect of instructional and emotional environments on children's learning (Perry et al., 2007; Stipek et al., 1998; Stipek et al., 1995).

Non-experimental field studies examining effects of instructional and emotional aspects of the classroom on children's academic achievement in the same prediction model have indicated that instructional and emotional components differentially predict children's gains on academic skills (Howes et al., 2008; Mashburn et al., 2008) and their trajectories of achievement (Curby et al., 2009; Pianta et al., 2008). It is important to note that very small effect sizes were reported in these studies. For instance, Howes et al.

(2008) analyzed data from two recent large-scale observational studies of state-funded pre-kindergarten classrooms. In both studies, one classroom in each site and four children in each classroom were randomly selected. Classrooms were observed four times during the year, and children's receptive and expressive language, basic literacy, and math skills were assessed in the fall and spring of the pre-kindergarten year. The instructional and emotional climate was evaluated with the CLASS in both studies.

Classrooms scoring higher on instructional climate were observed to have the following teacher practices: engaging children in interactions that encouraged communication and reasoning, promoting higher order thinking and creativity, and providing more verbal feedback relevant to children's performance. More positive emotional climates included teacher affective behaviors, such as being warm in interactions with children and sensitive to their needs, moods, interests, and capabilities, and establishing clear, but flexible expectations related to the classroom rules and routines. The researchers found that both the instructional and emotional classroom climate exerted small effects on children's gains on receptive language, basic literacy and math skills, and that instructional support also predicted gains on expressive language. In other words, children in highly supportive classrooms became slightly more proficient in language, literacy, and math skills. Furthermore, instructional support for learning predicted gains to a significantly greater degree than did emotional support. Thus, higher level instructional support provided to children in pre-kindergarten may be somewhat more salient for improving children's achievement gains than emotional support.

On the other hand, longitudinal field studies observing instructional and emotional classroom aspects experienced by somewhat older children indicated small

positive associations only between the observed levels of emotional support and children's trajectories of achievement (Curby et al., 2009; Pianta et al., 2008). For instance, observing teacher behaviors with the CLASS three times in both kindergarten and first grade years in seven rural schools serving poor and working-class families, Curby et al. (2009) found that emotional support provided to children in first grade was the only significant predictor of children's achievement growth in sound awareness.

In a similar investigation, Pianta et al. (2008) explored the independent effects of emotional and instructional support observed via the *Classroom Observation System* (COS). His investigation involved a subsample of children participating in the NICHD SECCYD observed once in first, third, and fifth grade years to examine the trajectories of children's achievement in reading and math from 54 months to fifth grade. Emotional climate referred to a number of different factors including teacher's use of overcontrol, chaos in the classroom, teacher's sensitivity, and positive and negative emotional climate, while instructional climate involved the degree of productive use of time and richness of instructional methods. The findings showed that greater emotional support in third grade predicted better third-grade literacy outcomes, while emotional support in fifth grade predicted enhanced math achievement, as well as literacy achievement in fifth grade. There was not a similar significant relationship between the level of instructional support and children's academic achievement, but this may be partly a consequence of measurement issues. Indeed, the observational system utilized in these studies might be somewhat insensitive to qualities of instruction in higher grades, since the instruction becomes more curriculum-specific in the later elementary grades (Pianta et al., 2008).

Given the evidence indicating both instructional and emotional classroom climate as salient predictors of children's academic achievement, researchers have investigated the relationship between these two components of the classroom environment. Correlational analyses revealed a significant positive relationship between teachers' affective behaviors and instructional practices (Hamre & Pianta, 2005; Hyson, Hirsh-Pasek, & Rescorla, 1990). These analyses imply that classrooms offering individualized, cognitively rich instruction tend to provide warmer and more respectful and responsive emotional environments for children. In response to the observed association between the two components of the classroom environment, some researchers have collapsed those components to create a global measure of classroom climate. For these researchers, the construct of high-level classroom climate involves teacher's use of differentiated instruction to meet individual children's needs, support for the development of analytic and inferential thinking in children, as well as warm, sensitive, and responsive interactions with a group of children. It seems reasonable to assume that high-level instruction would be easiest to accomplish in a warm and responsive classroom, though being warm does not guarantee high level instruction.

More supportive classroom environments measured by combining scores on instructional and emotional aspects of the classroom have been linked to higher scores on school standard-based tests of math achievement in first grade (Perry et al., 2007), as well as on standardized tests of basic math achievement, and tasks assessing language development and problem solving skills in pre-kindergarten and kindergarten (Stipek et al., 1995; Stipek et al., 1998). An example of this research is a study conducted by Perry et al. (2007) of 14 first grade classrooms serving children coming from middle- and

working-class families, as well as a small population of migrant farm workers. Children were individually assessed at the beginning and the end of first grade with a set of math achievement tests. The composite score on teacher behaviors at the global level consisted of three subscales; instructional climate, social climate, and management. In classrooms with high global ratings, instructional climate was characterized by the use of learning activities designed to be relevant and meaningful to children's lives, with more emphasis on conceptual understanding, and the use of cooperative group activities. The social climate included more positive teacher-child, as well as peer interactions, and warm, sensitive, and responsive teacher behavior towards children. Classroom management involved clear but flexible classroom rules and routines. The findings indicated that after controlling for fall achievement, the mean levels of children's math achievement in the spring were higher in classrooms with a heavier emphasis on cognitively rich instruction, a greater emotional support, and an establishment of clear but flexible rules and routines.

Comparison studies assessing the differential effects of two types of instructional programs (i.e., child-centered versus teacher-directed) on children's achievement gains in a given year have also shown that children in more child-centered classrooms with individualized, cognitively rich instruction and with greater emotional support perform better on academic achievement tests (Stipek et al., 1995, 1998). For instance, Stipek and her colleagues observed a group of very child-centered and very basic-skills-oriented (didactic) pre-kindergarten and kindergarten programs that served an ethnically and socio-economically diverse population of children. In child-centered programs, teachers were warmer and provided considerable child choice, opportunities for self-initiated activities, and exploration of concrete materials, while in didactic programs, teachers

appeared to be irritated by children's behavior, used threats of punishment, and taught basic skills in rote, repetitive manner. Stipek and her colleagues found that children in very child-centered programs had higher scores than children in highly structured, basic skills-oriented programs on standardized tests of basic math achievement (Stipek et al., 1995), as well as on tasks assessing problem solving and language skills (Stipek et al., 1998), but not on basic literacy achievement after controlling for entry skills.

In a follow up to the original work, Stipek et al. found later effects for pre-kindergarten and kindergarten classrooms with cognitively rich instruction and with more positive affect, indicated the advantage to children's exposure to this type of instruction (Stipek et al., 1998). For instance, Stipek et al. found that children who spent two consecutive years in a more individualized, cognitively rich, and more socially and emotionally supportive program, scored higher on achievement tests of basic literacy, numerical memory, conceptual grouping, and verbal fluency, after controlling for children's academic skills at school entry. Also, children who moved from a less basic-skills-oriented classroom to a more basic-skills-oriented one scored lowest on numerical memory and conceptual grouping tests at the end of their second year.

It appears that when the impacts of instructional and emotional climates of a classroom are considered together, they have stronger associations with the achievement outcomes compared to the findings of studies testing their effects separately. Studies examining the effects of these classroom environments in separate models fail to account for the influence of the other component that is also found to contribute to the prediction of the variation in children's outcomes. Those modeling with both together do not take into account the correlation between the two components and investigate how well each

independently predicts achievement above and beyond any relationship with the other since there is evidence on a significant association between instructional and emotional environments of a classroom. This analytic approach diminishes the probability of finding significant associations of these environments with children's achievement. In addition to the modeling issues, researchers need to consider whether favored patterns of instructional and emotional experiences identified in studies reviewed in the previous sections are beneficial for all children. Some research examined children's school entry characteristics as factors that may affect the direction and/or the strength of the relation between classroom environments and children's academic outcomes. The next section will present findings on that body of literature.

Interaction between instructional and emotional environments and child characteristics. Researchers have investigated whether the observed effects of emotional and instructional classroom climate on children's academic outcomes depend on children's entry level characteristics (Connor et al., 2004a; Connor et al., 2004b; Curby et al., 2009; Hamre & Pianta, 2005). One such characteristic involves children's entering achievement skills (Connor et al., 2004a; Connor et al., 2004b; Curby et al., 2009; Juel & Minden-Cupp, 2000). For instance, first graders at risk of reading difficulties (identified on the basis of test scores at the beginning of the school year) who received more teacher-directed code-based language arts instruction had higher word-decoding skills at the end of the year (Connor et al., 2004a). In contrast, teacher-directed code-based instruction made no difference in decoding skills for children with already high skills on this dimension at the beginning of the school year. These highly skilled children made the strongest gains in classrooms that offered more child-led

comprehension-based reading and writing activities. The findings of this study may imply that at least in first grade when most children have begun to master decoding skills child-led comprehension-based reading and writing activities may be best suited for children with high levels of decoding skills while children with low skills may need more direct instruction in the skills they are weak in.

Contrary to Connor et al.'s findings, Curby et al. (2009), also studying first grade achievement with an economically disadvantaged sample, found that children with lower initial literacy skills (identified on the basis of test scores on *WJ Letter-Word Identification* subtest in kindergarten) had greater growth in literacy in instructionally supportive first grade classrooms. In highly supportive environments, teachers encouraged analytic and critical thinking, used scaffolding and feedback loops, and were engaged in frequent conversations with children and elaborated on children's ideas. Children with higher initial literacy skills, however, could improve their literacy skills even in classrooms with lower support. These children seem to be less vulnerable to the negative effects of exposure to lower level instructional support.

At a higher grade level, Crosnoe et al. (2010) also found that economically disadvantaged children with low initial math skills (identified on the basis of test scores on *WJ Applied Problems* subtest at 54 months) who experienced relatively frequent inference-skills instruction directed by the teacher showed more rapid gains than similar children who experienced relatively infrequent inference instruction. Their study investigated the effects of observed instructional practices in third or fifth grade classrooms on trajectories of children's math achievement from third grade to fifth grade. Both the Curby et al. and Crosnoe et al. studies showed that the achievement gap in

literacy and math between high- and low-performing children was reduced by children's exposure to cognitively rich instruction in the early grades. The Curby et al. and Crosnoe et al. studies may imply that economically disadvantaged children with lower-initial skills can benefit more from analysis-inference instruction when it is controlled by the teacher.

Evidence also shows that the impact of classroom emotional climate on children's academic gains may be influenced by children's level of risk for early school failure (Curby et al., 2009; Hamre & Pianta, 2005). For instance, with an economically diverse sample of children, Hamre and Pianta investigated whether the effect of emotional classroom climate on children's academic achievement in first grade varied as a function of the degree of risk children had for early school failure due to a mixture of classroom problems (i.e., attention, behavior, social, and academic problems) identified in the kindergarten year. The researchers created a composite score of reading and mathematics subtests of the WJ-R cognitive and achievement battery to measure academic achievement. The COS-1 including global rating scales for the emotional aspects of the classroom environment and rating scales for the teacher's affective behavior towards individual children was used to measure emotional climate in a classroom. Classrooms were categorized as offering high, moderate, or low emotional support. They found that at-risk children in classrooms with high levels of emotional support had achievement scores that were more similar to their "low-risk" peers. In contrast, at-risk children in low or moderately emotionally supportive classrooms had significantly lower scores on achievement tests relative to their "low-risk" peers even after controlling for prior levels of achievement. At-risk children from diverse economic backgrounds seem to be sensitive to the level of emotional support provided in the classroom. On the other hand,

"low risk" children in classrooms with low or moderate levels of emotional support had higher achievement than similar children in classrooms with high level of emotional support. Thus, "low-risk" children from diverse economic backgrounds seem not to be negatively affected by emotionally less supportive classroom environments.

Studying children from poor and working-class families in rural districts, Curby et al. (2009), however, reported that in first grade classrooms with higher level emotional support, children with lower initial literacy scores (identified on the basis of test scores on the WJ Letter-Word Identification subtest in kindergarten) showed lower growth rates on the WJ Letter-Word Identification test from kindergarten to first grade than children with higher initial scores. Furthermore, lower achieving children in first-grade classrooms with lower level emotional support had higher growth rates on literacy. Children with higher initial literacy skills, however, benefited most from higher level emotional support. Thus, lower achieving children from economically disadvantaged backgrounds seem to be less vulnerable to the negative effects of exposure to lower level emotional support.

In short, findings revealed that specific patterns of instructional and emotional classroom environments differentially predicted children's academic achievement. Studies on children from economically disadvantaged backgrounds revealed that children with lower initial skills could improve their skills in classrooms offering high inferential instruction, while those with higher initial skills could perform better even in classrooms with less inferential instruction (Crosnoe et al., 2010; Curby et al., 2009). Considering emotional climate, studies showed that lower achieving children from economically disadvantaged backgrounds learned more in emotionally less supportive classrooms,

while higher achieving children from economically disadvantaged backgrounds scored higher in emotionally more supportive classrooms (Curby et al., 2009). Studies including economically diverse group of children revealed that low achieving children performed better in classrooms with teacher-directed basic skills instruction and in classrooms with greater emotional support, while high achieving children performed better in classrooms offering child-led comprehension based instruction and in classrooms with less emotional support (Connor et al. 2004a; Hamre & Pianta, 2005). Thus, while the findings are mixed, it appears clear that there is some interaction between the instructional and emotional aspects of a classroom and the characteristics children bring to it.

Summary. In classroom settings, teachers' interactions with children on a daily basis are viewed as the primary mechanisms through which schools provide opportunities for children to become engaged in academics, develop social skills, and, ultimately, develop competencies (Hamre et al., 2007). Such teacher interactions can be classified into two domains of support: instructional and emotional. An instructionally supportive classroom environment involves the use of learning activities designed to be relevant and meaningful to children's lives with more emphasis on conceptual understanding, as well as with basic skills supplements for children with low school entry skills. An emotionally supportive classroom environment is characterized by warm, sensitive, and responsive interactions between the teacher and the children. Existing data reveal that on average, the level of emotional support observed in classrooms is relatively high, while that of instructional support is low, but there is great variation across classrooms in terms of observed levels of instructional and emotional support.

The hypothesized impact of the instructional and emotional support on children's achievement is supported by correlational studies that report significant, but relatively small effects for each separately and the combination of the two. The observed effects of instructional and emotional aspects of a classroom on academic achievement change by grade level, children's school entry characteristics, and socio-economic backgrounds. Instructional support that promotes critical thinking in children has relatively stronger effects on standardized tests of language, as well as literacy and math achievement in pre-kindergarten, while emotional support that provides warmer and more sensitive environment for children exerts comparatively larger effects on children's achievement in literacy and math only in the elementary grades. On the other hand, the combined measure of instructional and emotional environments is predictive of children's achievement in both pre-kindergarten and elementary grades. The patterns of instructional and emotional classroom environments that support academic achievement of children at risk of early school failure change by children's socio-economic backgrounds.

In addition to the measures of teacher behavior indicating the levels of instructional and emotional support in the classroom environment, the measure of child behavior showing the patterns of engagement in learning within the context of the classroom provides information about dimensions of the classroom that are related to children's success in school. In the following section, first the construct of engagement with the physical and social environment will be defined. Then, the contributions of the classroom environment to the prediction of the variation in levels of children's behavioral

engagement in learning will be discussed. Finally, empirical evidence on the association between children's engagement in learning and academic achievement will be presented.

Engagement in Learning

Over the past 30 years, the construct of engagement with the physical and social environment has emerged as a key contributor to children's school success (Brophy & Good, 1986; Fredricks, Blumenfeld, & Paris, 2004). McGarity and Butts (1984) aptly summarize the importance of engagement in learning: "A student can be engaged and not achieve, but it is hard for a student to learn a task who was not engaged while that task was being taught" (p. 60). This statement implies that engagement in classroom activities may not be sufficient for learning, but may be a necessary component (Ladd & Dinella, 2009; McCormick, Noonan, & Heck, 1998; McWilliam, Trivette, & Dunst, 1985).

Generally, engagement can be understood to refer to the extent to which a child participates in either academic or non-academic tasks. The definition of engagement in academic work set forth by Newmann, Wehlage and Lamborn (1992) has often guided empirical work: they explain engagement in academic learning as "the student's psychological investment in and effort directed toward learning, understanding or mastering the knowledge, skill or crafts that academic work is intended to promote" (p.12).

More recently, however, definitions of engagement often include a broader framework of some combination of cognitive, emotional, and behavioral dimensions of the construct, especially in literature of older children (Fredricks et al., 2004; Ladd & Dinella, 2009). Cognitive and emotional dimensions represent internal processes, while

the behavioral dimension indicates observable processes of the construct of engagement. Indeed, *cognitive engagement* refers to students' investment in learning, and is also defined as being strategic or self-regulated in learning (Connell & Wellborn, 1991; Maddox & Prinz, 2003; Newmann et al., 1992). *Emotional engagement* is often regarded as related to students' feelings about school (Skinner & Belmont, 1993), students' sense of belonging in school (Finn, 1989; Furlong & Christenson, 2008; Jimerson, Campos, & Greif, 2003; Maddox & Prinz, 2003; Osterman, 2000; Voelkl, 1997), and how much they value school (Finn, 1989; Voelkl, 1997). Finally, *behavioral engagement* involves participation in academic tasks observed through behaviors such as task persistence, concentration, attention, and self-directed contributions to class discussion (Bohn, Roehrig, & Pressley, 2004; Patrick, Skinner, & Connell, 1993; Stipek & Byler, 2001), as well as participation in extracurricular activities, compliance with classroom rules, and the absence of such behavioral disruptions, as displaying difficulty sitting still in the classroom (Finn & Rock, 1997; Hughes & Kwok, 2006; Reynolds, 1991; Valeski & Stipek, 2001). Thus, engagement in the literature of older children has been defined as a multidimensional construct including children's cognitive processes, emotions, and behaviors that are highly interrelated with one another.

Definitions of engagement provided in early childhood literature are much less elaborated and differentiated than those in school-age literature. The constructs included in the definition of engagement in early childhood are mostly related to the behavioral dimension of engagement (Powell, Burchinal, File, & Kontos, 2008). Since learning occurs through play in early childhood settings, the construct of engagement in the early childhood literature includes child involvement in play while displaying cognitively

and/or socially complex interactions with the environment (with materials, teachers, or peers) (Howes & Smith, 1995; Kontos & Keyes, 1999; McWilliam & Ware, 1994). Often researchers who focus on the complexity of children's cognitive and social interactions with the environment rely on developmental stages described by Piaget (e.g., Howes & Smith, 1995; Wishard, Shivers, Howes, & Ritchie, 2003). Thus, they usually use hierarchical coding schemes as measuring young children's behavioral engagement. And they describe the level of complexity in children's engagement with the environment as an indicator of children's level of competence in cognitive and social domains (Pellegrini, 1991).

In this review, the term "engagement" refers to behavioral engagement including children's observed or teacher-perceived involvement in learning-related activities designed by the teacher with varying levels of child freedom and choice. In considering extant evidence, it is important to realize that not all researchers use equivalent definitions of behavioral engagement in learning, as well as methods to measure the construct. Indeed, studies investigating the association between children's behavioral engagement in learning and achievement usually used teachers' ratings of engagement irrespective of specific contexts, while studies on classroom environments generally used observation methods to record children's engagement in specific contexts. Also, the level of engagement measured at either individual level or the classroom level. The former measure of engagement indicates individual children's mastery of skills related to school readiness and their preferences, while the latter measure provides information on the context of the classroom.

Three lines of research dominate the literature on children's behavioral engagement in the classroom. The first focuses on child attributes, such as cognitive maturity and psychosocial behavior styles that are related to child engagement (e.g., Downer et al., 2007; Fantuzzo, Bulotsky-Shearer, Fusco, & McWayne, 2005; Rimm-Kaufman et al., 2002). The second places an emphasis on aspects of the classroom environment that are related to child engagement (e.g., Dolezal et al., 2003; Downer et al., 2007; McWilliam, Scarborough, & Kim, 2003). The third explores the association between children's behavioral engagement and academic outcomes (e.g., Alexander et al., 1993; DiPerna et al., 2005). Given the accumulating evidence on engagement with the environment across these studies, researchers have proposed behavioral engagement as one mechanism by which classroom environment affects children's academic achievement (e.g., Buysse & Bailey, 1993; Hughes & Kwok, 2007; Jones & Warren, 1991; McWilliam & Bailey, 1995; McWilliam et al., 1985; Raspa, McWilliam, & Ridley, 2001).

Yet, in early childhood settings, few researchers have examined the potential mediating role of children's engagement with the environment on instructional and emotional aspects of the classroom to predict children's gains in academic skills. With a structural equation modeling framework, Ponitz et al. (2009) tested the mediating effect of children's behavioral engagement on the relationship between global ratings of classroom environment and reading achievement in 36 kindergarten classrooms. They observed classrooms and children on three different days during the year. The CLASS was used to measure instructional, emotional, and organizational characteristics of classroom environments. Behavioral engagement construct consisted of the amount of

time children were observed off-task, teachers' ratings of children's behavioral self-control, and observations in which children's engagement, attention, self-reliance, compliance, and disruptive behaviors were rated on a 7-point scale. Children's reading achievement was measured using Letter-Word Identification and Sound Awareness subtests from the WJ III in the fall and the spring of the kindergarten year. Ponitz and her colleagues reported that classroom environment was significantly related to children's behavioral engagement and engagement was a significant predictor of children's reading achievement in the spring when controlling for initial reading level and family risk factors.

The mediating role of engagement has been also tested in studies examining teacher's emotional interactions with *individual children* (e.g., Hughes & Kwok, 2007; Ladd et al., 1999). Such studies provide empirical evidence for the mediating role of child engagement. More research is needed to prove the significance of engagement in learning as a process that mediates the relationship between classroom environments and children's achievement at the classroom level. The following sections will present extant research on children's engagement in learning investigating its links to instructional and emotional classroom environments and children's academic achievement, respectively.

Predictors of learning engagement. The associations among classroom environments (such as the structure of the activity, the focus of instruction, and emotional climate) and children's observed engagement have been investigated in many studies (e.g., Downer et al., 2007; NICHD ECCRN, 2002, 2005; Pakarinen et al., 2011; Pianta et al., 2002). Children's engagement in learning is related to the structure of instructional activity. Child care studies comparing the effects of very child-centered programs with

very teacher-directed programs on engagement reported beneficial effects for a child-centered approach (de Kruif, McWilliam, Ridley, & Wakely, 2000; McCormick et al., 1998; McWilliam et al., 1985; Raspa et al., 2001). For instance, McWilliam and his colleagues (1985) grouped programs based on observed frequency of certain teacher behaviors. The first group involved teachers who were expanding on children's focus and eliciting behaviors related to what children were already doing, while the second group included teachers who were directing children's attention to an activity that was different from what they were already engaged in. The findings indicated that the observed rate of children's engagement in classroom activities as a group was higher in programs using incidental teaching strategies (elaborative behavior) than in programs using structured instructional methods (directive behavior). Similarly, recent studies also reported that in classrooms of controlling teachers, fewer children were actively engaged in activities, whereas in classrooms of elaborative teachers, more children demonstrated sophisticated engagement behavior (de Kruif et al., 2000; Raspa et al., 2001).

In addition to the structure of instructional activities, the focus of instruction is related to children's behavioral engagement in learning. For instance, using part of the data obtained through a large-scale observational study conducted by the National Institute of Child Health and Development (NICHD), Downer et al. (2007) examined the likelihood of co-occurrence between child engagement (engaged vs. off-task) and focus of instruction (basic skills vs. analysis-inference) in third-grade classrooms. They reported that children were more likely to be observed highly engaged during analysis and inference instruction than during basic skills instruction.

Studies measuring independent and/or combined effects of instructional and emotional classroom environments have found that children in classrooms with higher instructional and/or emotional support are more likely to be engaged in learning (Downer et al., 2007; NICHD ECCRN, 2002; Pakarinen et al., 2011; Ridley et al., 2000). Measuring emotional support in child-care settings, Ridley et al. found that children as a group were more likely to be engaged in the classroom if their teachers were high in positive affect and sensitive, and low in detachment and harshness. As the independent effects of each component of the classroom environment were investigated in the same prediction model, the findings indicated that both emotional and instructional support provided to children in first grade classrooms exerted independent effects on the frequency of children's engagement in assigned activities, but that emotional support was more strongly related to engagement (NICHD ECCRN, 2002). Also, investigating levels of emotional and instructional support (e.g., overcontrol, positive emotional climate, negative emotional climate, classroom management, literacy instruction, evaluative feedback, instructional quality, and child responsibility dimensions) in third grade classrooms, Downer et al. (2007) found that children were more likely to be engaged when classroom support was higher. Furthermore, Pakarinen et al. (2011) investigated the association between instructional support and teacher-rated task-avoidant behavior of children in kindergarten in Finland. Five items in the Behavior Strategy Rating Scale was used to measure each child's task-avoidant patterns, such as failure expectations, low levels of effort and persistence in academic tasks. One hundred and thirty-seven classrooms were observed with the CLASS on two different days by a pair of observers. A task-avoidant behavior measure was included at both the child and the classroom level

in the model. Results showed that the classrooms with higher level instructional support had less task avoidant behavior in the classroom. In highly supportive classrooms, children were focused on the task at hand and showed persistence even in more difficult tasks.

To sum up, research suggests that children are more likely to be engaged in learning in early childhood classrooms where teachers design meaningful learning activities that follow children's interest and foster the development of analytic and inferential thinking in children, as well as where they form warm, sensitive, and responsive interactions with a group of children. These patterns of classroom environments are found to be related to both individual's learning engagement and engagement context of the classroom. It is also important to note that unlike the observed positive effects of teacher-directed basic-skills instruction and low emotional support on children's academic outcomes, there is no evidence indicating positive associations between these types of classroom environments and children's engagement. The next section will review research on the association between children's learning engagement and academic achievement.

Outcomes of learning engagement. The links between behavioral engagement in learning and achievement are well-established among children of elementary school-age (e.g., Alexander et al., 1993; DiPerna et al., 2005; Hughes & Kwok, 2007; Ladd et al., 1999; Pakarinen et al., 2011). For example, in a cross-sectional study involving two cohorts of kindergartners, Ladd et al. (1999) found that children who had higher teacher ratings on their levels of independent (self-directed) participation in classroom activities, as well as cooperative participation (acceptance of teacher's authority and compliance

with classroom rules and responsibilities) had higher scores on the school readiness test, holding entry factors (i.e., gender and receptive vocabulary skills), behavioral styles (i.e., prosocial and antisocial), and classroom relationships (i.e., positive and negative features of peer and teacher-child relationships at individual level) constant. However, that study suffers from the correspondence in informants – teachers provided the ratings and knew the test results on the children. With a similar flaw in design, Parkarinen et al. (2011) reported a significant association between classroom-level task-avoidant behavior rated by the teacher and the average level of math achievement at the end of kindergarten after controlling for initial math skills, gender, age, and mother's education. The lower the task-avoidance was rated by the teacher, the higher the math achievement was in the classroom.

Studies concerned with the significance of behavioral engagement in predicting later academic achievement have also documented that higher levels of engagement in learning predicted greater gains in academic outcomes (Hughes & Kwok, 2007; Hughes, Luo, Kwok, & Loyd, 2008). For instance, Hughes et al. (2008) collected data on teacher perceptions of individual children's behavioral engagement (i.e., effort, attention, persistence, and cooperative participation in learning) and psychosocial behavior, as well as on standardized tests of reading and math achievement for a sample of 671 ethnically diverse, lower achieving children in their first three years of formal schooling. They found that teacher-reports of behavioral engagement in learning at earlier waves (e.g., engagement at Year 2) predicted achievement in reading and math measured at later waves (e.g., achievement at Year 3).

Furthermore, the Beginning School Study (Alexander et al., 1993; Alexander et al., 1997) randomly sampling an ethnically and socio-economically diverse population of first graders showed that first grade teachers' ratings of children's engagement (i.e., attention-span) were related to children's gain scores on standardized measures of reading and math skills at the end of first, second, and fourth grade, their report card marks from the fourth quarter of those years, and their decisions to drop out of high school. Thus, the effects of early behavioral engagement on academic outcomes might last into high school and appear robust even when different teachers provide the ratings.

Taken together, this body of work provides support for the assumption that behavioral engagement in learning is a proximal process that produces learning. Despite the differences in the definitions and measures of engagement, findings collectively suggest that the level of children's behavioral engagement in classroom activities predicts subsequent achievement. Although this work offers promising directions, its generalizability is limited by the fact that it is quite narrowly focused with regard to participants' age (5-years or older) and method of measurement (teacher ratings). Hence, research establishing the link between learning engagement and achievement in younger children with use of different methods is needed.

Conclusions and Hypotheses

In the course of everyday interactions with the persons, objects, and symbols in the external environment, children develop skills that help them be ready for the academic and social demands of schooling. However, because school readiness skills are shaped by personal experiences, not all children have equal opportunity to successfully

adjust to the early demands of school. Children from low-income families, in particular, are more likely to enter school with differences in cognitive and social competencies that are associated with less successful academic trajectories. Thus, as one of the principal contexts in which young children live and learn, pre-kindergarten classrooms stand out as an opportunity to provide systematic support for young children's successful adjustment to school. Using that opportunity to best advantage, however, requires a more thorough understanding of the relationships among classroom experiences and children's developing academic competencies.

Instructional and emotional aspects of a classroom and the nature of children's engagement with the environment (with teacher, peers, or materials) help to define young children's classroom experiences. Teachers play an important role in determining the instructional emphasis (basic skills vs. analysis-inference), defining the mode of instruction (teacher-directed vs. child-centered), and setting the emotional tone in the classroom. Taken certain risk factors for poor achievement into account, specific patterns of instructional and emotional classroom environments differentially promote learning.

The nature of learning engagement children display is also important in understanding whether pre-kindergarten programs are successful in fostering young children's school readiness. Examining children's engagement can provide additional information about children's classroom experiences that is not otherwise captured in the environmental assessments. A direct examination of children's engagement at both the individual and the classroom level is needed to understand the patterns of interactions that support learning and the type of classroom environments that are more likely to engage children and as a consequence, promote learning.

Investigating classroom environments that lead children to be more engaged could provide valuable information related to children's achievement. The results of prior work suggest that this is an important area to cover, but the multitude of definitions and methods makes it hard to conclude anything definitive about the relationship. Hence, there is a crucial need for further investigations of the specific relationships among classroom environments, children's engagement in learning-related activities, and academic achievement, especially in earlier grades.

The present study extends the examination of predictors of early academic achievement by including direct observations of instructional and emotional environment, learning engagement context of a classroom, as well as learning engagement behavior of individual children. This study seeks to investigate the associations between instructional and emotional classroom environments, the amount and the complexity of classroom engagement in learning and average level of academic gains from fall to spring of the prekindergarten year. It was hypothesized that

1. Pre-kindergarten classrooms with higher levels of instruction and a more positive affect would be associated with greater academic gains.
2. Pre-kindergarten classrooms in which children were more often engaged in learning would have children with greater academic gains.
3. Pre-kindergarten classrooms in which children were engaged in learning at a more complex level would have children with greater academic gains.
4. Classroom engagement in learning at a more complex level would mediate the relationship between instructional and emotional classroom environments and children's academic gains.

The present study would also explore the following question:

1. To what extent was the association between instructional and emotional classroom environments and children's academic gains moderated by children's initial skill level?

CHAPTER III

Research Design and Procedures

Research Site and Participants

Research site. The data for this study were collected as part of the Technology Enhanced, Research Based Instruction, Assessment, and Professional Development (TRIAD) project that involved scaling up the *Building Blocks* prekindergarten mathematics curriculum. The project was funded by U.S. Department of Education Institute of Education Sciences. The project was designed as a randomized experiment evaluating the effectiveness of an intervention for enhancing children's math knowledge and school achievement. TRIAD was developed by researchers at the State University at New York at Buffalo (SUNY-Buffalo) (Clements & Sarama, 2007). The intervention program included a classroom component (whole group and small group math activities, math software, and math learning center), a home component (math activities and materials for families), and a professional development package consisting of workshops, one-on-one facilitation, and a website to implement the intervention with fidelity on a large scale and at a distance from the curriculum developer.

The main project was proposed to scale-up the implementation of TRIAD Treatment in pre-kindergartens. To be as representative as possible of scale-up conditions, the sample was selected to provide diversity in location, type of pre-kindergarten program, teacher characteristics, and background and characteristics of the children and their families. The project was conducted at three sites, Buffalo, Boston,

and Tennessee and involved two types of public pre-kindergarten programs established as intervention programs to support school success among children from low-income families. Data from the Tennessee site were the focus of this research investigation. Within Tennessee, one program was a pre-kindergarten program affiliated with an urban school system, while the other program was the local Head Start affiliated with a metropolitan non-profit agency.

The intervention project lasted five years with training and implementation of the curriculum during the first two years. The training program for the treatment teachers involved workshops, on-site training by internal facilitators, and encouragement for their use of the website (see Varol, Farran, Bilbrey, Vorhaus, & Hofer, 2011, for a full description of the training). The main study of the implementation occurred in 2007-2008 school year. During the remaining two years, the control teachers and non-study teachers were trained. Also, participating children were followed and assessed at the end of kindergarten and first grade. The present study utilized a subset of the pre-kindergarten math intervention project data (collected during the 2007-2008 academic year) obtained in the Tennessee site to examine the associations between instructional practices, the emotional tone of the classroom, children's behavioral engagement in learning, and their academic achievement.

Participants. TRIAD was conducted at two types of pre-kindergarten sites where "site" refers to a Head Start center or public school with one or more classrooms clustered at that location. The sample consisted of four Head Start centers (4 - 9 classrooms per site) and sixteen public schools (1 - 4 classrooms per site). These two

types of pre-kindergarten programs differ in their administrative structure and also somewhat in the income requirements for the populations they served.

Head Start is a federally funded program with specific federal guidelines. The Office of Head Start (OHS), within the Administration of Children and Families of the Department of Health and Human Services, awards grants to public and private agencies on a competitive basis to provide comprehensive services to specific communities. Head Start grantees provide the services as described in the Head Start Performance Standards and in accordance with the Head Start Act of 2007. The Office of Head Start is responsible for oversight of these grantees, to ensure the performance standards are met and the best quality of care is provided to the enrolled children. In addition, some cities, states, and federal programs offer funding to expand Head Start and Early Head Start to additional children within their jurisdiction (Early Childhood Learning and Knowledge Center, 2011). To be eligible for Head Start services, a child must be at least three years old by the date used to determine eligibility for public school in the community in which the Head Start program is located. Also, at least 90% of children who are enrolled in each Head Start program must be from families whose income is at or below the poverty level (U.S. Department of Health and Human Services Administration for Children and Families, 2011).

Funding for pre-kindergarten programs within the public schools can come in a variety of sources, such as federal, state, local public allocations, private sources, and parental fees (Levin & Schwartz, 2007). Schools are controlled by locally elected officials and their appointed superintendents (Education Encyclopedia - StateUniversity.com, 2011). In Tennessee, pre-kindergarten programs affiliated with the

public schools serve children meeting free or reduced price lunch income requirements; they must be four years old by September 30 of the year they begin pre-kindergarten.

The design of the original study included random assignment of sites (i.e., centers/schools) into one of two conditions: an intervention condition implementing the pre-kindergarten math curriculum and a control condition implementing a teacher-determined curriculum. There were 31 classrooms in the treatment sites and 26 classrooms in the control sites. The present study used all classrooms (N = 57) in all sites (N = 20) and treated them as one group in the analyses.

All study classrooms were staffed by a teacher who had Bachelor's or Master's degree. Among the 57 lead teachers, 38 held Bachelor's degrees and 19 held Master's degrees. Lead teachers had an average of 9.9 years of teaching experience.

Children were eligible to be recruited into the study at participating sites if (1) they were of an age to attend kindergarten the subsequent year; and (2) they enrolled in the classroom during the first two weeks of school. All eligible children in the classroom were invited to participate in the study, and all children with parent permission were selected. Among 1020 children in the classrooms, 771 families agreed for their children to participate in the study. Across classrooms, the average consent rate was 77%, with a range from 29.4% to 100%. Of the 771 children, 660 with complete data were included in the present study. Excluded from analyses were children who missed any standardized assessments, and/or were never observed during classroom visits. More specifically, 105 children who missed any pre and/or post assessments were excluded from the present study. Of the 666 children left in the sample, six children who had no record of behavioral observations in their classrooms were also excluded from analyses. The final

sample included 290 boys (43.9%) and 370 girls (56.1%). The majority of the children were African American (78.4%). The remaining children participating in the study consisted of Caucasian (8.5%), Hispanic (8.7%), and others (4.4%). Only 6.9% of children had an Individualized Education Plan (IEP), indicating a formal diagnosis of a disability. About 9.5% of participating children were English Language Learners (ELL).

In order to test for significant differences between the children included in the study and those who were not due to missing data, ANOVAs with an indicator of attrition were conducted on continuous variables and a logistic regression with attrition as a dependent variable was carried out for the categorical variables. Results indicated that children with missing data were more likely to be male than children with complete data (53.2% and 43.9%, respectively). Children with and without missing data did not differ significantly on ethnicity, disability status, ELL status, and pre-test scores.

Measures

Measurements are described in terms of their roles in the analyses to be reported. First, the variables used to control for child factors (i.e., child covariates) are described. Second, measures reflecting the child experiences in pre-kindergarten classrooms are described. Then, the measure reflecting child's behavioral engagement in learning is explained. Finally, child academic outcome measures are described.

Demographic controls. Several characteristics were measured in TRIAD to control for demographic variability between children in academic achievement. The present study used ethnicity and gender as control variables.

Instructional practices. Selected categories from the *Narrative Record of Preschool Classroom Observation* (Farran, 2003) and the *Teacher Observation in Prekindergarten Classrooms-Building Blocks* (TOP BB; Bilbrey, Vorhaus, Farran, & Shufelt, 2007) were used to measure instructional practices in study classrooms.

Narrative Record of Preschool Classroom Observation. The *Narrative Record* instrument was used for recording narrative notes about what was occurring in the classroom (i.e., what the teacher was doing and what the children were doing). The primary goal of this instrument is to accurately capture and quantify the range of instructional and non-instructional events during a typical school day.

The instrument consists of four categories: episodes of time, brief text description of what is happening in the classroom, and categorical definitions of the type of activity during the episode, and the content of instruction occurring during the episode (See Appendix A). This study used data from two *Narrative Record* categories (episodes of time and type of activity) to calculate the amount of time devoted to instruction and time spent on child-directed instruction in a classroom. Each of these categories is described below in greater detail.

In the category related to episodes of time, the beginning and end of each classroom episode were recorded to track the duration of events in the classroom. A new episode of time was started when the type of activity or the content of the activity changes. In each time segment, one code describes the Mode of Instruction. The Mode of Instruction category consists of twelve codes, namely Whole Group with Teacher (WGT), Whole Group (WG), Small Group with Teacher (SGT), Small Group (SG), Small Group with Teacher and Center(s) (SGTC), Small Group and Center(s) (SGC),

Center (C), Meal (M), Meal Out of Room (MOR), Transition (TRN), Transition Out of Room (TOR), and Out. Categories of interest for the present study reflected the duration of instruction occurring in the classroom that was characterized as WGT, WG, SGT, SG, C, SGTC, and SGC. The use of each of these codes during observations is described in greater detail.

WGT was coded when the teacher was the center of attention and was instructing the entire group of children (e.g., the teacher was reading aloud to the group). WG was coded when children were all working on the same activity (e.g., morning worksheets) that the teacher required them to do even if he or she was not directly instructing. When all children were in small groups led by a teacher, assistant teacher or other adult, SGT was recorded. SG was coded when children were learning in small groups focused on activities that the teacher required even if he/she was not directly instructing them. If children were working independently or with some guidance from the teacher or the assistant teacher at a table or an area in which there was a choice of activities, the observer coded C (Centers) as the mode of instruction. If there was at least one small group activity led by the teacher and at least one center in which children were independently engaged in an activity, SGTC was coded. If there was at least one small group of children working together with the teacher roaming but not actually engaged in teaching a small group and at least one center in which children were engaged in an activity that was their choice, the structure of activity was recorded as SGC.

For analysis purposes, the categorical codes for Mode of Instruction were combined with the duration of time of each episode to obtain the best estimate of daily amount of time devoted to instruction and time devoted to child-centered instruction in a

classroom. Proportions were calculated in relation to total observation time. First, the total observation time for each classroom was calculated by adding up all the episodes of time across the three observation points. Then, the time in the episodes organized by Mode of Instruction (i.e., WG, WGT, SG, SGT, C, SGC, & SGCT), indicating the occurrence of an instructional activity, was added across the three observation points for each classroom. Finally, the total amount of time a classroom as a whole spent on instructional activities was divided by the total observation time to get a proportion of the observed classroom day spent on instruction.

Furthermore, to estimate the proportion of the observed time a classroom spent on child-centered instructional activities, the time in the episodes organized by Mode of Instruction (i.e., C, SGC, & SGCT) indicating child direction of the activity was added across the three observation points for each classroom. Then, the total amount of time a classroom as a whole spent on child-centered instruction was divided by the total observation time.

Teacher Observation in Prekindergarten Classrooms-Building Blocks (TOP BB). The TOP BB is a system for observing teacher and assistant behavior in preschool classrooms (Bilbrey et al., 2007). The TOP BB combines snapshots of the behaviors of teachers and assistants to provide a picture of how teachers and teacher assistants are spending their time in a classroom. The observer focused on the teacher for a count of three, then coded the teacher's behavior along eight dimensions: verbal state (including whether the teacher was speaking or listening and to whom); schedule (e.g., whole group, centers, transition); proximity to others; task (e.g., instructional, assessment, managerial); level of instruction (on a five-point scale ranging from none to highly inferential); type of

materials (e.g., literacy, math, science); type of learning focus (e.g., literacy, math, science); and tone/affect (on a five-point scale ranging from vibrant to extremely negative) (See Appendix B). Once scoring had been completed for the teacher, the observer followed the same procedure for the teacher assistant in the classroom. The TOP BB was used in combination with a similar procedure focused on each child's behavior in the classroom. The observation of each child was completed before the teacher and the assistant were observed again, which constituted one "sweep." Within an observation period, the goal was to complete 24 sweeps. The observer stopped coding if the class was outside, in specials (i.e. gym or music), if an outside instructor was leading the lesson instead of the teacher, if the children were napping, or if the teacher/assistant was out of the classroom. On average, teachers were observed and coded 68.4 times (S.D. = 3.1, *range* = 61-72) and teacher assistants were observed and coded 67.3 times (S.D. = 4.6, *range* = 46-72) across the three observation points. This study used data from the TOP BB categories of Type of Task and Level of Instruction to compute the proportions of observed sweeps a teacher and an assistant spent on instruction and the level of instruction involved. Each of the TOP BB categories is described below in greater detail.

Type of task is a category intended to capture the task/activity with which the teacher/assistant is engaged. The emphasis is on what the teacher/assistant is attending to and intellectually engaged with. Codes of interest for the present study reflect the activities characterized as instructional or assessment. In a task coded as Instructional, the teacher/assistant is actively, purposely, teaching and monitoring the classroom for academic purpose. In early childhood classrooms, instruction is defined fairly broadly:

the teacher/assistant is interacting, talking, playing with and/or questioning the children with materials and/or a content focus. When Assessment is coded, the teacher/assistant is administering an assessment or test. Type Task codes that were not considered in this study denote engagement in Administrative (e.g., paperwork, attendance), Managerial (e.g., lining children up), Behavioral (e.g., proactive or reactive behavioral statements or actions in order to change child behavior), Personal Care (e.g., tying shoes), Monitoring (passive observation and modeling behavior), Socializing (e.g., talking about weekend plans), or the absence of a task to code (no engagement with activity, material, or children).

Level of Instruction characterizes the instruction that is occurring. Level of Instruction is rated on a scale of 0 to 4, with 4 being the highest level. The TOP BB observation manual (Bilbrey et al., 2007) provides descriptors for none, low level instruction, basic skills instruction, some/inferential learning, and high/inferential learning.

- None (0) indicates that the teacher/assistant is not instructing the class. Instead, the teacher/assistant is involved in a task that is required to run a classroom, such as organizing children to move from one activity to another, fixing clothes, and passively observing children during transition time.
- In Low Level Instruction (1), the observer cannot judge the intent to teach a specific academic skill even if the teacher is interacting with materials. Examples of this type of instruction involve cutting with scissors and singing songs that do not have instructional content.
- Basic Skills Instruction (2) involves the teacher's/assistant's drilling, direct instructing, reading a story without asking questions, or asking low level questions.
- Some/Inferential Learning (3) occurs when the teacher/assistant is instructing children using a mix of closed- and open-ended questions (what, when, why, or how) and children are interacting and participating with the teacher.
- In High/Inferential Learning (4), the teacher/assistant is instructing, interacting with children using inferential, open-ended questioning. Children are participating, sharing information, and directly interacting with the teacher and with each other. The teacher is purposely making connections between the

> information being taught to the child's outside world. Questioning and discussion by children and the teacher link the academic information to the child. (p. 8)

The ratings from 1 to 4 are used if the teacher/assistant is engaged in instruction or in an assessment type of task. In other cases, the level of instruction is rated as None (0).

Two analysis variables were computed: 1) the proportions of sweeps a teacher and a teacher assistant provided instruction for children in a classroom and 2) the level of the instructional focus. Because there were unequal numbers of sweeps indicating target behavior across classrooms, the proportions of sweeps a teacher and a teacher assistant provided instruction/ assessment for children in a classroom were computed from all sweeps across the three observation points.

Similarly, both the average level of instructional focus provided by the teacher and the teacher assistant in each classroom were computed. To compute the variables, ratings of the teacher's and the assistant's level of instruction were averaged across all the instances in which the teacher/assistant was observed to be involved in Instruction or Assessment type of task during three observation periods. Thus, six variables indicating the instructional practices (i.e., proportion of the observed classroom day spent on instruction, proportion of the observed classroom day spent on child-led instructional activities, proportion of sweeps a teacher and a teacher assistant provided instruction for children, and level of instructional focus provided by a teacher and a teacher assistant) were derived from the *Narrative Record of Preschool Classroom Observation* and the *Teacher Observation in Prekindergarten Classrooms-Building Blocks* (TOP BB).

Emotional tone. The TOP BB tone/affect category was used to measure the emotional tone set by the teacher and the assistant in each classroom. The codes in this

category reflect the positive or negative affect of the teacher and assistant. Tone/affect was rated on a scale of 1 to 5, with 5 being the most positive tone/affect. The following definitions for tone/affect are taken directly from the TOP BB manual (Bilbrey et al., 2007):

- In Extremely Negative (1), the teacher/assistant is strongly negative with his or her verbal and/or physical approach to the children. Teacher/assistant may be using sarcasm toward a child, yelling at children, or insulting them. The teacher/assistant may be physically moving children from place to place by dragging or pulling (rather than guiding).
- In Negative (2), the teacher/assistant is looking displeased and is exhibiting annoyance or disappointment (frowning, headshaking, negative gestures, eye rolling, sighing, etc.). The teacher/assistant may use mild threats to establish control (e.g., Be quiet or you will lose recess, I will put you in time out).
- In Flat (3), the teacher/assistant is neutral and shows no expression. He/she is involved in the activity, but does not show indications of affect regarding that activity.
- In Pleasant (4), the teacher/assistant is having a positive interaction with the children. He/she shows genuine interest and attention to the child and/or activity. The teacher/assistant nonverbally communicates a positive acknowledgement or appreciation of the children's efforts (e.g., looking directly to the child, eyebrows up, nodding, etc.).
- In Vibrant (5), the teacher/assistant is having a strong positive interaction with the children. The teacher/assistant is smiling and/or laughing with the children. The teacher/assistant exhibits genuine excitement about teaching. (p. 13)

To measure the emotional tone of the classrooms, both the ratings of the teacher and the assistant were averaged across the three observation points.

Engagement in learning. The *Child Observation in Prekindergarten Classrooms-Building Blocks* (COP BB; Farran, Plummer, Kang, Bilbrey, & Shufelt, 2006) was used to measure the amount and the complexity of children's behavioral engagement in learning in a classroom. The COP BB is an observational system based on the Manual for Observation of Play in Preschools (MOPP) (Culp & Farran, 1989; Farran & Son-Yarbrough, 2001) and the Manual for Child Observation in Primary

Grades (COPG) (Farran, Kang, & Plummer, 2003). The COP BB combines snapshots of children's behavior to provide a picture of how children are spending their time in a classroom (as an aggregate), as well as information about individual differences among children (Farran et al., 2006). The COP BB consists of eight categories: verbal state (including whether the child is speaking or listening and to whom); schedule (e.g., whole group, centers, transition); proximity to others; interaction state (e.g., nonacademic, parallel, associative); type of task (passive instruction, non-sequential, sequential); level of involvement (on a five-point scale ranging from low to high); type of materials (e.g., literacy, math, science); and learning focus (e.g., literacy, math, science) (See Appendix C).

Once each child was identified and identifiable descriptive information was recorded on the child's coding sheet by the help of the teacher or assistant, the observer looked at the first child for a count of three, then coded the child's behavior along 8 dimensions. The designated observation window of approximately 2-3 seconds has proven sufficient for determining the child's activity, but not so long as to allow the child to demonstrate multiple behaviors in a single category. After coding the first child's behavior with respect to each of the 8 categories, the observer moved on to the next target child. One "sweep" was complete when all target children had been observed. The sweep cycle was then repeated, with a goal of completing approximately 24 sweeps over the course of a morning-long observation. Children might be observed in any order on the first sweep, but were observed in the established order thereafter. On average, children were observed and coded 61.1 times (S.D. = 13.3, *range* = 16-72). In TRIAD, all children who were present in the classroom were observed on each visit. In the

present study, behavior records on children with parent permission were used to measure how children were spending their time in a classroom (as an aggregate). Classroom aggregate computed by data on consented children was considered as an adequate estimate of context. Considering the variability in engagement among children within a classroom, the present study included behavior records on individual children with complete data as an adequate estimate of individual differences among children within that classroom. Including engagement at both the individual- and the classroom-level, this study aimed to decompose the relationship between learning engagement and academic achievement into its within- and between-classroom components.

This study used data from three COP BB categories (type of task, level of involvement, and learning focus) to examine how children are engaged in learning in a classroom (as an aggregate). Each of these categories is described below in greater detail.

Type of Task is a category intended to capture the task demands of the learning material with which the child is engaged, as well as the type of learning engagement the child is displaying. The emphasis is on what the child is attending to and intellectually engaged with. Codes of interest for the present study reflect involvement with activities or objects that are characterized as passive instruction, non-sequential, sequential, or fantasy/drama. In Passive Instruction, the child is engaged in a structured teacher-directed activity that does not involve the child actively interacting with materials. In a Non-Sequential task, which might include sifting through a bin of Legos, the child is involved with an activity or materials but is not following a predictable set of steps. In contrast, a Sequential task involves a sequence of steps, and might include building a

model with blocks, assembling a puzzle, or sorting a collection of buttons by size. In Fantasy/Drama, the child is involved in make believe and pretend play and/or enacting familiar stories or plays. Type Task codes that are not considered in this study denote engagement in Social behavior (e.g., sharing birthday party plans) or the absence of learning behavior (no engagement with activity or materials, and disruptive behavior).

Involvement is a rating of how focused and engaged the child is in learning. Involvement is rated on a scale of 1 to 5, with 5 being the highest level of focus and concentration. The COP BB observation manual (Farran et al., 2006, p. 12) provides descriptors for high, medium, and low involvement. A child displaying high involvement is "intensely focused" on an activity, so much so that it would be hard to distract him or her. In contrast, a child displaying medium involvement pays "ordinary attention" to the activity. While interested in the activity, this child "also could easily give up that activity for another." A child displaying low involvement is "clearly not interested in the activity." Low is also the involvement rating assigned to children who are not involved in play, including children who are engaged an alternative activity (e.g., transition, social conversation, hand washing) and those who are unoccupied or disruptive. A child rated medium-high displays involvement that is between medium and high, and the child rated medium-low displays involvement that is between medium and low.

Learning Focus captures what the intent or content focus of the child's learning. Learning Focus is coded according to six categories (math, literacy, science, social studies, other, and none). Math-related focus category captures child's learning about numbers, operations, shapes, comparisons of numbers and shapes, compositions of shapes, spatial, measurement, patterning, and classification. Literacy-related focus

involves child's learning about letters, sounds, reading, writing, comprehension, and vocabulary. Science-related learning focus involves exploration of physical science and nature. Focus on social studies is related to understanding people, history, character, social/behavioral skills, and emotions. The content focus of child's play with toys (building with blocks, puzzles, matching, etc.) or doing an art or music activity is coded as Other. Under Learning Focus, the absence of a learning behavior is recorded as None.

For analysis purposes, two variables were obtained both at the child and the classroom levels: one refers to the proportion of sweeps in which the child was engaged in learning and the other stands for the complexity of child's engagement in learning. At the child level, the variables were created for each child with complete data in order to estimate variability in engagement within a classroom (N = 660). To calculate the proportions, the total number of sweeps for each child was computed by adding sweeps across the three observation periods. Then, the total number of sweeps in which the content focus of child learning was coded as math, literacy, science, social studies, or other was counted. Finally, the total number of sweeps in which the child was engaged in learning was divided by the total number of sweeps observed for him/her.

The second variable was created to measure the complexity of child's engagement in learning. This variable is a weighted measure. Following from Piagetian notions of cognitive development, increasingly complex engagement is assumed to represent increasingly complex cognitive activity. Levels of increasing complexity in the cognitive activity of the child's interactions with the environment (peers, teachers, or materials) were examined by categorizing the task demands of the learning activity with

which the child was engaged and the intensity of child's engagement using codes in the COP BB Type of Task and Level of Involvement categories.

First, across all sweeps in the three observations, sweeps in which the child was observed to have a learning focus were selected. Then, within these sweeps, the degree of the complexity of learning engagement was identified from the Type of Task category. On Type Task, complexity could vary from Passive Instruction, Non-Sequential, Sequential to Fantasy/Drama.[1] These codes were ordered to differentiate levels of increasing complexity in the cognitive activity of child's interactions with the environment. Passive Instruction was taken to indicate the least complex level of child engagement in learning (and scored as 1), Non-Sequential was scored as 2, while Sequential and Fantasy/Drama tasks representing the most complex level of child engagement in learning were scored as 3.

Within the sweeps in which the child was engaged in learning, the intensity of child's involvement was also coded from Low (1), Medium Low (2), Medium (3), Medium High (4), to High (5). For each sweep in which the child was engaged in learning, a total complexity score was calculated by adding scores on the Type of Task and the Involvement categories. Then, an average complexity score was computed for each child across all sweeps obtained within three observation times. The scores represented a combination of level of involvement and demand characteristics of the task. The highest score characterized high involvement in complex tasks.

To examine targeted child behaviors at the classroom level (e.g., proportion of sweeps children are engaged in learning), child-level data were aggregated to create a

[1] The codes of Sequential and Fantasy/Drama were collapsed into one code due to few numbers of observations of these child behaviors.

classroom index of child behavior. In the present study, 105 consented children who missed pre- or post-tests were excluded from the analyses. However, of the 105 children, 57 had record of behavioral observations in their classrooms. Thus, in order to use the best estimate of the classroom index of child behavior, the records on these children were also included in the calculation of classroom aggregate. Classroom aggregate computed by data on consented children with behavioral records (N = 717) was considered as an adequate estimate of context. In computing classroom proportions of engagement in learning, first, child-level proportional data were calculated across the three observation periods (count of child-level target behavior divided by number of child-level observations); next, child-level proportional data were averaged within classrooms to create classroom-level proportions. To compute the complexity of learning engagement averaged for the class as a whole, child-level averages were computed across the three observation times (a combination of level of involvement and demand characteristics of the task); next child-level mean complexity scores were averaged within classrooms to create classroom-level means.

Academic achievement. Children in TRIAD were individually assessed in the fall of (from August through October) and the spring (from April through May) of their pre-kindergarten year. The assessment battery included the three subtests from the *Woodcock-Johnson III Tests of Achievement* (Woodcock, McGrew, & Mather, 2001), the *Renfrew Language Scales- The Bus Story Test* (Renfrew & Hancox, 1997), and the *Building Blocks Mathematics Assessment* (Clements & Sarama, 2007). The present study used all of the tests as measures of child outcomes. Each of the tests included in the present study is described below in greater detail.

Woodcock-Johnson III Tests of Achievement (WJ III). The WJ III is an individually administered norm-referenced test. The WJ III has twenty-two subtests in which the items become increasingly difficult as the child goes further. The pre-kindergarten math intervention study used three subtests of this measurement tool, namely Letter-Word Identification, Applied Problems, and Quantitative Concepts. Each of these subtests is recommended by the test developers as appropriate for preschool aged children and is described below in greater detail.

Letter-Word Identification measures the child's letter and word recognition. The median reliability for this test is .91 in the age 5 to 19 range. Applied Problems evaluates the child's ability to analyze and solve math problems that require mathematical operations. The required calculations get more complex as the child gets higher questions. The median reliability for this subtest is .92 in the age 5 to 19. Quantitative Concepts measures "knowledge of mathematical concepts, symbols, and vocabulary" (Mather & Woodcock, 2001, p.15). There are two subtests: Concepts and Number Series. The former subtest measures the child's ability to count, to identify numbers, shapes, and sequences, and knowledge of mathematical terms and formulas. The latter subtest asks the child to figure out the missing number in a series of numbers that has a pattern. The reliability for this test is .90 in the age 5 to 19 (Mather & Woodcock, 2001).

The analyses in this study used *W* scores; the test developers provide a transformation of children's raw scores into *W* scores, a special form of Rasch scoring. *W* scores are basically raw scores that have been transformed to take item difficulty into account, and have been centered so that a value of 500 represents the approximate average performance of 10-year-olds (S. Hurley, personal communication, June 14,

2004). Because *W* scores are basically the raw scores transformed, they are more sensitive to change than standard scores.

Renfrew Language Scales- The Bus Story Test. The *Renfrew Bus Story Test* is an individually administered norm-referenced test applicable to ages $3^{1/2}$ years to 7 years. It is an assessment of narrative recall, in which the child is told the story by an examiner alongside a set of 12 pictures, and is asked to retell it afterwards, using the pictures as cues. The *Bus Story Test* measures the child's receptive and expressive language skills. The child's narrative speech is recorded on a tape. Using the transcribed utterances and the test manual the assessor scores for key information contained in the story (content), sentence length, linguistic complexity, and level of cueing. The test-retest reliabilities for information, sentence length, and complexity are .79, .73, and .58, respectively. The present study used raw scores on the Information category as a measure of children's narrative recall language skills.

Building Blocks Mathematics Assessment. The assessment uses an individual interview format, with explicit protocol, coding, and scoring procedures. Codes include correct/incorrect evaluations and separate codes for children's strategies that are intrinsically related to the learning trajectory level the item was designed to measure. The assessment has two tests: Number and Geometry. The Number component includes items measuring verbal counting, object counting, subitizing, number comparison, number sequencing, connection of numerals to quantities, number composition and decomposition, adding and subtracting, and place value. The Geometry test measures shape identification, shape composition and decomposition, congruence, construction of shapes, and turns. It also includes items on geometric measurement and patterning. The

final items both on number and geometry tests measure skills typically achieved at eight years of age. The assessment proceeds until the child makes three consecutive errors. The maximum score for number test is 97, while that for geometry test is 30. The assessment was refined in three full pilot tests. Content validity was assessed via expert panel review. Concurrent validity was established with a .86 correlation with another instrument (Clements & Sarama, 2007). The present study used raw scores on the *Building Blocks Number and Geometry Assessments* as a measure of children's mathematics skills.

To measure children's academic achievement, a composite score of achievement was created. First, zero-order correlations among pre- and post-test scores were conducted. Because of the different metrics used by the WJ III subtests, the *Bus Story Test*, and the *Building Blocks Mathematics Assessments*, children's scores were converted to standard scores (Z scores) across pre- and post-test. Standardization across time allows for the possibility of studying change in composite scores over time, since pre- and post-assessments still have different means and standard deviations within time points. Thus, standardization, making the scaling for all subtests similar, is necessary for the purpose of creating composite scores to which each subtest equally contributes. The pre-test composite score was used as a child-level covariate, while the post-test composite score was used as the criterion in the main analyses.

Procedures

Child assessment and classroom and child observation data for this study were collected during the 2007-2008 academic year.

Training. Assessment training began in the summer of 2007. Assessors were graduate assistants working on the project, fulltime project staff (including the principal investigator) and additional staff who were hired to help assess the children. The assessors were divided into two teams. The first team was trained on the *Building Blocks Geometry Assessment* and the three subtests of the WJ III (Letter-Word Identification, Applied Problems, and Quantitative Concepts), while the second team was trained on the *Building Blocks Number Assessment* and the *Renfrew Bus Story*. The training consisted of three days of structured introduction to the assessment measures and practice with the materials. Assessors were trained in both administration and scoring. Following the formal training, assessors practiced with each other and with children in non-study classrooms, and coded sample assessment videos. Then, assessors videotaped two practice assessments. These videotaped sessions were critiqued by head assessors, with feedback given to new child assessors. They were also used to double score in order to test reliability. Nashville head assessors certified assessors to give the WJ III, *Building Blocks Assessments,* and *Renfrew Bus Story*.

After finishing the child assessments, 13 of the 15 assessors were trained on classroom observation measures. Observers were divided into two teams. The first team was trained on the *Narrative Record*, while the second team was trained on the TOP BB and the COP BB. Two observers were trained on all observation measures and they served on both teams. All data collectors were knowledgeable about preschool environments and young children's behavior. Before beginning the data collection, observers, in each team, were trained in data collection procedures over the course of two weeks using five preschool classrooms that were not included in the study. Two

classrooms were equipped with an observation booth that had one-way mirrors and sound equipment. At the beginning of the training, all raters were trained by observing those two classrooms in its observation booth in order to exchange their ideas and solve questions. Then, two observers were assigned to each classroom to practice and obtain practice reliability. Group members were exchanged every time to ensure that every rater was reliable with every other. At the beginning of each observation cycle, the reliability visits were conducted in study classrooms. For this purpose, the groups of two observers visited three study classrooms for the first cycle, two classrooms for the second cycle and one classroom for the third cycle in order to obtain reliability.

Reliability. Certification was established through videotapes for the *Woodcock-Johnson III Tests of Achievement* (WJ III) and *the Building Blocks* pre- and post-assessments, and through transcriptions for the *Renfrew Language Scales- The Bus Story* pre- and post-assessments.

Reliabilities for the WJ III and the *Building Blocks Number and Geometry Assessments* were established through double coded videotapes. The total number of videotapes that were double coded was 22 for the WJ III, 37 for the *Building Blocks Geometry,* and 29 for the *Building Blocks Number Assessments*. Reliability for the assessments and the observation measures was calculated by percent agreement [agreement / (agreement + disagreement)]. The inter-rater reliability among eight assessors on the WJ III subtests was 97.9%, while reliabilities on the *Building Blocks Number and Geometry Assessments* were 95.8% and 89.6%, respectively. Reliability for the *Renfrew Bus Story* information category was established by comparing the scores

with scores from the expert through transcriptions of 241 assessment sessions. For information category, reliability was 88.7%.

Reliability for observations was established by comparing ratings through live visits for the *Narrative Record of Preschool Classroom Observations, Child Observation in Prekindergarten Classrooms- BB* (COP-BB), and *Teacher Observation in Prekindergarten Classrooms- BB* (TOP-BB) across three observation periods. Reliability among seven observers obtained from 329 segments coded on the *Narrative Record* episodes of time category was 91.7%, while that on the *Narrative Record* type of activity category was 96.5%. Reliabilities among eight observers for the TOP BB level of instruction and tone/affect categories were 96.3% and 89.3%, respectively. Field-based reliabilities among eight observers for the COP BB type of task, involvement, and focus categories were 92.7%, 87%, and 95.7%, respectively. Each pair of observers discussed the items on which they disagreed and created consensus codes as final data.

Observation procedure. Three observations, one each in the fall, winter, and spring, were completed for each classroom. The primary goal of the observations was to accurately capture and quantify the range of instructional and non-instructional events, to provide a picture of how teacher/assistant and children were spending their time in a classroom during the part of the school day most likely to be devoted to instruction. Classrooms were observed for 4 hours, typically from 8:00 a.m. until 12:00 p.m. Two observers visited study classrooms on the same day. One observer recorded field notes about classroom instruction and activity in the *Narrative Record* and collected data on early mathematics environment and teaching, while the other observer coded teacher's/assistant's and children's behavior. Each observer was assigned to observe five

to twelve classrooms. Also, each observer was assigned to visit different classrooms within treatment and control classes and across the two systems for each observation time to eliminate any observer effect on observation ratings. The classroom teachers were informed about the observation days and asked to make the observation day typical in terms of classroom experiences.

Assessment procedure. Children in the pre-kindergarten math intervention study were individually assessed in September and April of their pre-kindergarten year. The examiners arrived at schools when the class started and stayed until nap time. Assessments were administered to each child in a quiet area apart from the classroom (e.g., unoccupied classroom, school library, quiet hallway).

In the fall, assessments were administered in two sessions. The *Building Blocks Geometry Assessment* and the three subtests of the WJ III (Letter Word Identification, Applied Problems, and Quantitative Concepts) were given in one session. In another session the *Building Blocks Number Assessment* and the *Renfrew Bus Story* were administered. In the spring, expecting children to answer a greater number of items, three examiner teams were formed to assess children in three sessions, the *Geometry Assessment*, the *Number Assessment*, and the WJ III subtests with the *Renfrew Bus Story* in a single session. For both pretest and posttest, tests were administered in a specified order within each session. Each child was pre-tested on two different days by two different examiners, while they were post-tested on three different days by three different examiners. Stickers were provided as rewards for children as they completed each subtest.

Data Analysis

This study examined four a priori hypotheses regarding the associations among instructional classroom practices, emotional tone of the classroom, children's behavioral engagement in learning, and gains in academic skills. Independent variables consisted of two categories: classroom practices and engagement as a classroom index of child behavior. The category of classroom practices involved instructional practices (a combination of six variables indicating the quantitative and qualitative dimensions of instructional practices for a class), and emotional tone (the tone/affect ratings for the teacher and the assistant in a class). The category of engagement involved the amount (i.e., proportion of sweeps in which children in a classroom were observed to be engaged in learning) and the complexity of children's engagement as a classroom aggregate. The complexity of children's engagement in learning averaged for the class as a whole was also used as a mediator in the analysis. Individual children background characteristics (i.e., initial skill level, gender, and ethnicity) were used as covariates in related analyses. In addition, children's initial skill level was utilized as moderator variables in the analysis. The dependent variable was children's gain in academic skills from fall to spring of the prekindergarten year (a combination of language score on the *Renfrew Language Scales- The Bus Story Test*, literacy score on the WJ III *Letter-Word Identification* subtest, and mathematics scores on the WJ III *Applied Problems and Quantitative Concepts* subtests and *Building Blocks Number and Geometry Assessments*).

Across all hypotheses, except the mediation model, multilevel modeling was used to assess the predictive role of classroom practices and behavioral engagement on children's academic gains from fall to spring of the prekindergarten year. By taking into

account the fact that children are nested in classrooms, multilevel modeling provides more accurate estimates of standard errors, thereby reducing the likelihood of Type I errors (Raudenbush & Bryk, 2002). Variables specific to children (i.e., individual children's background characteristics, proportion of engagement in learning, and complexity of engagement in learning) were used at level one, as those specific to classrooms (i.e., instructional practices and emotional tone, the proportion of sweeps in which children in a classroom were engaged in learning, and the complexity of learning engagement shared across class members) were used at level two. In all analyses, variables indicating children's background characteristics (gender, ethnicity, and initial skills) were grand-mean centered to adjust for the inherent differences among classrooms. Variables indicating individual's learning engagement were group-mean centered to disentangle individual and contextual effects. Also, the magnitude of effects was computed for predictor variables in each model by multiplying the coefficient times the standard deviation for the predictor and dividing by the standard deviation of outcome.

As a first step in multilevel modeling, intraclass correlations were calculated for the residualized gains by means of a model without predictors. Generally, the intraclass correlation indicates if there is a significant amount of variability in the dependent measure for each level of the model and serves as a basis for choosing the appropriate number of levels that a model should include (Raudenbush & Bryk, 2002).

Hypothesis testing. The hypotheses tested in the study were:

1. *Pre-kindergarten classrooms with higher levels of instruction and a more positive affect would be associated with greater academic gains.* The first hypothesis involved an investigation of effects of the instructional practices and emotional

tone on children's academic gains from fall to spring of the prekindergarten year. Classrooms offering a greater amount of instruction and instruction that focuses more on analytic-inferential thinking, as well as more positive emotional environment would have children with greater achievement gains. For Hypothesis 1, a multiple regression analysis would be conducted while taking into account the fact that children were nested in classrooms. Children's background characteristics (initial skill level, gender, and ethnicity) were included as covariates because classroom effects were only of interest after potential confounding effects of child factors were accounted for.

Prior to the main analysis, the correlations among variables constituting instructional practices (proportion of time a classroom as a whole spent on instruction, proportion of time a classroom as a whole spent on child-led instructional activities, proportions of sweeps a teacher and a teacher assistant in a classroom spent on instruction, and levels of instructional focus observed for a teacher and a teacher assistant), emotional tone (levels of emotional tone for a teacher and a teacher assistant), and child academic achievement (pre- and post-test scores on language, math, and literacy assessments) would be explored in order to condense the number of variables due to small classroom sample size.

2. *Pre-kindergarten classrooms in which children were more often engaged in learning would have children with greater academic gains.* Hypothesis 2 suggested that gains in academic skills would be predicted from the general amount of learning engagement shared across class members. More specifically, classrooms whose children spent more time on being engaged in learning would

have children with higher academic improvement. In order to test this hypothesis, a multiple regression analysis would be carried out while taking into account the fact that children were nested in classrooms. Children's background characteristics (initial skill level, gender, and ethnicity) would be included as covariates. Individual children's amount of engagement in learning would be included to decompose the relationship of engagement with achievement gains into its within- and between-classroom components.

3. *Pre-kindergarten classrooms in which children were engaged in learning at a more complex level would have children with greater academic gains.* Hypothesis 3 asserted that more complex learning engagement in the classroom would be associated with larger gains in academic skills. In other words, classrooms whose children were engaged in more complex interactions with the environment (peers, teachers, and/or materials) would have children with higher gain scores on standardized achievement tests. To test Hypothesis 3, taking into account the fact that children were nested in classrooms, a multiple regression analysis would be carried out to examine the predictive contribution of the complexity of classroom learning engagement in relation to gains in achievement. Children's background characteristics (initial skill level, gender, and ethnicity) would be included as covariates. Individual children's complexity of engagement in learning would be included to decompose the relationship of engagement with achievement gains into its within- and between-classroom components.
4. *Classroom engagement in learning at a more complex level would mediate the relationship between instructional and emotional classroom environments and*

children's academic gains. For Hypothesis 4, a series of multiple regression analyses would be conducted in order to examine the mediating role of the complexity of learning engagement shared among class members on the relationship between instructional and emotional classroom environments and children's academic gains. To test the mediation for the classroom environment, first, the association between instructional and emotional classroom environment and children's academic gains would be investigated. Second, the relationship between the classroom environment and the complexity of classroom engagement in learning would be examined. Finally, the indirect effect of the classroom environment on children's academic gains would be tested via its effect on the complexity of classroom engagement in learning. For this set of analyses, single-level multiple regression models would be run. Classroom aggregates of children's background characteristics (initial skill level, gender, and ethnicity) would be included as covariates.

The present study also would explore the following question:

1. *To what extent are the association between instructional and emotional classroom environments and children's gains in achievement moderated by children's initial skill level?* In this model, the relationship of instructional and emotional classroom environments with children's academic gains in the presence of children's initial academic skills would be examined. Multiple regression analysis would be carried out while taking into account the fact that children were nested in classrooms. Children's initial skill level would be used as the moderator

variable. The main effects of the classroom environment and children's initial academic skills would also be included in the interaction model.

CHAPTER IV

Results

Descriptive Analyses

Classroom observations. Classrooms were observed once in fall, once in winter, and once in spring. In order to measure the levels of instructional practices, emotional tone of the classroom, and children's learning engagement in a classroom, several variables were created from the raw observational data and combined. In the following sections, descriptive statistics on the variables constituting instructional teacher practices, emotional tone of the classroom, and learning engagement analytic variables are presented.

Instructional practices. Table 1 displays the means and standard deviations of the components of instructional practices. Examining data from the *Narrative Record* about how the class time was divided, reveals the following: in the average classroom, 53.6% of the four hour morning observation was spent on instructional activities altogether, and 22.9% of the observation period was spent on activities that enabled children to control the activity. However, the percentage of observation time spent on instruction varied a great deal across classrooms, with some classrooms spending a small portion of the morning observation time on instructional activities and others spending a majority of their time on instructional activities. The variation across classrooms was also large in the percentage of observation period spent on activities led by children, ranging from 1.1% to 50.8%.

Data from the TOP BB provide specific information about the behaviors of teachers and assistants during the four hour observation. Across 57 classrooms, the mean percentage of sweeps a teacher spent on instruction was 32.9%, but ranged from 14.3% to 69.4%. Classrooms also varied in the percentage of observed sweeps for which a teacher assistant was involved in an instructional type of task, ranging from 1.4% to 30.6%. The level of instruction was 1.88 for the average teacher and 1.49 for the average teacher assistant. As described in Chapter III, this level of instruction was between low-level and basic skills.

Table 1

Descriptive Statistics for Components of Instructional Practices (N=57)

Source	Mean or %	SD	Minimum	Maximum
Narrative Record				
Classroom instructional time[a]	53.61 %	-	35.97%	69.17%
Classroom time led by children[a]	22.90%	-	1.11%	50.83%
Teacher Observation in Prekindergarten Classroom - Building Blocks				
Sweeps teacher spent on instruction[b]	32.85%	-	14.29%	69.44%
Sweeps teacher assistant spent on instruction[b]	12.60%	-	1.43%	30.56%
Teacher's instructional focus (1-4 scale)[c]	1.88	0.24	1.20	2.44
Teacher assistant's instructional focus (1-4 scale)[c]	1.49	0.31	1.00	2.17

Note. [a]Values indicate percentage of time across the three observations. [b]Values indicate percentage of sweeps across the three observations. [c]Values indicate mean level of instruction averaged across the three observations.

Emotional tone. The observer rated the levels of the emotional tone for the teacher and teacher assistant in a classroom using a five-point Likert scale. Descriptive data are presented in Table 2. The scores for teachers and teacher assistants on their emotional tone were in the mid-range. The mean level of teacher's emotional tone was 3.30 and the mean level of teacher assistant's emotional tone was 3.15. As described in Chapter III, the levels of emotional tone the average teacher and teacher assistant presented were neutral and indicated a somewhat flat affect. Classrooms varied in the emotional tone of the teacher and the teacher assistant; in some classrooms, teachers and/or teacher assistants created an emotional environment that was closer to negative while in others, they provided an emotional environment that was closer to pleasant. It is important to note that relative to the measures of instructional practices, the variation between classrooms on emotional tone was quite narrow.

Table 2

Descriptive Statistics for Emotional Tone (N=57)

Source	Mean	SD	Minimum	Maximum
Teacher's emotional tone (1-5 scale)	3.30	0.20	2.92	3.86
Teacher assistant's emotional tone (1-5 scale)	3.15	0.14	2.77	3.47

Note. Values indicate mean level of tone/affect averaged across the three observations.

Engagement in learning. The observer recorded discrete behaviors for each child. These child observations were combined to create a classroom index of child

behavior, as well as to measure individual differences among children. Table 3 displays the means and standard deviations of the proportion of sweeps in which children were engaged in learning and the complexity of their engagement at both the child and the classroom level. Individual level engagement variables were calculated by using data on each child with complete assessment and behavior records (N = 660). Classroom level engagement variables were calculated by averaging all data on children with any behavior records (N = 717) within each classroom across the three observation points.

Proportions of target behavior were calculated in relation to overall engagement. In calculating proportional data at the child level, observed instances of the target behavior were summed to be the numerator; the denominator was the total number of sweeps observed for a child across the three observation periods. When the child was engaged in an activity with a learning focus, the degree of complexity in learning engagement was computed by adding scores on task demands of the learning activity with which the child was engaged and the intensity of child's engagement. A total complexity score for a sweep in which a child was engaged in learning could range from 2 to 8. Proportional target behavior and average complexity scores were computed for each child and then, were averaged within each classroom. The two scores can be relatively independent of each other. The proportion of time children were observed with a learning focus varied across children, and within those learning focus sweeps, the complexity of engagement varied.

At the individual level, on average, children spent 45% of the four hour observation period engaged in learning. At the classroom level, total engagement in learning in the average classroom also represented 45% of total observed behaviors. The values ranged from 28% to 70% across classrooms. Thus, the proportion of

observed engagement in learning was quite high in some classrooms, and extremely low in others whether calculated from the data of all children observed at a time point or restricting the sum to only those children who will be included in the final analyses. The mean level of complexity in learning engagement was 5.17 across children, but ranged from 3.78 to 6.13. Classrooms also varied in average scores related to the complexity of engagement in learning, ranging from 4.77 to 5.70. The values on the proportion of engagement in learning and the complexity of engagement in learning at both the individual-level and the classroom-level were used as the predictor variables in order to decompose the overall relationship between learning engagement and academic gains into the within classroom and between classroom components. Also, the complexity of engagement averaged for the class as a whole was used as the mediator variable in the analysis.

Table 3

Descriptive Statistics for Learning Engagement

Source	Mean or %	SD	Minimum	Maximum
Individual Level (*n* = 660)				
Engagement in learning[a]	45.27%	-	20.83%	75.00%
Complexity of engagement in learning[b]	5.17	0.34	3.78	6.13
Classroom Level (*n* = 57)				
Engagement in learning[c]	45.06%	-	27.70%	70.33%
Complexity of engagement in learning[d]	5.16	0.21	4.75	5.77

Note. [a]Values are expressed as child proportions of engagement in target behavior in relation to total observed behaviors across the three observation time points. [b]Values indicate averages of complexity of child engagement in learning across the three observations. Total complexity score a child can have ranges from 2 to 8. [c]Values are expressed as classroom proportions of engagement in target behavior in relation to total observed behaviors across the three observation time points. [d]Values indicate classroom averages of complexity of engagement in learning across the three observations.

Academic achievement. Children were individually assessed in the fall (from August through October) and the spring (from April through May) of their pre-kindergarten year. Table 4 displays the means and standard deviations of children's pre- and post-test scores. As might be expected with a low-income sample, both fall and spring mean scores on standardized measures of math skills were below the national average. On the other hand, average pre- and post-test scores on the WJ III Letter-Word Identification were very close to the average score of the standardization sample that is representative of the U.S. population (Mather & Woodcock, 2001). Table 4 illustrates that there was great variation both on pre- and post-test scores of the WJ III subtests across study children.

Summarizing the scores from the non-standardized measures, children's raw scores on the Information category of the *Renfrew Bus Story Test* ranged from 0 to 32 on pre-test and from 0 to 39 on post-test. It shows that some children could recall none of the key information contained in the story (content) even on post-test.[1] Raw scores on the *Building Blocks Number and Geometry Assessments* ranged widely across children and the minimum score was "0" on both pre-and post-tests.[2]

Table 4

Descriptive Statistics for Pre- and Post-test Scores (N =660)

	Pre-test				Post-test			
Source	M	SD	Minimum	Maximum	M	SD	Minimum	Maximum
Letter-Word Identification[a]	98.8	16.6	58.0	163.0	106.3	12.6	59.4	153.0
Applied Problems[a]	87.9	16.5	37.5	123.0	95.5	13.6	33.6	132.0
Quantitative Concepts[a]	86.8	10.9	62.0	130.0	94.7	14.3	54.1	135.0
Renfrew Bus Story Information[b]	8.8	6.0	0.0	32.0	14.2	7.5	0.0	39.0
BB Number Assessment[b]	8.1	6.1	0.0	38.0	17.8	9.0	0.0	41.0
BB Geometry Assessment[b]	3.7	2.7	0.0	13.0	7.6	3.7	0.0	18.0

Note. [a]The standard scores used in the WJ III subtests are based on a mean (M) of 100 and a standard deviation (SD) of 15. [b]The raw scores were used in the *Renfrew Bus Story Test* and the *Building Blocks Number and Geometry Assessments*. BB = Building Blocks

[1] On the Information category of the *Renfrew Bus Story Test*, 64 children scored "0" at pre-test, while 14 children scored "0" at post-test. Of these children, 10 scored "0" at both time points.

[2] On the *Building Blocks Number Assessment*, 48 children scored "0" at pre-test, while 2 children scored "0" at post-test. Of these children, only one scored "0" at both time points. On the *Building Blocks Geometry* Assessment, 54 children scored "0" at pre-test, while 9 scored "0" at post-test. Of these children two scored "0" at both time points.

Summary of Descriptive Results

The previous section provides descriptive data related to the variables constituting instructional classroom practices, emotional tone of the classroom, observed amount and complexity of learning engagement at both the individual and the classroom level, and child academic achievement. According to those findings, on average, classrooms as a whole spent half of the four hour morning observation on instructional activities, while they enabled children to lead the instructional activities one fifth of the observation period. Teachers and teacher assistants spent a smaller portion of the observation on instruction, with low ratings for instructional focus. They were observed to be emotionally neutral towards children. On average, total engagement in learning observed for individual children and in classrooms represented 45% of total observed behaviors. The mean complexity of engagement in learning measured both across children and classrooms was 5. The level of complexity, however, ranged from 3.78 to 6.13 among children, while it ranged from 4.75 to 5.77 among classrooms. The average pre- and post-achievement scores of the study children on standardized measures of math skills were below the average scores of the standardization sample while those on the standardized measure of literacy skills were close to the national average. Also, the variation in children's standard scores on the WJ III subtests, as well as raw scores on the *Renfrew Bus Story Test* and the *Building Blocks Number Assessment* were large, while that in children's raw scores on the *Building Blocks Geometry Assessment* was modest. In the next section, results of data screening check, variable construction, and the correlations among predictors, covariates, and the criterion are presented.

Preliminary Analyses

Prior to the main analyses, the data were checked for normality and outliers. All variables had approximately symmetric distributions and none had a highly skewed or flat distribution. Box plots were used to check outliers in the data. Tukey's Hinges were used as the basis for outlier analyses. Based on those values the outlier boundaries for each variable were calculated. The interquartile range (IQR), the difference between the 75^{th} percentile (Q_3) and the 25^{th} percentile (Q_1), was calculated for each variable. Observations smaller than the lower outer bound, $Q_1 - (3 * IQR)$, and/or those greater than the upper outer bound, $Q_3 + (3 * IQR)$, were considered extreme values. In the present data, there were extreme values that were outside the outer boundaries. Extreme values were found in the following individual-level data sets: pre-test on the WJ III Letter-Word Identification and the *Building Blocks Number Assessment*, and post-test on the WJ III Letter-Word Identification and Applied Problems. Extreme values in these data were recoded to the boundary values to test whether the results of main analyses with extreme values differed from those with recoded values.

In order to check whether the few children who had dramatic losses on the assessments of academic achievement had a significant influence on the results, these children's post-test scores were replaced by their pre-test scores. Sensitivity analyses were run to test whether the results of main analyses with original data differed from those with recoded data. The results indicated no change in the pattern of significance. Therefore, the original data were used in multilevel models testing hypotheses.

After data screening, due to the small number of classrooms, composite scores were created in order to condense the number of variables. In the following sections,

variable construction is explained, and then the correlations among predictors, covariates, and the criterion are presented.

Creating an instructional practices analytic variable. Prior to the main analyses, the correlations among six variables related to instructional practices observed in classrooms were examined to determine whether the variables should be tested individually or used as a composite variable. These correlations are presented in Table 5. Overall, associations were quite modest. A stronger correlation appeared between the percentage of observation time a classroom as a whole spent on instruction and the percentage of time children in a classroom led the activity to some extent, since the percentage of classroom instructional time included the percentage of observation period led by children (r = .66, p< .01). The percentage of the four hour morning observation spent on instruction was also positively significantly correlated with the percentages of sweeps teacher and teacher assistant spent on instruction, and with the level of instruction teacher assistant provided for children (r = .33; r = .27; r = .28, p's< .05, respectively). Finally, the percentage of observation time spent on child-directed activities in a classroom was significantly but modestly correlated with the level of instruction the teacher assistant provided for children (r = .30, p< .05).

As the percentage of sweeps a teacher spent on instruction increased, the level of instruction the teacher provided for children increased. Furthermore, the level of instruction the teacher provided for children was related to the level of instruction the teacher assistant provided for children. The level of teacher's instruction was negatively but not significantly associated with the proportion of observation period in which the classroom activity was led by children and with the proportion of sweeps a teacher assistant was engaged in instructional type of tasks.

Table 5

Pearson Correlations among Components of Instructional Practices (N=57)

	Classroom time led by children	Sweeps teacher spent on instruction	Sweeps teacher assistant spent on instruction	Teacher's instructional focus	Teacher assistant's instructional focus
Classroom instructional time	.66**	.33*	.27*	.15	.28*
Classroom time led by children		.11	.16	-.03	.30*
Sweeps teacher spent on instruction			.14	.29*	.16
Sweeps teacher assistant spent on instruction				-.04	.22
Teacher's instructional focus					.33*

*Note. **p<.01, *p<.05.*

Again, due to the classroom sample size, the variables indicating instructional practices were not tested individually. As discussed in Chapter III, each variable was on a different scale. In order to create a composite variable, the scores across the six variables listed in Table 5 for each classroom were standardized so that they all were on the same scale. The instructional practices composite variable was formed by standardizing and then averaging the classroom scores on all indicators of instructional practices. Doing so allowed each component to count equally towards the instructional practices observed in each classroom. The mean composite score on the level of instructional practices was 0 (SD = 0.59), with a range from -1.23 to 1.54. The instructional practices composite variable was treated as a continuous variable and used as a predictor in related analyses.

Creating an emotional tone of the classroom analytic variable. The teacher and the teacher assistant both contribute to the overall emotional tone of the classroom for children. In order to test whether a composite score of emotional tone of the classroom could be created, a zero-order correlation between teacher's and teacher assistant's average scores on the level of tone/affect category was conducted. The correlation between the level of teacher's emotional tone and the level of teacher assistant's emotional tone was positive, but not significant. Scores from the teacher and the teacher assistant were combined into a single measure by averaging ratings within a classroom. This allowed the teacher and the teacher assistant to contribute equally to the level of emotional tone provided for children in each classroom. The mean level of emotional tone observed across 57 classrooms was 3.22 (SD = 0.13), with a range from 2.96 to 3.57. Emotional tone was treated as a continuous variable and used as a predictor in related analyses.

Creating pre and post academic achievement analytic variables. To measure children's academic achievement, a composite score of achievement was created by standardizing across the two time points, and then, averaging the scores across tests within each time point. First, zero-order correlations among pre- and post-test scores were conducted. These correlations were presented in Table 6. Measures of academic achievement were modestly to moderately correlated with each other ($p < .01$). Also, they were associated both within and over time.

Because of the different metrics used by the WJ III subtests, the *Renfrew Bus Story Test*, and the *Building Blocks Number and Geometry Assessments*, children's scores were converted to standard scores (Z scores) across pre- and post-test. Standardization across time allows for the possibility of studying change in composite scores over time, since pre- and post-assessments have different means and standard

deviations within time points. Thus, standardization, making the scaling for all subtests similar, is necessary for creating composite scores to which each subtests equally contribute. Means and standard deviations for composite scores are presented in Table 7. The result of the correlation analysis indicated a positive significant association between pre-composite achievement and post-composite achievement ($r = .64$, $p < .01$). The pre-composite score was used as a child-level covariate, while the post-composite score was used as the criterion in the main analyses.

Table 6

Pearson Correlations among Measures of Academic Achievement (N = 660)

	APW pre	QCW pre	NU pre	GEO pre	REN pre	LWW post	APW post	QCW post	NU post	GEO post	REN post
Letter-Word Identification Pre-test (LWWpre)	.49*	.64*	.50*	.38*	.38*	.55*	.41*	.48*	.42*	.36*	.38*
Applied Problems Pre-test (APWpre)		.65*	.61*	.44*	.50*	.42*	.64*	.54*	.55*	.51*	.52*
Quantitative Concepts Pre-test (QCWpre)			.71*	.56*	.48*	.52*	.56*	.66*	.61*	.54*	.49*
BB Number Assessment Pre-test (NUpre)				.54*	.52*	.40*	.57*	.57*	.62*	.49*	.47*
BB Geometry Assessment Pre-test (GEOpre)					.33*	.31*	.42*	.44*	.42*	.46*	.36*
Renfrew Bus Story Information Pre-test (RENpre)						.28*	.43*	.38*	.38*	.34*	.66*
Letter-Word Identification Post-test (LWWpost)							.50*	.60*	.47*	.42*	.35*
Applied Problems Post-test (APWpost)								.68*	.66*	.59*	.49*
Quantitative Concepts Post-test (QCWpost)									.68*	.58*	.43*
BB Number Assessment Post-test (NUpost)										.63*	.43*
BB Geometry Assessment Post-test (GEOpost)											.44*

Note. * $p < .01$.

Table 7

Descriptive Statistics for Composite Academic Achievement Scores (N = 660)

Source	Mean	SD	Minimum	Maximum
Pre achievement	-0.49	0.62	-1.88	1.83
Post achievement	0.49	0.71	-1.43	2.60

Note. Composite values were based on scores converted to standard scores (Z scores) across pre- and post-test.

Correlations among classroom measures. Table 8 presents the associations among classroom measures. Overall, associations were modest. Stronger associations were observed between the amount of classroom engagement in learning and the level of instructional practices and the complexity of classroom engagement in learning. Classrooms that spent more time on instruction and that had more instructional activities presumed to affect higher-order thinking had children who were engaged in learning more often and who interacted with the environment at a more complex level. Also, classrooms with higher level of instructional practices were observed to have a more positive emotional tone. Furthermore, the more positive the emotional tone of the classroom was, the more the children were engaged in learning, as well as the more complex the level of children's engagement was. Moreover, the more the children were engaged in learning, the more complex the children' learning engagement was in a classroom.

Table 8

Correlations among Classroom Measures

	Classroom emotional tone	Classroom engagement	Complexity of classroom engagement
Classroom instructional practices	.42*	.65*	.46*
Classroom emotional tone		.35*	.35*
Classroom engagement			.59*

Note. Numbers in table are Pearson Product Moment Correlations. * $p < .01$.

Correlations between classroom measures and academic achievement.

The following information relates to the association of classroom level measures and classroom mean levels of achievement. Table 9 shows the correlations between classroom measures and the children's pre and post academic achievement. None of the classroom measures was significantly related to children's pre academic achievement. This indicates that in the present study, there was not any initial spurious relationship because of non-random assignment of children to classrooms. Children's post achievement was significantly related to classroom instructional practices, and the amount of classroom engagement. More specifically, classrooms with higher levels of instructional practices had children with higher achievement at the end of pre-kindergarten. Also, classrooms with higher average amounts of engagement in learning had children who showed higher levels of academic achievement in the spring of prekindergarten year.

However, despite positive significant correlations between some classroom measures and post-achievement, there was no relationship between level of emotional tone observed in the classroom and classroom mean levels of achievement measured

in the spring of pre-kindergarten year. This might be due to the limited variation on the measure of emotional tone employed in the present study. Also, the correlation between the level of complexity in classroom learning engagement and the post academic achievement showed a positive (though non-significant) relationship.

Table 9

Correlations between Classroom Measures and Academic Achievement

	Classroom instructional practices	Classroom emotional tone	Classroom engagement	Complexity of classroom engagement
Classroom pre achievement	.18	-.25	.15	.01
Classroom post achievement	.34**	-.02	.35**	.22

Note. Numbers in table are Pearson Product Moment Correlations. * $p < .05$; ** $p < .01$.

Gender and ethnicity. Analyses examined the influence of gender and ethnicity on the dependent and independent measures to evaluate if they should be included as covariates in the analyses. Multilevel models were run to test the effect of gender and ethnicity on measures at the individual level, such as pre and post achievement, and the amount and the complexity of individual's engagement in learning, while t-tests were used to estimate the influence of gender and ethnicity on measures at the classroom-level, such as instructional practices, emotional tone, the amount and the complexity of classroom engagement in learning. Multilevel models indicated that boys scored lower than girls on the composite academic achievement measure at pre- and post-assessments, p's $< .01$. T-tests revealed that African Americans were in classrooms with less positive emotional tone, $p<.01$. This suggests that ethnicity may moderate the relationship between emotional tone of the

classroom and academic achievement. This moderation was tested and was found to be non-significant. To sum up, gender and ethnicity were included as covariates in the main analyses.

Hypotheses Testing

Analytical strategy. Multilevel modeling was used to examine whether instructional practices, emotional tone of the classroom, and classroom engagement in learning predicted variation among classrooms in average levels of achievement with a sample of 57 classrooms nested in 20 schools. This approach takes into account the grouping of children within classrooms and classrooms within schools/sites. It assesses both between- and within-school effects simultaneously by allowing each school to have a unique intercept and slope. This multilevel modeling provides more accurate estimates of standard errors, which reduces the likelihood of Type I error (Raudenbush & Bryk, 2002).

As a first step in multilevel modeling, the unconditional model was tested without predictor variables. This analysis was motivated by the need to partition the total variance in the outcome into a component at child level, a component at classroom level, and a component at school/site level. The unstandardized residual for post composite achievement was saved after a linear regression model in which post composite achievement was regressed on pre composite achievement and then was used as the dependent variable in the unconditional model. As can be seen in Table 10, the between-school and between-classroom within school variability in residualized gain was significant. The partitioning of the total variance showed that 18.51% (0.0367/(0.0367+0.0163+0.1453)) of the variance in academic achievement was accounted for by schools/sites and 8.22% (0.0163 /(0.0367+0.0163+0.1453)) of

the variance in academic achievement was accounted for by classrooms within schools.

Results indicated that a large percentage of the variation in residualized gain was at the child and the school level, while relatively little variance to be explained was at the classroom level. The present study is interested in explaining the variance between classrooms in average level of achievement gains. Therefore, despite the significant variation among schools in the residualized gain, the present study used a simpler two-level analysis of children at level-1 and classes at level 2, incorporating the between-school variance into the between-classroom within-school component to model the total variance across classrooms. Also, on average, there were only three classrooms per school, ranging from 1 to 9, which makes it difficult to reliably estimate the two variance components (i.e., between-classroom between-school and between-classroom within-school variances) in the present study.

Table 10

Unconditional Model for the Prediction of the Residualized Academic Gains

	Variance	*SE*	%Variance
Random Parameters			
School level	0.0367*	0.0167	18.51
Classroom level	0.0163*	0.0068	8.22
Child level	0.1453**	0.0084	73.27

Note. Dependent variable is the residual for post achievement. *$p < .05$, **$p < .001$.

As a second step, the assumptions underlying the multilevel modeling were checked. The following paragraphs address these assumptions. One of the

assumptions of multilevel modeling is related to linearity between the outcome variable and the predictors. To test linearity, first, residuals for each level were saved. Then, residual plots against predictor variables were applied for each model. The plots showed a random scatter of residuals around the zero line, which indicates the relationships between the predictor and the outcome variables were linear. Another assumption is that the data need to be normally distributed. The points on the normal probability plot of regression standardized residual formed a nearly linear pattern, which indicates that the data set was approximately normally distributed.

Another assumption of multilevel modeling is independent errors, meaning that the residual terms should not be correlated. Durbin-Watson test was used to test this assumption. Based on the test results showing a value closer to 2, which mean that the residuals are uncorrelated, this assumption was met for the models in this study.

Final analytic models. All analyses, except the one testing the mediation effect, employed a two-level model in which the main purpose was to examine the contribution of classroom environments to the prediction of differences between classrooms in mean level of academic gains. Thus, in each model, the intercept was allowed to vary, while the slopes were not. It was assumed that the relationships between child variables (i.e., initial skill, gender, ethnicity, and child engagement in learning) and the outcome were the same across all the classrooms. Research rationale for each analytic model can be seen in Appendix D.

Examining the influence of classroom environment on academic achievement. Hypothesis I focused on the behaviors of the teacher and the teacher assistant and predicted that prekindergarten classrooms with higher levels of

instruction and a more positive affect would be associated with greater academic gains. A set of two-level models, nesting children within classrooms, was used to investigate the effects of instructional classroom practices and emotional tone of the classroom on variation between classrooms in average level of achievement. Selection of predictors for this analysis was guided by the underlying conceptual premise that child achievement is shaped both by instructional classroom practices and by emotional tone of the classroom. Support for this claim was found in the significant correlation between the measures of instructional practices and child achievement in the spring of prekindergarten year, as reported earlier in Table 9. Despite a non-significant correlation with the achievement scale, the observed emotional tone of the classroom also is included as a predictor based on the belief that it carries potentially relevant information about the characteristics of a classroom that is not otherwise captured in the observation-based instructional practices scale.

In the present study, the combined influence of the two classroom components was tested. The measures of instructional practices and emotional tone were found to be correlated with each other ($r = .42$, $p < .01$), as can be seen in Table 8. The significant association indicated that teachers offering relatively higher levels of instructional support tended to use warmer and more positive emotional tone while addressing children. In response to this observed association between the two classroom aspects, scores on instructional practices and emotional tone were combined into a single composite variable to test their conjoint influence.

The outcome variable in this analysis was children's end-of-prekindergarten academic achievement and children's initial academic achievement scores were entered as the first predictor in the model. Gain scores in this analysis are thus represented as residualized gains (outcomes not predicted solely from the pretest

value) rather than simple gain scores. In addition to children's initial academic skills, children's gender and ethnicity were included as covariates. The main predictor in this model was the global measure of classroom environments including scores on instructional and emotional aspects of each classroom. A weighted global environment score was created for each classroom. This measure took into account the independent relationships of instructional and emotional classroom aspects with the outcome. Unstandardized regression coefficients obtained in a multilevel model testing individual effects of the two classroom environments on the outcome were used to weight the contributions of instructional practices and emotional tone to the global measure of classroom environment (see Model I in Table 11). Indeed, scores on instructional practices and emotional tone were multiplied with the corresponding coefficient, and then added together to create the composite variable for the classroom environment.

Table 11 displays the unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance values for the independent effects of the classroom environments in Model I and for the combined effects of the classroom environments in Model II. Results of the independent effects model indicated that the relationship between emotional tone observed in a classroom and gains in academic skills was not significant while the association between the level of instructional practices and gains in academic skills approached significance. Thus, no evidence emerged to indicate that the average level of academic achievement for a classroom was associated with classroom/teacher level behaviors of the amount of instruction and the focus of instruction observed in the classroom or how positive the teacher's and the assistant teacher's emotional tones were while addressing children.

On the other hand, findings of the combined effect model showed that after controlling for fall achievement and the percentages of male and African American children, mean levels of achievement in the spring were higher in classrooms with a relatively heavier emphasis on instruction and a more positive emotional tone. Thus, the more supportive the classroom was, the greater the gains in academic skills were. Considering the results of the two models, it appears that in order to better estimate the magnitude of the effect of classroom environments on academic achievement, the use of a combined measure may be more beneficial than the use of measures of instructional and emotional classroom aspects individually.

It is worth further exploring the different ways in which classroom environments influence mean level achievement gains. Following this idea, another model in which the interaction term was added to test whether the effect of instructional practices is contingent on emotional tone of a classroom.

As indicated in Model III in Table 11, the main effects of instructional practices and emotional tone were non-significant, but the interaction effect of instructional practices and emotional tone was significant. In other words, the mean level of academic gains was predicted by a combination of instructional practices and emotional tone.

Table 11

Results for the Influence of Classroom Environment on Academic Gains

Fixed Effects	*b*	*SE*	*β*	*p*
Model I				
Instructional practices	0.10	0.06	0.08	.103
Emotional tone	0.18	0.27	0.03	.514
Model II				
Classroom environment[a]	1.00	0.44	0.10	.028
Model III				
Instructional practices	0.08	0.05	0.07	.136
Emotional tone	-0.10	0.24	-0.02	.662
Instruction×Emotion	1.37	0.31	0.17	.000

Note. Numbers in table are unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance levels. Covariates include child initial academic skills, gender, and ethnicity. [a]A weighted composite score is created to measure the global classroom environment.

Figure 1 was created to graphically demonstrate the relationship between instructional practices and mean level of residual gains in the presence of emotional tone of a classroom. A categorical variable was constructed for emotional tone, based on a median split. The blue line stands for the emotional tone below the median, while the green line represents the emotional tone above the median. As can be seen in the figure, classrooms providing higher levels of instructional support and relatively more positive emotional tone demonstrated higher levels of residual gains than those offering higher levels of instructional support, but less positive emotional tone.

The effect of instructional practices on residual gains is strengthened when the emotional tone is relatively more positive. The figure also shows the impact of emotional tone on mean level of residual gains to be larger for classrooms with higher level instructional support, compared to classrooms with lower level instructional support. In short, the effect of instructional practices on mean level of academic gains was larger in classrooms with more positive emotional tone.

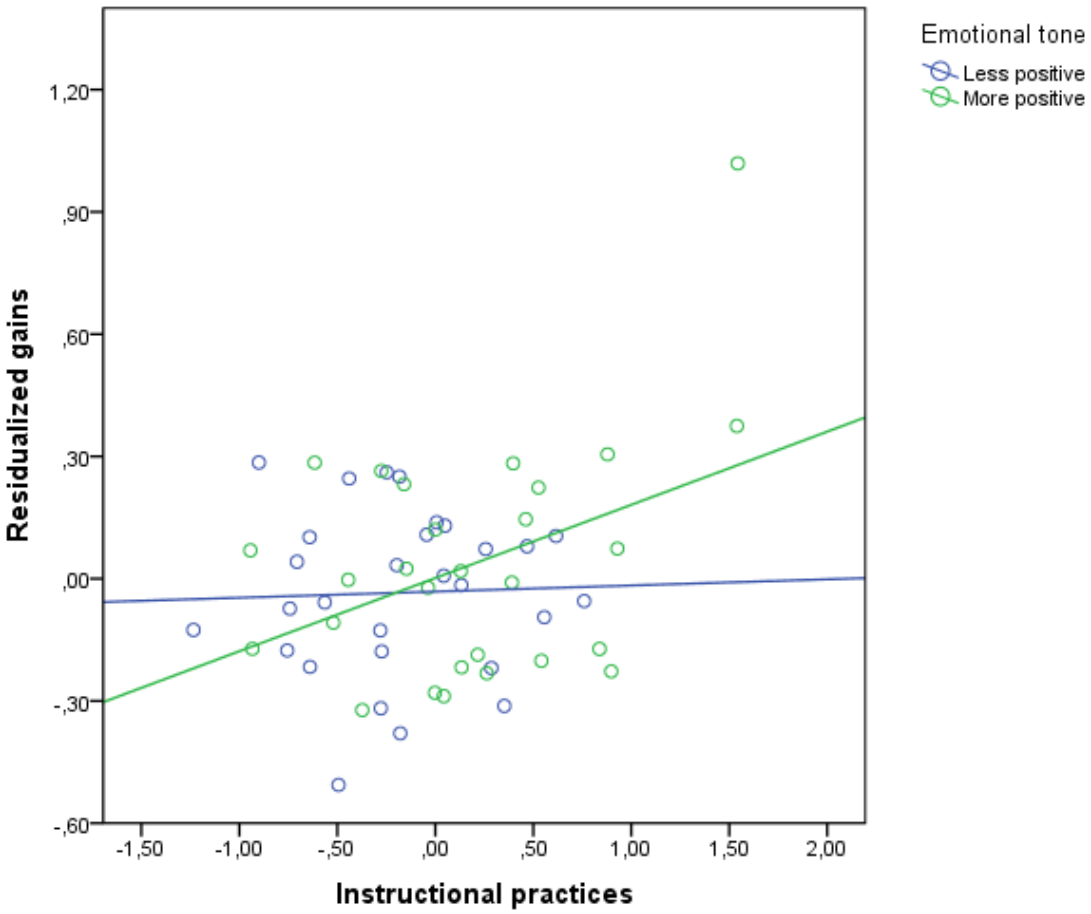

Figure 1. Interaction graph for instructional practices and emotional tone.

Considering the findings, Hypothesis I was supported as the combined influence of instructional practices and emotional tone on academic achievement was

examined or as the relationship between instructional practices and achievement was tested in the presence of emotional tone.

Examining the contextual effect of the amount of classroom learning engagement on academic achievement. Hypothesis II focused on the observed behaviors of the children in the classrooms and proposed that pre-kindergarten classrooms in which children were more often engaged in learning would have children with greater academic gains. A two-level model, nesting children within classrooms, was conducted in which variation between classrooms in average level of achievement was predicted from the amount of engagement in learning observed in each classroom. In this model, the purpose was to assess the classroom contextual effect of engagement through estimating the extent to which the magnitude of classroom-level relationship differed from the individual-level effect. Thus, the amount of engagement in learning was included at both the individual and the classroom-level to decompose the relationship between the amount of engagement and achievement gains into its within- and between-classroom components.

The outcome variable in this analysis was children's end-of-prekindergarten academic achievement and children's initial academic achievement scores were entered as the first predictor in the model. The predictor was the amount of engagement in learning included at both the individual- and the classroom-level. In addition to children's initial skills, covariates included in the model were children's gender and ethnicity. Children's gender, ethnicity, and initial skills were centered around their grand means. Thus, the estimated coefficient for the mean outcome (intercept) was adjusted for differences among classrooms in the percentages of male and African American children, as well as in the initial academic skills. On the other hand, the proportion of engagement in learning at the individual-level was centered

around its class mean; thus, the estimated coefficient (the slope of individual's proportion of learning engagement) for each group showed within class influence, controlling for the other level one covariates in the model.

Results of the multilevel analysis are presented in Table 12. A higher amount of classroom engagement in learning was related to larger gains in academic achievement, after separating out the effect of the individual's amount of engagement in learning relative to the mean in the respective classroom. Also, within a classroom, children who were more frequently engaged in learning had higher gains than those who were relatively less frequently engaged. Thus, Hypothesis II was confirmed.

Table 12

Results for the Influence of the Amount of Classroom Engagement on Academic Gains

Fixed Effects	*b*	*SE*	*β*	*p*
Child engagement	0.60	0.26	0.05	.020
Class engagement	0.92	0.39	0.10	.020

Note. Numbers in table are unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance levels. Covariates include child initial academic skills, gender, and ethnicity.

Examining the contextual effect of the complexity of classroom learning engagement on academic achievement. Hypothesis III also focused on the observed behavior of the children in the classrooms and predicted that pre-kindergarten classrooms in which children were engaged in learning at a more complex level would have children with greater academic gains. A two-level model, nesting children within classrooms, was conducted in which variation between classrooms in average level of achievement was predicted from the average complexity of

engagement in learning observed in each classroom. In this model, the purpose was to assess the classroom context effect through estimating the extent to which the magnitude of classroom-level relationship differed from the individual-level effect. Thus, the complexity of engagement in learning was included at both the individual and the classroom-level to decompose the overall relationship into its within- and between-classroom components.

The outcome variable in this analysis was children's end-of-prekindergarten academic achievement and children's initial academic achievement scores were entered as the first predictor in the model. The predictor was the complexity of engagement in learning included at both the individual- and the classroom-level. In addition to children's initial skills, covariates included in the model were children's gender and ethnicity. Children's gender, ethnicity, and initial skills were centered around their grand means. Thus, the estimated coefficient for the mean outcome (intercept) was adjusted for differences among classrooms in the percentages of male and African American children, as well as in the initial academic skills. On the other hand, the complexity of engagement in learning at the individual-level was centered around its class mean; thus, the estimated coefficient (the slope of individual's complexity of learning engagement) for each group showed within class influence, controlling for the other level one covariates in the model.

Results of the multilevel analysis are presented in Table 13. The more complex engagement in learning observed in a classroom was related to larger gains in academic achievement, after separating out the effect of the individual's complexity of engagement in learning relative to the mean in the respective classroom. Thus, classrooms offering activities that required more complex interactions with the environment had greater mean achievement gains than those

providing activities that involved relatively less complex participation in the environment. Also, within a classroom, children who were engaged in learning-related activities at a more complex level had higher gains than those who were engaged at a relatively less complex level. On the basis of these results, Hypothesis III was confirmed.

Table 13

Results for the Influence of the Complexity of Classroom Engagement on Academic Gains

Fixed Effects	*b*	*SE*	*β*	*p*
Complexity of child engagement	0.19	0.05	0.08	.000
Complexity of class engagement	0.32	0.15	0.10	.039

Note. Numbers in table are unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance levels. Covariates include child initial academic skills, gender, and ethnicity.

Examining the mediator role of the complexity of classroom engagement in learning on the relationship between classroom environment and children's academic gains. Hypothesis IV proposed that classroom engagement in learning at a more complex level would mediate the relationships between the level of support observed in the classroom environment and children's academic gains. Selection of the predictor for this analysis was guided by the underlying conceptual premise that instructional and emotional support in a classroom played a role in the complexity of learning engagement context of that classroom, which then predicted gains in academic outcomes. Thus, it was expected that high level instructional and emotional support in a classroom would increase academic achievement only to the extent that

this support facilitated the level of complexity in learning engagement in that classroom.

In the analyses, the outcome variable was classroom mean post achievement and classroom mean pre achievement scores were entered as the first predictor in the model. In addition to mean pre achievement scores, covariates included in the model were classroom mean percentages of male and African American children. The initial variable in this mediation was the general level of support in the classroom environment. The mediator was the complexity of classroom engagement in learning.

To establish mediation among these variables on the basis of the Baron and Kenny (1986) criteria, the following associations were investigated: (a) classroom environment was related to gains in academic skills (*path c*); (b) classroom environment was related to the complexity of classroom engagement in learning (*path a*); (c) the complexity of classroom engagement in learning was associated with gains in academic skills after controlling for global classroom environment (*path b*); and (d) the effect of general classroom environment on gains in academic skills was reduced or eliminated when the contribution of the complexity of classroom engagement in learning was statistically controlled (*path c'*). Empirical evidence for the hypothesized mediation effect is not defined in terms of statistical significance. Instead, it is stated in terms of zero and nonzero coefficients (Baron & Kenny, 1986).

In the mediation model proposed by Baron and Kenny (1986), *path c* indicates the total effect while *path c'* shows the direct effect. The product of *path a* and *b* shows indirect effect. The estimate of the indirect effect based on the study sample is used to infer that hypothesized mediation (a nonzero $\alpha\beta$) exists in the population. Evidence for that can be obtained through different tests. There are five approaches to statistical mediation analysis: (a) causal steps, (b) test of joint significance, (c) z

test of *ab*, (d) asymmetric confidence interval, and (e) bootstrap resampling (Stapleton & Beretvas, 2010). In the present study, asymmetric confidence interval approach was used to test the hypothesized mediation. In this approach, The Product of the Coefficients Confidence Limits for the Indirect Effects (PRODCLIN) program is used to test mediation (MacKinnon, Fritz, Williams, & Lockwood, 2007). The program computes confidence limits for the product of the two paths (*ab*) involved in the indirect effect. It provides an empirical distribution of z of the ab product. If the confidence interval estimated by the program does not include '0' it means that the mediation effect is significant.

Due to the features of multilevel data, the mediation can take different forms (e.g., *Upper level or Cross level mediation*). The mediation specified above is an *Upper level mediation* in which the effect of a group level predictor (classroom environment) on an individual level outcome (post composite achievement) is mediated by another group level predictor (complexity of classroom engagement) (Bauer, Preacher, & Gil, 2006; Krull& MacKinnon, 2001). For simplicity, the mediating effect of the complexity of classroom learning engagement was investigated at a single-level (i.e., classroom-level only). To test the paths described in the Baron and Kenny's mediation model, three multiple regression models were run. For consistency across models, individual level covariates (i.e., initial skills, gender, and ethnicity) were aggregated to the group level and used as covariates in the multiple regression analyses.

Results of mediation for classroom environment are presented in Table 14. As shown in Model I, the level of instructional and emotional support in the classroom environment predicted variation between classrooms in average level of post achievement after controlling for differences in initial academic skills, and

percentages of male and African American children (b = 1.01, p< .05, β = .23). Findings in Model II indicated that classroom environment was statistically related to the complexity of classroom engagement in learning after controlling for variation between classrooms in percentages of male and African American children, and initial academic skills (b = 1.48, p< .001, β = .50). As the independent effects of the global classroom environment and the complexity of classroom learning engagement investigated in the same prediction model, the effect of classroom environment on average achievement gains was reduced. However, the complexity of classroom engagement in learning was not statistically related to gains in academic skills after controlling for the contribution of the global measure of the classroom environment (b = 0.22, p< .10, β = .15). The estimate of the indirect effect (the product of 1.48 and 0.22) was 0.3256. The 90% confidence interval for the indirect effect was -0.09174 to 0.81213. Since this interval included '0' the mediation effect for classroom environment was non-significant.

Table 14

Results for the Mediating Role of the Complexity of Classroom Engagement on the Relationship between Classroom Environment and Academic Gains

Fixed Effects	*b*	*SE*	*β*	*p*
Model I: Mean Achievement				
Classroom environment	1.01	0.45	0.23	.030
Model II: Complexity of Classroom Engagement				
Classroom environment	1.48	0.36	0.50	.000
Model III: Mean Achievement				
Classroom environment	0.68	0.52	0.15	.194
Complexity of class engagement	0.22	0.18	0.15	.209

Note. Numbers in table are unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance levels. Multiple regression analyses are conducted. Covariates include classroom mean initial academic skills, and classroom percentages of male and African American children.

Examining the moderating effect of children's initial academic skills on classroom environment and academic gains. Following the primary analyses, the present study explored whether the effect of instructional and emotional classroom environments on achievement gains vary as a function of children's school entry skills. This exploratory question was guided by research indicating significant interactions between instructional and emotional aspects of a classroom and entry level characteristics children bring to the classroom. To test the moderating effect of children's initial academic skills on the relationship of the classroom environment with average academic gains, a two-level analysis was conducted.

The outcome variable was academic achievement in the spring of prekindergarten year. The predictor was the global measure of the classroom

environment. Children's initial skill level was used as the moderator variable in the interaction model. Also, while testing the moderating effect of initial skill level, the effects of children's gender and ethnicity on academic achievement were controlled. To build cross-level interaction between classroom environment and initial skills, the predictor variable at the classroom level and moderator variable at the child level were grand-mean centered by subtracting the original value from the overall mean of each variable. Then, in addition to main effects, the products of these centered variables were constructed to test interaction effects in the same prediction model.

Result of the moderating effect of children's initial academic skills on classroom environment and gains in academic outcomes are shown in Table 15. There was no evidence for differential effect of classroom environment on gain scores depending on children's initial academic skills. On the other hand, there were statistically significant main effects for classroom environment and initial academic skills. In summary, the impact of classroom support on achievement gains was not moderated by children's initial skills in the present study.

Table 15

Moderating Effect of Children's Initial Academic Skills on the Relationship of Classroom Environment with Achievement Gains

Fixed Effects	*b*	*SE*	*β*	*p*
Preachievement	0.94	0.03	0.82	.000
Classroom environment	1.03	0.45	0.10	.025
Preachievement x Environment	0.22	0.42	0.01	.595

Note. Numbers in table are unstandardized regression coefficients, standard errors, standardized regression coefficients, and significance levels. Covariates include child gender and ethnicity.

Summary

To test the four hypotheses, primary analyses examined the effects of instructional practices, emotional tone of the classroom, and the amount and complexity of classroom engagement in learning on gains in academic skills. It was hypothesized that higher level of instructional practices and a more positive emotional tone would be related to greater academic gains in prekindergarten classrooms. Neither instructional practices nor emotional tone exerted an independent effect on average level of achievement. However, it was found that the combined measure of instructional and emotional aspects of a classroom was predictive of classroom achievement gains. Also, it was observed that the strength of the relationship between instructional classroom practices and achievement gains was dependent on the level of emotional tone. Classrooms offering higher level instructional support in conjunction with more positive emotional tone had greater mean achievement gains. As hypothesized, classrooms in which children were more often engaged in learning activities had children who gained significantly more on academic achievement measures. In addition, the complexity of the learning engagement in a classroom

significantly predicted variation between classrooms in average level of achievement. It was also hypothesized that classroom engagement in learning at a more complex level would mediate the relationship between classroom environment and children's academic gains. However, no statistically significant mediated effect was detected, thus this hypothesis was not supported. Furthermore, the moderating effect of children's initial academic skills was investigated in the present study. Results indicated that the effect of classroom environment on achievement outcomes was not moderated by children's entry skills.

CHAPTER V

Summary, Discussion, and Conclusions

The purpose of this study was to investigate relationships between instructional practices, emotional tone in the classroom, classroom levels of children's engagement in learning, and the average level of achievement in prekindergarten classrooms serving children from economically disadvantaged backgrounds. First, the effect of instructional and emotional environments on gains in academic achievement across the prekindergarten year was examined. Then, the effects of the amount and the complexity of children's engagement in learning at the classroom level on gains in academic skills were investigated. Finally, the mediating effect of the complexity of classroom learning engagement on the relationship between instructional and emotional classroom environment and academic achievement was examined. This study also sought to explore the moderating effect of children's initial academic skills on the relationship between instructional and emotional classroom environment and academic achievement. This chapter presents a summary of the analytical results, a discussion of the findings, and a description of the strengths and limitations of the study.

Summary of Results

The nature and effectiveness of aspects of the classroom were examined in 57 prekindergarten classrooms. Classroom observation measures concerning how much

of the four-hour classroom morning time was devoted to instructional activities and what kind of learning skills the teacher and the teacher assistant facilitated in children during instructional activities, as well as how positive the teacher and the teacher assistant were, provided information about the classroom environment. Child observation data collected during the four-hour morning observation time were also used to assess children's classroom experience from their point of view by focusing on classroom-level averages of the amount and the complexity of children's engagement in learning-related tasks. Classroom-level gains on achievement tests from fall to spring of the prekindergarten year were used as indicators of change in children's academic competency in prekindergarten. The differences among classrooms in the percentages of male and African American children, as well as the initial academic skills were controlled in all analyses.

The effect of the classroom environment on academic gains. Hypothesis I focused on the behaviors of the teacher and the teacher assistant and predicted that higher level instructional practices and a more positive emotional tone in pre-kindergarten classrooms would be associated with greater academic gains. Neither instructional classroom practices nor emotional tone exerted independent effects on mean achievement gains. However, the combined measure of instructional practices and emotional tone was predictive of achievement gains. Furthermore, the interaction of instructional practices and emotional tone with mean achievement gains was statistically significant. Thus, the effect of instructional classroom practices was contingent on the emotional tone of the classroom. The level of observed instructional practices had larger effects on mean level of achievement in classrooms with more positive emotional tone. Thus, this hypothesis was confirmed.

The effect of classroom learning engagement on academic gains. Hypothesis II and III focused on the observed behavior of the children in the classroom. These hypotheses dealt with the contributions of the amount and the complexity of classroom learning engagement to academic achievement. Two models pertaining to the effect of classroom learning engagement on achievement were tested. Both hypotheses were confirmed on the basis of the two models. The results showed that higher total amounts of and more complex classroom levels of children's engagement in learning were each related to higher levels of achievement. The present study extends existing work by showing the predictive role of not only the amount, but also the complexity of learning engagement in achievement gains in prekindergarten at both the individual and the classroom level.

The mediating effect of classroom learning engagement on the relationship between the classroom environment and academic gains. Hypothesis IV proposed that classroom levels of children's engagement in learning at a more complex level would mediate the relationship between the classroom environment and children's academic gains. It was assumed that instructional practices and emotional tone observed in a classroom facilitated more complex engagement in learning, which then predicted gains in academic outcomes. Test results for the hypothesized mediation effect indicated non-significant mediation for the effect of the classroom environment on achievement gains. Thus, this hypothesis was disconfirmed.

The moderating effect of children's initial academic skills on the classroom environment and academic gains. Following the primary analyses, the present study sought to examine the moderated effect of the classroom environment.

It was conjectured that children's initial skills could moderate the relationship between the level of support in the classroom environment and average gains in achievement. The idea was that the direction and/or the magnitude of effects of the classroom environment on academic achievement might depend on children's initial academic skills. The findings indicated that children's initial skill levels did not have significant impact on the relationship between the general classroom environment and achievement gains.

In summary, results from the present study indicated that higher levels of instructional practices and a more positive emotional tone in combination were related to average academic gains. There is also evidence to conclude that both a higher amount of and more cognitively complex classroom levels of children's engagement in learning led to significant improvements in academic skills of prekindergarten children from economically disadvantaged backgrounds. However, neither mediated nor moderated effects of the classroom environment on academic achievement were found in the present study.

Discussion

This study used observed measures of classrooms and children to examine the nature and effectiveness of classroom environments in 57 prekindergarten classrooms. Elements of classroom experience were considered in relation to growth in children's academic competencies, which were measured through pre and posttests on standardized and non-standardized measures of literacy, math, and language skills. This study adds to the growing body of work by systematically investigating quantifiable descriptive information about instructional practices, emotional tone, learning engagement, and changes in children's academic competency in

prekindergarten classrooms serving children of low-income parents. Most importantly, this study establishes links between classroom environments and learning engagement in the context of the classroom and child outcomes. Implications of findings are discussed below.

The results of this study highlighted a number of important points to explore further. First, the descriptive information on measures of classroom environment (i.e., instructional practices, emotional tone and classroom levels of children's engagement in learning) are discussed in the following paragraphs. Then, the contributions of each to academic achievement are discussed. Furthermore, the influence of instructional and emotional environments on classroom levels of children's engagement in learning is interpreted.

Instructional environment. Consistent with recent views of effective teaching as involving cognitively rich instruction (Connor et al., 2004b; Crosnoe et al., 2010; Curby et al., 2009; NICHD ECCRN, 2004), level of instructional support in this study was measured with the combination of the amount of classroom time spent on instruction and child-centered activities, the amount of teachers' and teacher assistants' involvement in instructional activities, and the level of focus on the improvement of analytic and inferential thinking in their instruction. With respect to observed practices, the relatively low level of instructional support was observed in some study classrooms.

Classrooms varied widely in how much of the four-hour observation time was devoted to different modes of instructional activities, while they looked similar in the focus of their instruction. In some classrooms, time was used effectively and almost 70% of the observed time was spent on instructional activities. In others, however, only 36% of the time was devoted to instruction. Classrooms spending less time on

instruction occupied children with non-instructional activities, such as meals, waiting for the next activity, lining up for lunch or bathroom, or with special area classes. Thus, in such classrooms, it would be hard to observe high amount of engagement in learning, and as a consequence perhaps, high level of achievement gains.

Also, in some classrooms, half of the activity observed was organized as child-centered instruction; in others almost none of the activities observed could be coded in this type of instruction. Classrooms that did not offer many child-centered activities used teacher-directed instruction during activities identified as instructional. Thus, in such classrooms, teachers did not allow children to have much freedom to choose their activities. According to Perry et al. (2007), appropriate early childhood education requires teachers to know individual learners in their classrooms and to be able to make adjustments in their instruction to create responsive, supportive, and appropriately engaging environments. Teachers using appropriate practices appear to know that different forms of instruction are better suited for achieving different goals (Stipek et al., 1995), and children with varying skills can benefit more from different forms of instruction (Perry et al., 2007). Thus, these teachers are characterized as offering a blend of teacher-directed and child-centered activities in their classrooms. Some of the prekindergarten teachers observed in the present study seemed to fit this picture.

Teachers' frequent interactions with children for the purpose of intentional teaching are also an important aspect of a supportive classroom environment (Curby et al., 2009; NICHD ECCRN, 2004). In the present study, on average, only 33% of the observed teacher behavior could be coded as involvement in active purposeful teaching, while only 13% of the observed teacher assistant behavior could be categorized as involvement in instructional type tasks. Instead, teachers in this study

were more likely to be involved in administrative tasks, such as paperwork and attendance, managerial tasks, such as lining up children, behavior management, personal care, passively observing the classroom, social talk, or they demonstrated no engagement with the activities, materials, or children. Teachers, in the present study, were relatively infrequently observed interacting, talking, playing with, or questioning children with materials and a content focus. Thus, there appeared to be a surprisingly low level of teacher support for children's learning in these classroom settings.

Furthermore, the present study investigated the focus of the instructional tasks provided by teachers and teacher assistants. Findings showed that when an average teacher or teacher assistant provided instructional activities, she focused on the development of low to basic skills in the children. Even in the classrooms where children made more progress, children were mostly exposed to basic skills instruction. Investigating the focus of instruction in prekindergarten classrooms, this study confirms the findings from observations in elementary schools that children are exposed to basic skills instruction far more than they are to analysis-inference instruction (Curby et al., 2009; NICHD ECCRN, 2005).

All these findings indicate that children in early education are exposed to an instruction that requires them to memorize and master facts so that they can successfully recall information. This may be explained by the demands of the curriculum used in pre-kindergarten to first grade. Children need to master certain skills, such as knowing the alphabet, sight words, and counting up to 10, in order to proceed to the next grade. However, the curriculum in later grades asks children to synthesize, analyze, and criticize the information. Thus, in order to achieve some goals, teachers may feel pressure in the early grades to use explicit teaching of basic

skills; however, a merely basic-skills oriented instruction in early education is unlikely to promote children's success later in school.

Prior research also showed that children from disadvantaged backgrounds benefit from explicit teaching of basic skills in kindergarten to third grade (Gersten et al., 1988), but not all children require this type of instruction to improve their skills. More recent research has shown that dependent on children's background characteristics, the direction of the effect of basic-skills oriented instruction on learning outcomes changes (Connor et al., 2004a, 2007; Crosnoe et al., 2010). Low achieving children from economically disadvantaged backgrounds made more improvement in basic literacy and math skills in classrooms offering analytic-inferential instruction (Crosnoe et al., 2010; Curby et al., 2009). Taken all together, instructional support in prekindergarten classrooms is a complex issue, and teachers will likely have to make appropriate decisions based on the needs of each child.

In regard to the present study, all the findings describing the instructional classroom environment suggest that instructionally supportive teaching was not reflected in most of the classrooms' day-to-day practices. However, as Hamre and Pianta (2005) mentioned, quite small increases in instructional practices can produce significant gains in academic skills of young children. In the present study, a significant correlation between the level of instructional support and children's post achievement was observed, but no independent effect of instructional practices on children's academic gains was found. This finding could have resulted from the relatively low levels of instruction observed in this study.

Emotional environment. In addition to the level of instructional support, the level of emotional support offered to children is identified as another classroom aspect that describes children's classroom experiences (Rudasill et al., 2010). In the present

study, the measure of emotional tone was used as the indicator of emotional environment in the classroom. On average, the teachers and the teacher assistants showed a neutral affect while interacting with children. It seems teachers in the present study avoided showing noticeable affect that could result in any positive or negative influence on children. Also, limited variability among classrooms in the level of emotional tone was observed. Within this limited range, the ratings varied from a negative to a pleasant tone. This resulted in a non-significant relationship between emotional tone and children's post achievement in the present study.

Learning engagement. In this study, the amount of engagement in learning ranged from 21% to 75% across individual children and 28% to 70% across classroom averages. This shows that some children were less likely to be engaged in learning, while others were relatively more likely to be involved in learning. In regard to the general engagement shared across class members, the percentage of observed engagement in learning was quite high in some classrooms, and extremely low in others.

Ratings of the level of complexity in learning engagement ranged from 3.78 to 6.13 on a 7 point scale across children. Classrooms also varied in average ratings related to the complexity of engagement in learning, ranging from 4.77 to 5.70. One expects large differences among children, but the range observed across classrooms in the present study seems unexpectedly large. It shows an enormous variability among classrooms that in turn, creates variability in the classroom experiences across children.

The contribution of instructional and emotional environments to academic achievement. Depending on the choice of the analytic model, variability

in the experiences offered to children was found to be related to children's gains in academic skills from fall to spring of the prekindergarten year. Before making any conclusions, it is important to discuss the ways to investigate the influences of instructional and emotional classroom environments on children's academic outcomes.

It appears that when the impacts of instructional and emotional climates of a classroom are considered together, they have stronger associations with the achievement outcomes compared to the findings of studies testing their effects separately. Similar to prior research indicating a relatively stronger effect for instructional practices than emotional tone on academic achievement in the prekindergarten year (Howes et al., 2008; Mashburn et al., 2008), in the present study, the observed impact of instruction on achievement was stronger than that of emotion as the independent contributions of the two classroom environments were examined in the same prediction model. However, none of these predictors exerted a statistically significant effect on academic gains. Non-significant findings could have resulted from the limited range in emotional tone observed in this study. Also, the correlation between the measures of instructional practices and emotional tone could prevent us finding a significant independent influence of either component on achievement. Thus, it is necessary to find alternative ways to investigate the impacts of these environments on children's learning.

One alternative can be testing the combined effect of the two classroom aspects. Results from this study indicated that the global measure of environment combining instructional and emotional assessments of the classroom context significantly predicted gains in academic achievement. This finding is similar to one obtained by Perry et al. (2007). Perry et al. found that gains in children's math

achievement across first grade were higher in classrooms with a heavier emphasis on cognitively rich instruction, greater emotional support, and an establishment of clear but flexible rules and routines. There are at least two differences between the current study and the Perry et al.'s study. Perry and her colleagues assessed the environment in first grade classrooms, while the current study observed prekindergarten classroom environments. Also, Perry and her colleagues showed the impact of classroom environment only on math achievement, but the present study extends this finding by showing the impact of instructional and emotional classroom climates on a composite measure of academic achievement including assessments of language, literacy, and math. Thus, these prekindergarten classrooms in which teachers effectively used classroom time, supported child freedom and choice of activities, were frequently involved in instructional activities with children, supported the development of higher order thinking in children, as well as used a more positive tone while interacting with children fostered children's language, literacy, and math skills.

This finding indicates that individual measures of instructional and emotional climate each carry potentially relevant information about the characteristics of a classroom that is not otherwise captured in one or the other measure. Thus, in order to better understand the relationship between classroom experiences and children's developing academic competencies, the impacts of instructional and emotional classroom components need to be considered together rather than being compared with each other.

Another way to test the effects of environments on learning outcomes is to examine the interaction between instructional practices and emotional tone. It was found that the impact of instructional practices on academic achievement was strengthened by the presence of a more positive emotional tone. The effect of

instructional practices on average academic gains was larger in classrooms with more positive emotional tone. Children in classrooms providing higher levels of instructional support and relatively more positive emotional tone demonstrated the highest levels of gains. On the other hand, children in less positive environments did not appear to benefit from the high-level instructional support provided to them. This finding supports the claim that young children who are dealing with the academic and social demands of schooling may feel more secure and confident in classrooms with more positive affect, and consequently benefit more from instructionally rich environments (Hamre & Pianta, 2007).

This interpretation is also suggested by earlier findings of Stipek and her colleagues (1995, 1998) indicating that compared with classrooms providing basic skills instruction in a less positive environment, those offering more child-centered cognitively rich instruction in a more positive environment were more effective in improving children's math and language skills in both the short- and long-term. However, the Stipek studies did not investigate the effects of cognitively rich instruction in a less positive environment or basic-skills instruction in a more positive environment. On the other hand, the present study investigated the whole spectrum and found that classrooms offering higher levels of instructional support in a more positive environment had greater mean achievement gains than those providing higher levels of instructional support, but in a less positive emotional environment.

The findings of these alternative analyses suggest that researchers examining environmental effects need to collect information about both the level and the amount of instruction teachers are delivering and the affective nature of the classroom in order to predict gains in achievement. The debate in the literature about which classroom

aspect was more important is not helpful – both are important, but only if they are examined together.

The contribution of instructional and emotional environments to learning engagement. Another body of work on classroom environments has focused on the influence of varying classroom components on children's learning behavior patterns. One such behavior is children's engagement in learning in the context of the classroom. Given that children construct knowledge in interaction with the physical and social world, there is a strong conceptual justification for designing classroom environments that not only permit but also foster children's active engagement in learning-related activities. The present study provides empirical evidence in support of that claim. In regard to relationships between classroom features and the level of complexity in learning engagement shared among the class members, this study found that classrooms with a stronger focus on instruction in conjunction with more positive affect had children who exhibited more complex engagement in learning. This finding suggests further that the level of support for children's active engagement in learning in a classroom environment can be used to assess program effectiveness in improving children's achievement (Chien, 2010; Ridley et al., 2000).

This result somewhat corroborates other findings studying children at different ages and using different observation measures of engagement. Indeed, prior research showed higher co-occurrence between the analysis-inference instruction and individual children's engagement in learning in third grade (Downer et al., 2007) and an advantage of child-centered instruction over teacher-directed instruction in the levels of child engagement during activities in child care settings (de Kruif et al., 2000; McWilliam et al., 1985). Studying toddlers, Raspa et al. (2001) found that children in classrooms offering child-centered instruction spent more time in

sophisticated engagement involving behaviors, such as problem solving, the use of language and pretend play, and manipulating objects to create or build something. As in the present study, these studies used observation measures to assess children's engagement. Employing a more complex measure of engagement the present study, however, provides a richer picture of how children are engaged in the classroom environment.

In the existing body of work on engagement in early childhood, some researchers studied children's percent of engaged behavior (e.g., Downer et al., 2007), while others measured complexity (e.g., Kontos & Keyes, 1999; Raspa et al., 2001). For example, Kontos and her colleagues categorized children's interactions with materials on the basis of type of task in which the child was engaged (e.g., Kontos & Keyes, 1999). McWilliam and his colleagues created a single observational code to capture the intensity of engagement and the type of task in which the child is engaged. In the present study, the intensity and the type of task were separately coded and then combined together to measure the level of complexity. This process created more differentiated codes for complexity of engagement. This means that the highest ratings were given to the instances in which children were more intensely involved in more demanding tasks. Relatively lower ratings were given to the instances in which children were less intensely involved in tasks that might have been just as demanding. Thus, even though the task was demanding in both instances, the complexity score changed as a function of the level of intensity children demonstrated while engaging in the task. The complexity score also differed therefore between instances in which the level of intensity was the same, but the task demands were different. Employing an observation measure that provided a richer picture of patterns of children's engagement may help us to better identify classroom aspects that promote certain

engagement behavior, which in turn, could contribute to improved academic outcomes.

The contribution of learning engagement to academic achievement. This study showed that higher amount of and more complex learning engagement of a classroom predicted enhanced achievement. But it is not just classroom levels of children's engagement in learning that appeared to contribute to academic achievement in this correlational study. This study also found that children who were engaged in learning more frequently and/or at a more complex level gained more than their peers in the same classroom who were engaged in learning less frequently and/or at a less complex level. These results are in line with the findings of previous studies of elementary school children (Alexander et al., 1993; DiPerna et al., 2005; Hughes & Kwok, 2007; Ladd et al., 1999). Ladd et al. (1999) found that children who had higher teacher ratings on self-directed and cooperative participation in classroom activities had higher scores on school readiness tests in kindergarten. Also, Pakarinen et al. (2011) found that teacher-rated task-focused behavior averaged for the class was related to average level of math achievement in kindergarten. This research of somewhat older children tended to use teachers' ratings to measure the level of engagement at the individual level. The present study extends this evidence with teacher ratings by providing more direct assessments of children's engagement behavior at both the individual and the classroom level. Observational measures of child engagement locate more precisely the processes that account for the observed effects.

Implications for Policy and Practice

This study described instructional and emotional classroom environments, as well as learning engagement context in which children were involved and explored whether variability in the classroom experiences offered to children was related to children's gains in academic skills from fall to spring of the prekindergarten year. Extant research on environmental assessments has guided teachers' attention to the physical and interactional aspects of their classrooms. Results from the present study might encourage teachers to evaluate the learning engagement context of their classrooms by looking at children's behavior, and in turn, translating this knowledge into instructional decisions to provide opportunities for individual children to practice the skills they need to improve, as well as for the entire group to focus more intensely on cognitively challenging tasks.

Teachers, educators, and policy makers need to consider the factors in the early education system that prevent the existence of more classrooms offering high-level instructional and emotional support for children. Early childhood teachers are increasingly pressured by the federal and state mandates, as well as demands of the school districts and Head Start for having children ready for formal schooling. They try to accomplish many things in a short period of time. Within a morning, they schedule many activities to teach children school readiness skills. Perhaps because the teachers do not have adequate time, their instruction does not involve deeper, well-designed activities. Their focus is on the improvement of basic skills in children. Also, in Head Start programs, teachers deal with enormous amount of paper work. In such a pressured atmosphere, teachers cannot have the opportunity to allow children to have some freedom and choice, to have frequent involvement in active teaching, or to foster analytic-inferential thinking along with basic skills. They cannot be

responsive and sensitive about individual children's needs. Results from the present study, however, suggest that children benefit most from classroom environments in which teachers provide high-level instructional support with a positive affective tone.

Strengths

One of the great strengths of the present study is both its focus on classroom processes and its focus on children's behavior. The majority of research studies on classroom experiences investigated the context from a global point of view. They assessed the context through teachers' instructional and affective behavior. However, it is also important to observe children's lived experience in the classroom. Thus, the present study contributes to the literature through observing the classroom experiences from not only the teachers', but also the children's points of view and examining the effects of both on learning outcomes.

Further, the present study provides an effective measure of classroom environment that looks beyond instructional and emotional features of the classroom environment and provides information on children's shared classroom experiences, as well as mastery of skills. Focusing directly on children's behavior and experiences, this classroom engagement measure not only more precisely discriminates between levels of cognitive complexity involved in the engagement behavior shared among children in a classroom, but also provides a new environmental assessment tool as a supplement to global measures focusing on teachers' behavior.

The measures of instruction in this study not only focused on global ratings of classroom experiences, but also focused on detailed descriptions of teacher behavior. Such observations provided an opportunity to differentiate the amount of time a

teacher was engaged in instruction from the instructional time observed in her classroom. By separating out the amount of teachers' involvement in instruction from the amount of class time spent on instruction, this study provides a more reliable estimate of total time teachers' instructional interactions with children.

Furthermore, the present study not only observed lead teachers' instructional and emotional behavior, but also focused on the same behaviors in teacher assistants. Prior studies described classroom environments only through the lead teacher's point of view. However, teacher assistants also interact with children and thus, contribute to the instructional and emotional environments in a classroom. By using different sources to globally depict the classroom context in which young children experience learning, the present study extends the prior work and captures more aspects of the environment to which the children were exposed.

Revealing a significant interaction between classroom instruction and affective tone, this study contributes to the literature. Studies on these classroom aspects examined either independent or combined effects of instructional and emotional classroom environments. Some investigated their interaction with children's risk status for academic failure. Yet to my knowledge, none has examined the effect of instruction on children's achievement outcomes in the presence of affective tone.

Limitations

Sample. One of the limitations of the present study is the use of a small sample size (N=57) given its focus on classroom effects. A larger sample size might have revealed stronger effects with respect to the instructional and emotional classroom environments. Another limitation related to the sample is the lack of

sufficient diversity among children and among teachers. A majority of the children in the study were African American and all were from economically disadvantaged backgrounds. They attended either Head Start centers or public prekindergarten classrooms located in a major metropolitan city in Middle Tennessee. The results cannot be generalized beyond this population of students. Results might be different among children from other economic backgrounds, among children located in private child care settings, or among children located in different regions of the state or country.

Number of observations. Classrooms were observed three times in pre-kindergarten year. It would be preferable to observe classrooms for more days, thereby increasing the reliability of measurement of classroom experiences.

Observational data. Because observations of children and teachers were multiple but brief, this system could have missed times in which children or teachers were engaged in learning activities. A more comprehensive measure of child and teacher behavior with more snapshots might have provided a different profile of classroom-level engagement.

The same observer recorded the teacher and child behaviors within a classroom visit, so shared source may account for some of the associations found between some of instructional practices and emotional tone and learning engagement. Concern about this is somewhat lessened by the fact that different observers visited the classrooms for the three sessions and thus observer bias from session to session was reduced. Within a single observation, however, observers might not be able to distinguish teacher behavior from child behavior.

Assessment measures. The achievement measures included in the present study might not capture the depth of learning in preschool age children. Standardized measures used to assess change especially in children's mathematical and literacy competencies across the year have limited number of items in the expected response range. More sensitive measures of children's understandings designed for use with this age group might reveal different patterns of competencies than did the standardized assessments used in this study.

Conclusions

This dissertation sought to examine the impacts of the level of instructional and emotional support in the classroom environment and the engagement context of the classroom on children's achievement gains within the prekindergarten year. Analyses were conducted to test the combined impacts of instructional and emotional classroom environments on achievement gains. Next, the impacts of the amount and the complexity of classroom learning engagement on average achievement gains were examined in separate prediction models. Then, the mediating role of the complexity of learning engagement on the relationship between the classroom environment and the achievement gains was investigated. In addition to the hypotheses, this dissertation explored the moderating effect of children's initial academic skills on the relationship between the classroom environment and academic achievement.

Results indicated that neither instructional practices nor emotional tone exerted independent effects on achievement, although the separate effect of instructional practices approached significance. On the other hand, instructional and emotional classroom environments in combination were related to average academic

gains in classrooms. Also, it was found that the effect of instructional climate on achievement gains was strengthened in the presence of affective tone. The high-level instructional support had the largest impact on academic gains in classrooms characterized with more positive emotional tone. This study suggests the use of combined measure of environment in order to better assess the effect of environment on children's learning outcomes. Also, examining the interaction between instructional and emotional environments of the classroom this study may provide valuable information on the interplay between the two classroom components.

Variability in the amount of learning engagement across individual children within a classroom and across classrooms was related to learning across the year. But it is not just the amount of engagement in learning that appeared to contribute to academic achievement in this correlational study; more complex learning engagement predicted enhanced achievement at both the individual- and the classroom-level. Given a direct relationship between classroom learning engagement and child outcomes, this study suggests the use of children's experiences in the classroom as a measure of learning context, and emphasizes the need for teachers of young children to continually evaluate classroom experiences from children's points of view.

The results of mediation analyses indicated that instructional and emotional support of a classroom in combination was predictive of complexity of classroom engagement, as well as classroom achievement gains. As mentioned above, the complexity of classroom engagement was also related to the mean level of academic achievement. This study provides valuable information on the potential mediating role of the learning engagement in the relationship between classroom environments and academic outcomes.

The results of the moderation analysis showed that the children's level of achievement at the beginning of prekindergarten had no significant impact on the association between classroom environment and gains in academic skills. Thus, the influence of certain patterns of classroom contexts on learning outcomes was same across low and high achieving children in the present study.

This study identified analyzing classroom effects and measuring learning engagement as major issues. The strength of the study included its measures used to evaluate classroom instruction and engagement. The limitations of the study involved the homogeneity of the sample, and some design and measurement issues.

There are several directions future research might take to extend the present work. This study has contributed a new way to examine the complexity of children's engagement with learning materials in prekindergarten classrooms, one that takes into account both the cognitive demands of the learning activity and the intensity of the child's involvement. Future research might examine the complexity of children's learning activities in even more depth. For example, researchers could develop a more comprehensive measure that assesses many types of higher order skills, such as understanding the order of precedence in problem solving, making plans, and use of language with accuracy and clarity. This kind of measure might involve focusing longer on a child's behavior than the snapshot approach used in the current study.

Finally, future research can build on this essentially correlational study to determine if the teacher and assistant instructional and emotional behaviors can be experimentally manipulated. Are these behaviors changeable? If so, perhaps interventions can be developed to alter these important classroom characteristics to produce the kinds of achievement gains desired for these very vulnerable children.

Appendix A

Narrative Record of Preschool Classroom Observations

Teacher/class ID_____

Start Time	**Brief description** (child and teacher)	**Activity Type:** WGT, WG, SG, SGT, Center, SGCenter, SGTCenter, Meal, MOR, Out, TRN, TOR	**CODE for Content:** M, R, LA, Sc, SS, A/M, MIX, None

Appendix B

Teacher Observation in Prekindergarten Classrooms- Building Blocks

Teacher Observation in Prekindergarten Classrooms- Building Blocks (TOP-BB) | Page

Place teacher label here.	Date		
	Observer		
	Start Time	End Time	

X out	No Yes Listen	No Talk Child Sm Grp Wh Grp Self Parent Teacher Ext Adlt	WG SG Centers SGC Transition MealTime Other	Adult Child SG SGT WG WGT Self CT	Instruction AssessT MAnage Behavior Approving Dissapp. Pers/ Care MOnitor ADmin SOCial None	0 none 1 low 2 skills 3 inf 4 hi inf	Math Literacy SCIence Soc. Studies Toy Art / Music Dramatic Computer Gross Motor TV / video Can't Code None	Math Literacy SCIence Soc. St Other None	Vibrant Pleasant Flat Negative Extreme Neg

Subscripts
* Building Blocks
~ Worksheet
= Out of Room

Time	Sw	Verbal	To Whom	Sched. #	Prox	Task	Level of Instrct.	Materials * ~	Focus *	Tone/ Affect
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

Appendix C

Child Observation in Prekindergarten Classrooms - Building Blocks

Child Observation in Prekindergarten Classrooms- Building Blocks (COP-BB) Page

Place child label here.	Date	
	Observer	
	Start Time	End Time

X out

No
Yes
Listen
FasCry

Teacher
Child
SmGrp
SGT
WhGrp
WGT
Self
No Talk

WG
SG
Centers
SGC
Transition
MealTime
Other

Teacher
Child
SG
SGT
WG
WGT
Self

Non Acad
Parallel
ASsoc
Coop
ALone
Onlooker
SOCial
Unocc
TimeOut

Pass Inst
Non Seq
SeQ
Fantsy Dr
None
Other
SOCial
Disruptive
TimeOut

High
Med H
Med
Med L
Low

Math
Literacy
SCience
Soc. Studies
Toy
Art / Music
Dramatic
Computer
Gross Motor
TV / video
Can't Code
None

Math
Literacy
SCience
Soc. Stud.
Other
None

Subscripts
* Building Blocks
~ Worksheet
≠ Out of Room

Time	Sw	Verbal	To Whom	Sched. * #	Prox.	Interact.	Type Task	Involv.	Materials * ~	Focus *
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									

Appendix D

Analytic Models

Models Testing the Effect of Instructional and Emotional Classroom Environments on Achievement Gains

To test Hypothesis I, three different multilevel models were run.

Independent effects model. Two sets of equations were used to model the independent effects of instructional practices and emotional tone on the outcome. The equation at level-one was written as

$$PostAchievement_{ij} = \beta_{0j} + \beta_{1j}(\mathrm{Pr}eAchievement) + \beta_{2j}(Gender) + \beta_{3j}(Ethnicity) + r_{ij}.$$

The level 2 (classroom level) equation was specified as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Instructional\ \mathrm{Pr}actices) + \gamma_{02}(EmotionalTone) + u_{0j},$$

$$\beta_{1j} = \gamma_{10},$$

$$\beta_{2j} = \gamma_{20},$$

$$\beta_{3j} = \gamma_{30}.$$

In these equations, $PostAchievement_{ij}$ was the individual child achievement at the end of prekindergarten. $\beta_{1j,}\beta_{2j,}$and β_{3j} were the nonrandom, fixed, individual level covariate effects for initial skills, gender, and ethnicity, respectively. The effects of these covariates on post achievement were not hypothesized to randomly vary across classrooms so their coefficients remained constant across level 2 units. $\beta_{0j}$was mean child achievement in the spring of prekindergarten for classroom *j* after controlling for

initial skills, gender, and ethnicity. In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the instructional classroom practices γ_{01}, emotional tone γ_{02}, and a random component u_{0j}. Since child gender, ethnicity, and initial skills were centered around their grand means at level-1, the grand mean of the outcome (γ_{00}) was adjusted for differences among classrooms in the percentages of male and African American children, as well as in the initial academic skills. The instructional classroom practices and emotional tone components indicated whether these classroom characteristics added a significant amount of predictive value over the grand mean. The r_{ij} and u_{0j} coefficients were the individual and group level residuals, respectively.

Combined effect model. The level-1 equation used to test the combined effect of instructional and emotional classroom environments is same as above. The level 2 (classroom level) equation was specified as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(ClassroomEnvironment) + u_{0j},$$

$$\beta_{1j} = \gamma_{10},$$

$$\beta_{2j} = \gamma_{20},$$

$$\beta_{3j} = \gamma_{30}.$$

In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the global measure of classroom environmentγ_{01}, and a random component u_{0j}. Since child gender, ethnicity, and initial skills were centered around their grand means at level-1, the grand mean of the outcome (γ_{00}) was adjusted for differences among classrooms in the percentages of male and African American children, as well as in the initial academic skills. The predictive value of the global

measure of classroom environment over the grand mean was tested in this model. The r_{ij} and u_{0j} coefficients were the individual and group level residuals, respectively.

Interaction effect. The level-1 equation used to test the combined effect of instructional and emotional classroom environments is same as above. The level-2 equation was written as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Instructional\ Practices) + \gamma_{02}(EmotionalTone) + \gamma_{03}(Instructional\ Practices \times EmotionalTone) + u_{0j},$$

$$\beta_{1j} = \gamma_{10},$$

$$\beta_{2j} = \gamma_{20},$$

$$\beta_{3j} = \gamma_{30}.$$

The explanation of the level-one model was provided above. In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the instructional classroom practices γ_{01}, emotional tone γ_{02}, the interaction between instructional practices and emotional tone γ_{03},and a random component u_{0j}. Since child gender, ethnicity, and initial skills were centered around their grand means at level-1, the grand mean of the outcome (γ_{00}) was adjusted for differences among classrooms in the percentages of male and African American children, as well as in the initial academic skills. The predictive value of the interaction term over the grand mean, and over the independent effects of instructional practices and emotional tone was tested in this model. The u_{0j} coefficient was the group level residual.

Model Testing the Effect of Amount of Classroom Learning Engagement on Academic Gains

Two sets of equation were used to model Hypothesis II. At level one, the model was specified as

$$PostAchievement_{ij} = \beta_{0j} + \beta_{1j}(\mathrm{Pr}eAchievement) + \beta_{2j}(Gender) + \beta_{3j}(Ethnicity) + \beta_{4j}(ChildEngagement) + r_{ij}.$$

The level 2 (classroom level) model was specified as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(ClassroomEngagement) + u_{0j},$$

$$\beta_{1j} = \gamma_{10},$$

$$\beta_{2j} = \gamma_{20},$$

$$\beta_{3j} = \gamma_{30},$$

$$\beta_{4j} = \gamma_{40}.$$

In these equations, $PostAchievement_{ij}$ was the individual child achievement at the end of prekindergarten. $\beta_{1j,}\beta_{2j,}$andβ_{3j} were the nonrandom, fixed, individual-level covariate effects for initial skills, gender, and ethnicity,respectively. β_{4j} was the nonrandom, fixed, individual level effect for the proportion of engagement in learning. The effects of these variables on post achievement were not hypothesized to randomly vary across classrooms so their coefficients remained constant across level 2 units. $\beta_{0j}$was mean child achievement in the spring of prekindergarten for classroom *j* after controlling for child initial skills, gender, and ethnicity. In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the proportion of engagement in learning averaged for the class γ_{01}, and a random component u_{0j}. γ_{01} was the expected difference between the means of two classrooms, which differed by one unit in the proportion of classroom engagement in learning. In contrast, γ_{40} represented the expected difference in the outcome between two children in the same classroom who differed by one unit in the proportion of child engagement

in learning. The contextual effect was the expected difference in the outcome between two children who had the same proportion of engagement in learning, but who attended classrooms differing by one unit in the proportion of classroom engagement in learning. The r_{ij} and u_{0j} coefficients were the individual and group level residuals, respectively.

Model Testing the Effect of Complexity of Classroom Learning Engagement on Academic Gains

Two sets of equation were used to model Hypothesis III. At level one, the model was specified as

$$PostAchievement_{ij} = \beta_{0j} + \beta_{1j}(\mathrm{Pr}eAchievement) + \beta_{2j}(Gender) + \beta_{3j}(Ethnicity) + \beta_{4j}(ChildComplexEngagement) + r_{ij}.$$

The level 2 (classroom level) model was specified as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(ClassroomComplexEngagement) + u_{0j},$$

$$\beta_{1j} = \gamma_{10},$$

$$\beta_{2j} = \gamma_{20},$$

$$\beta_{3j} = \gamma_{30},$$

$$\beta_{4j} = \gamma_{40}.$$

In these equations, $PostAchievement_{ij}$ was the individual child achievement at the end of prekindergarten. $\beta_{1j,}\beta_{2j,}$and β_{3j} were the nonrandom, fixed, individual-level covariate effects for initial skills, gender, and ethnicity, respectively. β_{4j} was the nonrandom, fixed, individual-level effect for the complexity of engagement in learning. The effects of these variables on post achievement were not hypothesized to randomly vary across classrooms so their coefficients remained constant across level

2 units. $\beta_{0j}$was mean child achievement in the spring of prekindergarten for classroom *j* after controlling for child initial skills, gender, and ethnicity. In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the complexity of engagement in learning averaged for the class γ_{01}, and a random component u_{0j}. γ_{01} was the expected difference between the means of two classrooms, which differed by one unit in the complexity of classroom engagement in learning. In contrast, γ_{40} represented the expected difference in the outcome between two children in the same classroom who differed by one unit in the complexity of child engagement in learning. The contextual effect was the expected difference in the outcome between two children who had the same level of complexity in learning engagement, but who attended classrooms differing by one unit in the complexity of classroom engagement in learning. The r_{ij} and u_{0j} coefficients were the individual and group level residuals, respectively.

Models Testing the Mediating Effect of Complexity of Classroom Learning Engagement on the Relationship between Instructional and Emotional Classroom Environments and Academic Gains

The equations for each step necessary for testing mediated effect of classroom environment are describedin the following paragraphs. In the first step, the contribution of classroom environment to post academic achievement (*path c*) was estimated. The model was specified as

$$ClassroomPostAchievement_i = \beta_0 + \beta_1(Classroom\Pr eAchievement)_i + \beta_2(ClassroomGender)_i + \beta_3(ClassroomEthnicity)_i + \beta_4(ClassroomEnvironment)_i + r_i.$$

In this equation, β_0 was the expected level of classroom mean achievement observed in the spring of pre-kindergarten year. β_1,β_2, β_3, and β_4 represented the expected changes in the classroom mean achievement in the spring of pre-

kindergarten year associated with a unit increase in classroom average achievement in the fall of pre-kindergarten year, the percentage of male children and African American children in the classroom, and the level of support in the classroom environment, respectively. The error term, r_i, represented a unique effect associate with classroom *i*.

In the second step, the effect of classroom environment on the complexity of classroom engagement in learning (*path a*) was tested. The multiple regression model was specified as

$$ClassroomComplexEngagement_i = \beta_0 + \beta_1(ClassroomPreAchievement)_i + \beta_2(ClassroomGender)_i + \beta_3(ClassroomEthnicity)_i + \beta_4(ClassroomEnvironment)_i + r_i.$$

In this equation, β_0 was the expected level of complexity in learning engagement observed in a classroom. β_1,β_2, β_3, and β_4 represented the expected changes in the complexity of classroom engagement in learning associated with a unit increase in classroom average achievement in the fall of prekindergarten year, the percentage of male children and African American children in the classroom, and the level of support in the classroom environment, respectively. The error term, r_i, represented a unique effect associate with classroom *i*.

In the final step, the post academic achievement was regressed on the general classroom environment and the complexity of classroom engagement in learning simultaneously (*path c'* and *b*). The model was written as

$$ClassroomPostAchievement_i = \beta_0 + \beta_1(ClassroomPreAchievement)_i + \beta_2(ClassroomGender)_i + \beta_3(ClassroomEthnicity)_i + \beta_4(ClassroomEnvironment)_i + \beta_5(ClassroomComplexEngagement)_i + r_i.$$

In this equation, β_0 was the expected level of post achievement observed in a classroom. β_1,β_2, β_3,β_4, and β_5 represented the expected changes in the classroom mean achievement in the spring of pre-kindergarten year associated with a unit increase in classroom average achievement in the fall of pre-kindergarten year, the percentages of male and African American children in the classroom, the level of support in the classroom environment, and the complexity of classroom learning engagement, respectively. The error term, r_i, represented a unique effect associate with classroom *i*.

Model Testing the Moderating Effect of Children's Initial Academic Skills on the Relationship between Classroom Environments and Academic Gains

The level 1 interaction model was built as follows

$$PostAchievement_{ij} = \beta_{0j} + \beta_{1j}(\mathrm{Pr}eAchievement) + \beta_{2j}(Gender) + \beta_{3j}(Ethnicity) + r_{ij}.$$

At the group level, the model was specified as

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(ClassroomEnvironment) + u_{0j},$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}(ClassroomEnvironment),$$
$$\beta_{2j} = \gamma_{20},$$
$$\beta_{3j} = \gamma_{30}.$$

In the level-1 equation, $PostAchievement_{ij}$ was the individual child achievement at the end of prekindergarten. β_{1j}, β_{2j},and β_{3j} were the nonrandom, fixed, individual level effects for initial academic skills, gender, and ethnicity, respectively. The effects of these variables on post achievement were not hypothesized to randomly vary across classrooms so their coefficients remained constant across level 2 units. $\beta_{0j}$was mean child achievement in the spring of prekindergarten for classroom *j* after controlling for initial skills, gender, and ethnicity. In the level-2 equation, β_{0j} was represented as the grand mean of the outcome measure γ_{00}, plus the global level of

support in the classroom environment γ_{01}, and a random component u_{0j}. β_{1j}at the group level indicated the cross-level interaction in which the effect of initial academic skills on post academic achievement was tested in the presence of level of classroom support. The r_{ij} andu_{0j} were the residuals for their respective equations.

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