2014-07-10

Learning through Inquiry: Examining the Relationship between Child-Generated Questions, Teacher Practices, and School Readiness in Head Start Classrooms

Irena Nayfeld
University of Miami, inayfeld@gmail.com

UNIVERSITY OF MIAMI

LEARNING THROUGH INQUIRY: EXAMINING THE RELATIONSHIP BETWEEN CHILD-GENERATED QUESTIONS, TEACHER PRACTICES, AND SCHOOL READINESS IN HEAD START CLASSROOMS

By

Irena Nayfeld

A DISSERTATION

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Doctor of Philosophy

Coral Gables, Florida

August 2014

UNIVERSITY OF MIAMI

A dissertation submitted in partial fulfillment of

the requirements for the degree of

Doctor of Philosophy

LEARNING THROUGH INQUIRY: EXAMINING THE RELATIONSHIP BETWEEN CHILD-GENERATED QUESTIONS, TEACHER PRACTICES, AND SCHOOL READINESS IN HEAD START CLASSROOMS

Irena Nayfeld

Approved:

_________________ Daryl B. Greenfield, Ph.D. Professor of Psychology	_________________ Heather Henderson, Ph.D. Associate Professor of Psychology
_________________ Rebecca Bulotsky-Shearer, Ph.D. Associate Professor of Psychology	_________________ Brian Doss, Ph.D. Associate Professor of Psychology
_________________ Batya Elbaum, Ph.D Associate Professor, Department of Teaching and Learning	_________________ M. Brian Blake, Ph.D. Dean of the Graduate School

NAYFELD, IRENA (Ph.D., Psychology)
Learning through Inquiry: Examining the Relationship between Child-Generated Questions, Teacher Practices, and School Readiness in Head Start Classrooms (August 2014)

Abstract of a dissertation at the University of Miami.

Dissertation supervised by Professor Daryl B. Greenfield.
No. of pages in text. (58)

Research consistently shows that children from low-income environments tend to lag behind their peers in school readiness, language-development, and problem-solving skills. A number of studies have indicated that inquiry, or asking questions, is a domain-general learning tool that can help improve outcomes in all areas of academic readiness. Research conducted in middle-income samples shows that by the time children enter preschool, they often generate questions that seek to explain phenomena or extend understanding, and that those children who ask more questions have better academic outcomes. This work, however, has not been replicated with children from low-income families. Using multilevel modeling, the proposed project is the first to empirically examine child-generated inquiry in a sample of preschoolers from disadvantaged backgrounds. The study also assessed gains in inquiry over the school year, and the moderating role of teacher emotional and instructional support on these gains. Further, the study investigated associations between children's inquiry and their school readiness outcomes (i.e., mathematics, literacy, and science). Findings revealed that children asked few questions overall, that they made significant gains in inquiry over the school year, and that Emotional Support significantly moderated gains in inquiry. Children who showed a basic level of inquiry in the fall made more vocabulary gains over the course of the school year than those who did not. Implications for research, practical applications, and future directions in the field of child-generated inquiry as well as teacher practices are discussed.

Dedication

This work is dedicated to my parents, Anna and Gregory, my siblings, Helen and Alex, and my grandmothers, Shiva Nayfeld and Nadezhda Goltser. I am forever thankful for your love and support; this project, and everything I do, is for you.

Acknowledgments

I would like to thank my mentor, Daryl Greenfield, and my committee members for their advice and encouragement over the last five years. I would also like to thank our research team and my lab mates; your constant support and friendship made this project possible. Finally, I would like to thank the Office of Head Start for funding this project, and all the children and teachers with whom I have had the pleasure to work.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

Young children are naturally curious, eager to explore their environment, and ready to seek explanations for the unknown (Piaget, 1969). Asking questions (i.e., inquiry) is one of the hallmark indicators of curiosity and exploration; inquiry signals interest and engagement in a topic, facilitates interaction as well as conceptual understanding, and provides a foundation for further learning (Berland & McNeill, 2009; Gopnik, 1998). To ensure that children from at-risk backgrounds are receiving the highest quality of education, Head Start mandates that education be driven by teacher-child interactions which promote conceptual development and critical thinking skills (Office of Head Start Summit, February 2011). By building on and encouraging children's natural curiosity, teachers can meet these goals and ensure that children develop inquiry skills that will benefit their learning trajectories across academic domains.

The present study is the first to empirically examine inquiry skills of children enrolled in a large urban Head Start program. Although previous research has found that middle-income preschoolers successfully ask questions to gather information, this work has not been extended to low-income populations. Further, work with older students has found associations between asking questions and academic performance; however, these relationships had not been empirically examined in a preschool population. The proposed study extends this research by testing the association between inquiry skills and gains in mathematics, literacy, and science in a sample of preschoolers from low-income backgrounds. Because teachers play a critical role in structuring the classroom climate and shaping children's educational experiences, this study also examines the moderating role of teacher practices on children's inquiry skills, as well as on the associations between inquiry and gains in school readiness.

An achievement gap is consistently found between children from low-income backgrounds and their middle- to high-income peers in academic performance, language development, and analytical reasoning skills (Hart & Risley, 1995; Lareau, 2003; Walker, Greenwood, Hart, & Carta, 1994; Weatherholt, Harris, Burns & Clement, 2006). These differences are observable by the time a child begins formal education (Magnuson & Duncan, 2006; Neuman & Celano, 2006) and continue through later grades (National Assessment of Educational Process [NAEP], 2009). Deficits experienced as a result of growing up in an at-risk environment cumulate over time, perpetuating the differences in educational attainment among children from low-SES backgrounds and their peers (Entwisle, Alexander, & Olsen, 2005). Unfortunately, these deficits impact the development of language and cognitive skills that in turn impact outcomes across all academic domains. One excellent avenue to decreasing this gap, then, is through the identification of malleable domain-general skills, or mechanisms that have the potential to significantly affect early academic achievement across all learning domains (e.g. mathematics, literacy, science, etc.). Examining such skills and the mechanisms that promote their development in populations of children from at risk backgrounds is a powerful strategy for informing teacher practice and guiding targeted research-based interventions that successfully improve school readiness across ***all*** readiness domains.

Theoretical Background

Programs such as Head Start are dedicated to improving children's academic success by exposing children to rich language and higher-quality teacher-child interactions, with the goal of improving school readiness skills (Improving Head Start for School Readiness Act of 2007, Section 641A, Paragraph 2, Subparagraph F). According to the sociocognitive model of development, young children's conceptual development, causal understanding, and their linguistic and cognitive skills are constructed through social interactions (Bruner, 1984; Rogoff, 1990; Vygotsky, 1978). According to this Vygotskian framework of learning and development, parents and teachers model interactions and behaviors, which are then internalized to guide and shape the child's developing cognition. This theory specifically emphasizes the role of language in the co-construction of knowledge; cognitive development takes place through social interactions, and language is a critical tool that allows the adult to model, and the child to extend information and understanding (Bodrova & Leong, 2007; Dickinson & Smith, 1994).

Not only do children co-construct knowledge with adult interaction, but they also play an important role in initiating this process by asking questions. According to Gopnik (1998), children possess a "theory drive", or an active theory-formation system that causes them to engage in autonomous exploration as well as question-asking to confirm, shape, and strengthen their theories about the world around them. The child's search for explanation through inquiry can act as a catalyst for meaningful social interactions that result in learning and cognitive development. Questions identify areas of interest, evoke dialogue, provide a cue to an adult that scaffolding is needed, and create new knowledge, all leading to meaningful interactions and increased learning.

Explanatory Inquiry

All questions serve some purpose; children generate several types of questions which are used with different intentions and thus elicit different types of responses. The literature on inquiry in young children identifies two broad categories of questions asked by young children towards parents and teachers: explanatory/information-seeking and non-explanatory/non-information-seeking questions (Callanan & Oakes, 1992; Chouinard, 2007). Non-explanatory questions are asked by children for purposes such as getting attention or clarification, prompting adult action, asking permission, or extending pretend play. In contrast, this study focuses on explanatory questions, or questions that help the child retrieve information that he or she needs to solve a problem or resolve cognitive disequilibrium. Explanatory questions can be questions about: 1) Fact/definition or function of a stimulus; these questions are used to understand properties and purposes of objects (e.g., What is that? What does X mean?); 2) Causal relationships between objects or events; these questions clarify how something works or why events occur (e.g., Why is the sky blue? How do seeds become flowers?); 3) Causal consequence of events (e.g., What would happen if I spill this water?) and 4) Transformations or change; questions that are asked to understand origins or destinations of objects or events (e.g., Where does the water go when I drink it? Does the moon disappear during the day?). These types of questions can help a child extend understanding and improve academic outcomes across instructional contexts and activity settings (i.e.: direct instruction, free play, etc.). The current study examines these skills in a population of children enrolled in Head Start.

Development of Inquiry-Generation

"Asking questions is a central part of what it means to be a child" (Chouinard, 2007). An investigation of the development of questions found that two-year-old children ask their parents an average of 107 questions per hour (Chouinard, 2007). Extant research with children from middle-income families suggests that two-year-olds ask both explanatory and non-explanatory questions, that the proportion of explanatory questions increases with age, and that preschoolers ask explanatory questions to obtain knowledge about form, function, meaning, and causal relationships of objects (Callanan & Oakes, 1992; Chouinard, 2007; Hickling and Wellman, 2001; Greif, Nelson, Keil, & Gutierrez, 2006; Frazier, Gelman, & Wellman, 2009; Mills, Legare, Bills, & Mejias, 2010).

Recent findings indicate that 3 year olds effectively use "how" or "why" questions to gather information, and that the number of such explanatory questions increases with age (Frazier, Gelman, & Wellman, 2009). This study also highlighted the instructional function of questions. In an experimental set-up, adults were instructed to either answer children's questions with informative or non-informative statements. Findings revealed that when questions were answered by a non-informative statement, children persisted in asking until a satisfactory answer was given (Frazier, Gelman, & Wellman, 2009). When a logical, explanatory answer was provided, however, children did not repeat the question. Children do not merely ask questions to get attention or initiate interaction; questions are expected to inform, and are asked to elicit an explanation. These findings identify child-generated inquiry as an ideal mechanism for enhancing learning; by facilitating and encouraging inquiry, adults, particularly preschool teachers, can identify areas of interest as well as gaps in knowledge, assess and scaffold understanding, and foster learning.

Existing Research on Preschoolers' Inquiry Skills

Studies consistently find that active engagement and questioning results in better learning, understanding, and recall (Chouinard, 2007; Chin & Osborne, 2010, Dyasi, 2001). Asking questions requires more thought and active participation than listening to the teacher present material or just answering questions (Engel, 2011; Martin & Pressley, 1991; Perry, VanderStoep, & Yu, 1993). Studies with older students have found that inquiry-based instruction is related to increases in student's use of complex language and vocabulary (Chin & Osborne, 2010), increased interest in the material, as well as achievement in mathematics and science (Blank & Covington, 1965; Chin & Brown, 2002, Newman, 1998; Perry, VanderStoep, & Yu; 1993). However, work examining the relationship between asking questions and learning outcomes has not been replicated with preschoolers.

Some existing research on preschoolers' inquiry abilities has been conducted to examine children's use of explanatory questions. These assessments of inquiry generally measure one of two sets of skills: 1) the ability to ask specific, efficient questions to figure out a solution to a problem (e.g.: narrowing down a set of pictures to a pre-selected target), or 2) the ability to generate questions that demand information or explanation (explanatory questions) when presented with novel stimuli (e.g.: asking "What is that?" when shown an image of an unfamiliar animal). Extant work, all conducted in middle-income samples, indicates that preschoolers can successfully engage in both types of inquiry (Chouinard, 2007; Frazier, Gelman, & Wellman, 2009; Mills, Legare, Bills, & Mejias, 2011). However, little is known about inquiry skills of children from disadvantaged, low-income samples.

Preliminary replications of these studies in a low-income population suggest children at risk have difficulty generating efficient questions to solve a problem (Nayfeld, 2011), and ask questions in response to novel stimuli at an alarmingly lower rate than children from middle-income samples (Pilot Study, described below). While the ability to ask effective questions to solve a problem is an important problem-solving tool, these questions are task-specific, and do not necessarily provide information that extends overall general knowledge. In comparison, generation of explanatory questions in response to novel stimuli is more closely aligned with natural exploratory behavior and the type of inquiry that is most likely to occur in classrooms. For this reason, the present study focuses on these skills.

Pilot study with low-income preschoolers. No work to date had empirically assessed child-generated explanatory inquiry in a population of preschoolers from low-income backgrounds. Pilot work was therefore conducted in the spring of 2012 to inform the design of a sensitive measure of these skills for this population. The initial procedure used was based on an assessment found to successfully generate questions in a population of middle-income preschoolers (Greif, Nelson, Keil, & Gutierrez, 2006). Children were presented with a set of 11 pictures of unusual animals (i.e.: a tapir, a sloth, etc.) and people/animals acting in odd ways. First a puppet, Iggy, was introduced and asked the assessor questions about one of the pictures (predetermined and the same picture for all children) to model the task. The child was then instructed to choose a picture from the remaining set of 10 pictures. The assessor asked the child whether there was anything they want to know about the picture. If the child did not generate a question, there were told “Ask me a question. Is there anything you want to know about this picture?” If the child made a statement or did not generate a question again, they were told “Iggy loves questions. Ask me a question about the picture so that Iggy can learn about it too.” If the child did not generate a question, he or she was prompted to pick another picture. This procedure was repeated until the child had selected all 10 pictures and had the opportunity to ask questions about each one.

Data collected in this pilot test revealed that children rarely asked questions. In the Greif, Nelson, Keil, & Gutierrez (2006) study where middle income preschoolers were presented with 12 pictures, child asked an average of 26.1 total questions throughout the assessment (across the six pictures). In contrast, children in our sample asked an average of 1.55 total questions across ten pictures. Ninety-seven children (62% of the sample) did not ask any questions, 32 children (20.4%) asked one or two questions, and only 5 children (.3%) asked ten or more questions.

The pilot work also resulted in several anecdotal observations. While children rarely asked questions, they were much more likely to make descriptive statements about the picture. We also found that, when questions were asked, they were frequently generated spontaneously (before any prompt to ask a question was given). However, when asked whether there was anything else they wanted to know about the picture or when directed to ask a question, children responded affirmatively (by nodding or saying “yes’) but then made statements describing the picture or repeated a description previously made. These findings indicated that children within this population may not be familiar with requests to ask a question, or may not have a clear working definition of what a ‘question’ is. In a formal schooling environment, where children are often asked whether they have any questions throughout instruction, not being able to respond to this request can severely stifle learning.

These findings and experience conducting the assessments lead to several conclusions: 1) The pictures presented to the child did not adequately evoke curiosity or tap into inquiry skills, 2) Children may have felt uncomfortable asking questions to an unfamiliar adult, and 3) The task was eliciting two types of questions: questions generated spontaneously and questions generated in response to a prompt. To address these concerns, the task was redesigned with stimuli more likely to evoke more spontaneous questions from children. Additionally, a screener was added in which the child was allowed to describe and inquire about pictures prior to the assessment in order to build rapport with the assessor, as well as to test for verbal ability. Finally, the task was also redesigned to parse apart the two types of questions generated.

Using the redesigned task, physical objects likely to be unfamiliar (i.e.; a cookie cutter, a battery) or puzzling (i.e.: a popped balloon, a box with a penny inside) were presented to the child. In the beginning of the task, the child was told that he or she could play with any object and ask anything they wanted. They were then allowed to explore the objects. No further prompts were given, and all questions were recorded. When the child was finished exploring (3 minutes of inactivity), the children were then shown a picture of an unusual scenario (a front cover of a “The Magic School Bus” book) and again allowed to spontaneously generate questions. They were then presented with direct requests to ask a question about the picture. This was repeated with three pictures and all questions were recorded. The task ended when the child indicated that he or she had no further questions or did not generate questions after two prompts.

This task was piloted with a random subsample (N=104) of the original pilot sample described above. Results indicated that children asked more spontaneous questions in response to the physical stimuli and pictures; on average, a child asked a total of 3.64 questions about the physical stimuli, and an average of 2.28 questions about the pictures. Taken together, children asked an average of 5.92 *(SD* = 7.18*; range* = 0 to 30 questions) over the course of the inquiry task. Requests for the child to ask a question still tended to generate descriptive statements or no response. These preliminary findings indicated that this task design elicited more questions and confirmed our finding that children may be unfamiliar with requests to ask a question.

Based on these findings, it was concluded that this task is an appropriate measure of question generation for our sample. Finally, we tested variations of the language and structure of the assessment to assure that the assessment was clear and developmentally appropriate for the population. We also used children's reactions to various stimuli to arrive at a subset of objects and pictures in which children showed most interest, and were therefore most likely to evoke use of inquiry skills. This work led to a sensitive uniform measure of explanatory inquiry appropriate for our targeted population.

Inquiry and Teacher Practices

Inquiry is by definition a social process. The benefits of asking questions described above can only affect a child's cognitive development if the inquiries are addressed. Adults can influence the benefits of inquiry by the way that they structure the environment, as well as by their response to the questions posed by children during interactions (Chak, 2010). School is a place for learning and exploration; the classroom is therefore an important context for maximizing learning opportunities offered by children's questions. In spite of this, observations of classroom environments reveal that children across all ages rarely ask questions during school hours (Engel, 2011; Chin & Osborne, 2010). The enormous potential of teacher-children interactions to foster child-generated inquiry, and thereby extend learning, makes these findings disconcerting and urgently calls for further investigation.

Questions have the potential to extend discussion in the classroom and provide the teacher with opportunities for meaningful teacher-child interactions. While a child's curiosity might propel them to explore a novel stimulus or identify a gap in knowledge, young children are limited in their access to stimuli and sources of information. Adults, such as parents and teachers, must, therefore, serve as a medium to ensure that children are cognitively stimulated and that they feel comfortable using the adult as a resource (Chak, 2002). Not surprisingly, findings indicate that a warm, encouraging, and supportive classroom environment facilitates student engagement, motivation, and academic achievement (Hambre & Pianta, 2005). Further, such settings have been found to increase young children's likelihood to explore, express curiosity, and ask questions (Engel, 2011; Henderson, 1984). A study found that children show higher levels of curiosity during an exploration of novel stimuli when teachers smile and speak in an encouraging manner (Hackmann & Engel, 2002). A classroom environment in which the teacher encourages children to explore, vocalize their thoughts, and ask questions is likely to create a learning space in which children feel comfortable engaging in inquiry, thereby practicing and improving this skill while simultaneously gaining new knowledge.

Cognitively-challenging instruction through the use of rich language, high-quality feedback, and concept development has also been found to relate to children's academic achievement (Curby et al., 2009; Mashburn et al., 2008). Unlike traditional, rote instruction in which the teacher transmits information in a unidirectional mode, cognitively-challenging instruction promotes co-construction of knowledge through thinking, feedback loops and extension (Dickinson & Smith, 1994; Hamre & Pianta, 2005). Research suggests that this form of instruction may be particularly beneficial for children from low-income backgrounds. A study that compared low-income classrooms that emphasized rote instruction and basic-skills with those that employed more cognitively-challenging instruction found that the latter form of instruction resulted in higher motivation and cognitive outcomes (Stipek et al., 1998). This finding is supported by other research that has found that children from low-income backgrounds benefit from cognitively-challenging dialogue and promotion of higher-order thinking (Huebner & Meltzoff, 2005; Valdez-Menchaca & Whitehurst, 1992).

Unfortunately, observations have indicated that cognitively-challenging instruction rarely occurs in low-income preschools (Burchinal et al., 2008; Howes et al., 2008). This is likely related to findings that indicate that despite children's natural curiosity and tendency to ask questions, student-generated explanatory questions rarely occur during instruction (Chin, Brown, & Bruce; 2002; Engel, 2011; Palincsar & Brown, 1984). Despite the fact that parents promote curiosity and overwhelmingly identify it as leading goal of education (Engel & Randall, 2009), teachers tend to dominate interactions, and student questions are rarely generated or used to guide classroom activity (Dillon 1988; Ibanez Molinero & Garcia Madruga, 2011). These findings indicate that teacher practices and classroom environment moderate the potential benefits of inquiry. Considering these benefits and the importance of providing children from low-income backgrounds with an education that places them on equal footing with their middle-income peers, facilitation of child-generated inquiry in preschool classrooms is a crucial area for study and intervention.

Regulations, requirements, and performance assessments put pressure on teachers to cover prescribed material and not deviate from the curriculum (Chak, 2010). One study found that teachers sometimes purposefully discourage questions because of pressure to fulfill pre-set curricula requirements (Engel & Randall, 2009). However, when the focus of instruction was shifted from mastery to understanding, teachers readily encouraged curiosity, facilitated higher-level dialogue, and used children's questions to engage in hands-on exploration. Understanding teacher practices that facilitate inquiry can help structure professional development that best trains teachers to fulfill curricula and policy requirements while simultaneously taking advantage of children's curiosity. This has the potential to reduce stress and workload, create a more engaging and cognitively stimulating learning environment, and improve school readiness of children in programs such as Head Start.

Current Study

Ultimately, the goal of preschool education is to develop skills that will improve children's school readiness and set them up for academic success. To accomplish this, we must identify skills that improve learning across domains and equip teachers with strategies that promote children's development of these skills. In the pursuit of meeting this goal, the present study extends previous research by addressing three aims:

Aim 1: Assess child-generated inquiry over the course of the school year in a sample of preschoolers from low-income households enrolled in a large urban Head Start program.

This study is the first to assess child-generated, explanatory inquiry in a low-income sample, and is therefore exploratory in nature. This project measured child-generated, explanatory inquiry in the beginning of the school year (fall time point) and in the end of the school year (spring time point). It was predicted that children's inquiry skills would significantly increase from fall to spring. Based on pilot work conducted this past spring (see Pilot Study in Introduction Section above), it was predicted that children would ask approximately 3 to 4 spontaneously generated questions at the end of the school year, and that the majority of children would ask between 0 and 5 questions.

Aim 2: Examine the relationship between inquiry skills and mathematics, vocabulary, listening comprehension and science readiness over the course of the year.

No study to date had empirically examined the relationship between child-generated, explanatory inquiry and school readiness in preschoolers. Based on literature on the role of inquiry in promoting engagement, recall, and understanding (Callanan & Oakes, 1992, Chouinard, 2007; Engel 2011) and on studies conducted with older students (Chin & Osborne, 2010) it was hypothesized that inquiry skills at the beginning of the school year, as well as gains in inquiry skills, would positively predict gains in all school readiness domains over the course of the year.

Aim 3: Assess effects of classroom quality by 1) examining the main effect of teacher's emotional support and instructional support on inquiry outcomes; 2) examining the moderation effect of emotional and instructional support on gains in inquiry skills over the course of the school year; and 3) examining the moderation effect of emotional and instructional support on the relationship between inquiry skills and mathematics, vocabulary, listening comprehension and science knowledge over the course of the school year.

Based on research on the extension of inquiry by emotionally supportive and cognitively challenging interactions with an adult, it was hypothesized that emotional and instructional support would predict inquiry outcomes at the end of the school year as well as moderate gains in inquiry skills, such that children would achieve greater gains at higher levels of support. Based on literature that has found a positive relationship between instructional support, emotional support, and school readiness outcomes, it was predicted that the level of emotional support would moderate the relationship between inquiry skills and school readiness outcomes, such that there would be a stronger relationship between inquiry skills and school readiness at higher levels of emotional support. It was also predicted that instructional support would moderate the relationship between inquiry skills and school readiness outcomes in the same manner.

Chapter 2

Method

Participants

In the fall of 2012, inquiry and school readiness assessments were conducted with 367 children across 37 classrooms (approximately 10 children per classroom). Children were an average of 48.23 months old (SD = 7.1) at the time of the first fall assessment. The majority (70.1%) of participants was African-American, a substantial minority was Hispanic (23.9%), and a small minority was identified as Caucasian, biracial, or of other ethnicity (6.1%).

Procedure

Demographic information for all children was obtained through center records. Direct assessments of inquiry, mathematics, literacy, and science skills were administered in the fall to establish baseline skills in these domains at the beginning of the school year. Assessments were administered on separate days. The sample was first assessed on inquiry (EIA), followed by math and literacy (Learning Express) and then science (Lens on Science). In the winter, participating classrooms were observed for emotional and instructional support (the CLASS). In the spring, children were assessed again in inquiry, mathematics, literacy, and science to allow for computation of gains across the school year.

Measures

Mathematics and literacy readiness. Children's mathematics, vocabulary, and listening comprehension skills were assessed using the Learning Express (McDermott, Fantuzzo, Angelo, Waterman, Warley, Gadsden, & Zhang, 2009). The Learning Express

(LE) is a validated Item-Response-Theory (IRT)-based, criterion-referenced school readiness assessment designed to detect growth in cognitive competencies in the Head Start population. The test is comprised of four subscales: Vocabulary, Mathematics, Listening Comprehension, and Alphabet Knowledge. Each scale has two forms (A and B), allowing for valid retesting. Reliability across subscales ranges from .93 to .98. External and predictive validity has been established for all subscales (McDermott et al., 2009). Individual assessments are conducted using a flip-book format; a trained assessor administers items verbally and the child responds by pointing to pictures, answering verbally, or manipulating stimuli. Children's responses are standardized, and final scores are tabulated based on IRT parameters. The scores are standardized on a metric with a mean of 200 and a standard deviation of 50.

Science readiness. Science readiness was assessed using the *Lens on Science* computer-adaptive direct assessment (Greenfield, Dominguez, Fuccillo, Maier, & Greenberg, 2012).The *Lens on Science* (Lens) assessment is a computer-administered, touch-screen Item Response Theory (IRT)-based direct assessment of science knowledge and practice skills (Greenfield et al., 2012). This assessment was specifically designed to detect growth in the Head Start population. Items were created based on a review of preschool and kindergarten state and national standards as well as current preschool science curricula. The assessment was designed to cover a range of difficulty appropriate for Head Start preschoolers as well as a range of science process skills and science content from "life science," "earth and space sciences" and "physical and energy sciences". Convergent and divergent validity for the flipbook version of this assessment has been established in the Head Start population and the assessment has been found to detect growth in science school readiness within this population across the school year (Greenfield et al., 2012).

Instructional and emotional support. The Classroom Assessment Scoring System (CLASS; Pianta, La Paro, & Hamre, 2006), was used to assess Emotional Support and Instructional Support. This observational tool is designed specifically to measure quality of interactions between teachers and children, and has been validated in a Head Start sample (Pianta et al., 2005). The CLASS contains dimensions organized into three domains: Emotional Support, Classroom Organization, and Instructional Support. All dimensions within each domain are scored on a 7-point scale. Internal consistency has been established for each domain. Detailed descriptions are provided for each item at the low (1-2), medium (3-5), and high (6-7) ranges of quality.

The Emotional Support domain is a composite score of four dimensions: 1) Positive Climate, measured by the emotional connection between the teacher and students as well as the warmth, respect, and enjoyment of interactions; 2) Negative Climate, measured by the overall level of expressed negativity in the classroom; 3) Teacher Sensitivity, measured by teacher's awareness of and responsiveness to students' academic and emotional needs; and 4) Regard for Student Perspectives, measured by the degree to which teacher's interactions with students and classroom activities place an emphasis on students' interests, motivations, and points of view.

The Instructional Support domain is a composite score of three dimensions: 1) Concept Development, measured by the degree to which teachers promote higher-order thinking skills through discussion and activities; 2) Quality of Feedback, measured by the extent to which teachers' responses extend learning; and 3) Language Modeling, measured by teachers' support and facilitation of language use.

CLASS observations took place during one to two mornings. Start times were based on when the teacher to be observed reported that a typical day of instruction began and ended around lunch time (approximately a 4 hour time period). Observation cycles included a 20-minute observation period and a 10-minute scoring period. Observers completed at least 4 cycles during the 4 hour period. Final scores were obtained by averaging dimension scores across observation cycles within each domain.

Explanatory inquiry. Inquiry skills were assessed using the Explanatory Inquiry Assessment (EIA), designed by the author using a combination of techniques previously used to examine children's ability to generate questions (Greif, Nelson, Keil, & Gutierrez, 2006; Henderson, 1984). These techniques were pilot-tested in the spring of 2012 to generate a sensitive assessment that is appropriate for the Head Start population. Specifically, children were presented with novel stimuli or unusual items that may stimulate curiosity. Objects included uncommon toys (e.g.: a puzzle watch, a magnet fishing rod, pick-up sticks), as well as some items that were "broken" or did not look or function as expected (e.g.: a crayon box with a penny inside, two toy animals glued together, empty candy wrapper). The EIA measured freely-generated, explanatory questions (unprompted questions in response to novel stimuli) and explanatory questions asked in response to a prompt (i.e. "Do you want to know anything about this picture? Ask me a question about this picture.") Freely generated questions assess whether a child uses inquiry to acquire information when he or she lacks understanding or wants to fill a knowledge gap. Questions asked in response to a prompt indicate whether the child understands a request to ask a question and can in turn successfully produce a question in response. For a list of all items, see Figure 1.

First, a screener was administered in which the child was presented with two pictures and asked to describe what they saw and answer a question on a topic related to the picture. Children were shown a picture of fruit and asked what they saw, as well as what their favorite fruit is. Next, they were shown a picture of a cat reaching into a fishbowl. They were again asked what they saw and then asked whether they have any pets or animals at home. The purpose of the screener was to make the child comfortable with the assessor and the experimental set-up, as well as to assess verbal ability. If a child did not respond verbally, the assessment was discontinued at this point.

If a child made verbal responses to the screener, the child was presented with a set of 10 stimuli consisting of unfamiliar toys or objects chosen to evoke curiosity. Children were randomly selected to receive either Form A, or Form B, each consisting of 10 unique items and 3 unique pictures. All items were pilot tested and counterbalanced; children's performance on the assessment did not differ by form. Children who received Form A in the fall received Form B in the spring to ensure that stimuli were novel for each child at both time points. The child was told "You could play with anything you want and ask me anything you want!" After a minute of inactivity on the part of the child, she was prompted with a query as to whether she would like to play with anything else. Based on the response, the child was either given more time until another minute of inactivity had elapsed or that portion of the assessment was concluded.

A protocol for administering the assessment was created based on pilot work and previous research, and a team of assessors were trained on said protocol, responses to children's verbalizations, and recording of data. Inter-rater reliability was established (κ = .83). If a child asked a question that called for a definition or function of an item (e.g.: What is that? What can you do with it?), they were given a previously agreed-upon name or function of the item. If the child asked a "Who" question (e.g.: Who broke that?), the assessor responded "My friend did that." If a child asked a "How" or "Why" question, or a question that called for the assessor to make a guess or voice an opinion, the assessor responded "Hmm, I don't know. What do you think?" Assessors responded to statements with neutral feedback that promoted participation but did not give additional information about any of the stimuli (e.g.: That's a good idea." "I am having fun playing with you.")

The child was then shown 3 pictures of children's book covers (from the "Magic School Bus"), one at a time. She was first told that "You could look at the picture and ask me anything you want!", following the same procedure as that used previously with the 10 items. After the child was silent for 1 minute following the prompt, the child was directed to ask a question about the picture. This was done by telling the child "Now, ask me a question about this picture." The response was recorded and followed by neutral feedback and another request for a question. A question was requested a total of three times. This was done with each picture, making a total of 9 direct requests for a question (3 requests for 3 pictures).

All questions and statements made were recorded based on the item to which they pertained. After the completion of the assessment, all verbalizations were coded with a Q for "question", an "S' for statement. If the child made a verbalization that did not address any property of the item (e.g.: Oh, wow!) or did not pertain to the task (e.g. Where do you live?), the verbalization was coded as N/A and did not count towards the final score.

At the end of the assessment, questions and statements were counted for each item. This procedure was followed for the spontaneous inquiry portion and the direct request portion. All data was double-verified before being entered into the database. Once entered, spontaneous questions for each item were aggregated to create a total score for number of questions asked. The same procedure was followed to create a score for total statements made, total questions asked, and total statements in response to a request.

Data Analytic Plan

To account for the nested structure of the data (children are nested within classrooms), and to examine cross-level interactions between teacher practices and inquiry skills, all analyses were conducted through multilevel modeling using HLM 7 software (Raudenbush, Bryk, Cheong & Congdon, 2004).

To assess spontaneous inquiry over the course of the school year, descriptive analyses were conducted for the inquiry assessment at the fall and at the spring time point. The means, range, and variability of scores were examined. In addition, frequencies were analyzed to determine how many participants did not ask any questions, as well as how many asked an average of one or more questions per item. Analyses to assess gains in inquiry over the course of the school year were examined by entering fall inquiry scores as child-level predictors. Age, gender, and ethnicity were also examined as child-level covariates. To assess inquiry in response to a request, the average number of statements as well as the average number of questions asked in the portion of the assessment where children were prompted to ask a question was generated.

To test whether inquiry skills predict outcomes in mathematics, vocabulary, listening comprehension and science knowledge, correlations between children's inquiry scores and each of the four school readiness outcomes in the spring were examined. For relationships with significant correlations, analyses were conducted to examine whether children's initial inquiry scores in the fall predicted readiness outcomes in the spring, controlling for initial levels of that skill and demographic variables. Finally, a binary variable was created to dichotomize fall inquiry scores into two groups: those who did not ask any questions and those that asked one or more question. This variable was used to tests whether asking at least one question predicted gains in school readiness, controlling for age, gender, and ethnicity.

To assess the effects of classroom quality, emotional support and instructional support were examined as predictors of inquiry outcomes and as moderators of gains in inquiry skills over the course of the school year. A multilevel model was built in a series of steps. First, an unconditional model was run to determine the amount of variance of spring inquiry at the classroom level. Next, child-level variables were entered as predictors (demographic covariates, fall inquiry skills) of spring inquiry skills. Second, classroom level variables (emotional support and instructional support) were entered as predictors to examine the main effect of classroom quality on spring inquiry. Finally, cross-level interactions between fall inquiry and both classroom-level variables were included to examine whether gains in inquiry skills are moderated by the level of classroom quality. See Figure 1 for a visual representation of the multilevel model.

Due to the count nature of the outcome data, Poisson 2-level HLM models were run. Poisson distributions deal with zero-inflated count data; as the mean increases, the distribution approaches normal. When the variance of the outcome variable exceeds the mean, as was the case with the present data, overdispersion must be adjusted for in the model. In HLM, outcomes of Poisson models generate logit coefficients. To make coefficients in count models interpretable, logit coefficients can be exponentiated to create Incidence Rate Ratios (IRRs; Raudenbush & Bryk). IRRs measure the expected frequency of occurrence of an event (e.g.: asking a question) in a given period of time (e.g.: Explanatory Inquiry Assessment). Child- level fall scores were centered at the group mean, age and classroom-level variables were centered at the grand mean, and gender and ethnicity were left uncentered (Enders and Tofighi, 2007). These models are represented by the following equations:

Level-1 Model

$$E(SpringInquiry_{ij}|\beta_j) = \lambda_{ij}$$

$$\log[\lambda_{ij}] = \eta_{ij}$$

$$\eta_{ij} = \beta_{0j} + \beta_{1j}*(Ethnicity_{ij}) + \beta_{2j}*(Gender_j) + \beta_{3j}*(Age_{ij}) + \beta_{4j}*(FallInquiry_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(EmotionalSupport_j) + \gamma_{02}*(InstructionalSupport_j) + u_{0j}$$

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

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

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

$$\beta_{4j} = \gamma_{40} + \gamma_{41}*(EmotionalSupport_j) + \gamma_{42}*(InstructionalSupport_j) + u_{4j}$$

In the Level 1 equation, the spring inquiry score of the i^{th} child in the j^{th} classroom (η_{ij}) is estimated as a function of the intercept ($\beta_{0j;}$ the mean score for children in each classroom), the fixed effects associated with the demographic covariates ($\beta_{1j}, \beta_{2j}, \beta_{3j}$), fall inquiry skills ($\beta_{4j}$), and the residual of the spring score of the i^{th} child in the j^{th} classroom after adjusting for Level 1 variables (r_{ij}).

In the Level 2 equations, the two classroom-level variables (instructional and emotional support) are included as predictors. As a result, the intercept (β_{0j}) is a function of the mean of spring inquiry (γ_{00}), the mean differences in spring inquiry associated with the classroom-level predictors (γ_{01} and γ_{02}), and the random effect associated with the intercept (u_{0j}). Level 2 equations for child level demographic predictors (β_{1j}, β_{2j}, β_{3j}) are a function of the mean differences in spring inquiry per unit change in demographic predictors across classrooms (γ_{10}, γ_{20}, γ_{30}). For parsimony, variance components were fixed to zero if the variance terms associated with the random effects of the Level 1 variables were not significant, indicating that the association between these variables and outcomes did not vary across classrooms. The Level 2 equation for the slope associated with fall inquiry (β_{4j},) is a function of the mean differences in spring inquiry per unit change in fall inquiry across classrooms (γ_{40}), the cross-level interaction of Instructional Support with fall inquiry and cross-level interaction of Emotional Support and fall inquiry (γ_{41}, γ_{42}), and the random variance associated with each estimated mean difference (u_{4j}).

Chapter 3

Results

Inquiry Assessment

Upon administration of the assessment and subsequent data analysis, it was noted that children's spontaneous inquiry was impacted as a result of the direct requests for a question for the first picture shown. Most children responded to these requests with statements and/or descriptions of the picture. Therefore, when they were shown the second picture, children were primed by the previous request; their responses were no longer spontaneous. For this reason, responses for the spontaneous portion of the assessment with the last two pictures were not included in analyses; spontaneous inquiry scores were therefore operationalized as the total number of questions asked in response to 11 items (10 objects and 1 picture). Total statements were also calculated based on these 11 items. Using these scores, means and standard deviations of total questions asked and total statements made were calculated to examine spontaneous inquiry. In addition, inquiry scores were coded based on whether the child asked any questions at all, creating a dichotomous variable. The total number of questions asked in response to a request, means, and standard deviations were also calculated for the portion of the assessment in which children were directed to ask a question (3 requests for each of 3 pictures).

Fall Descriptive Statistics

Spontaneous inquiry. All children in the sample made verbal responses to the screener and were subsequently assessed on the EIA. Descriptive analyses revealed that children asked an average of 3.79 (SD = 5.1) spontaneous questions throughout the assessment in the fall. 41.4% of the children did not ask any questions throughout the assessment. 9.8% of the sample asked an average of one or more questions per item. One-way ANOVA revealed that children's inquiry scores varied significantly across classroom ($F = 2.09$, $p < .01$); post-hoc analyses indicated that this result is driven by classrooms in which one or two children asked significantly more questions than average, affecting the mean score for that classroom. Performance in the fall did not differ by age, gender, or ethnicity. Children made an average of 5.87 ($SD = 5.6$) statements over the course of the assessment. There was a moderate correlation between questions and statements ($r = .38$, $p < .01$). See Table 1 for descriptive statistics.

Inquiry in response to a request. Children were directly requested to ask a question about each of the three pictures. Children were prompted 3 times for each picture to ask a question about the picture. In response to these 9 total requests, children generated an average of .5 ($SD = 1.4$) statements. Questions in response to a request were correlated with spontaneous questions ($r = .32$, $p < .01$). See Table 2 for all correlations.

Spring Descriptive Statistics

Spontaneous inquiry. Descriptive analyses revealed that children asked an average of 5.9 ($SD = 7.6$) spontaneous questions throughout the assessment in the fall. 29.6% of the children did not ask any questions throughout the assessment. 19.3% of the sample asked an average of one or more questions per item. One-way ANOVA revealed that children's inquiry scores varied significantly across classroom ($F = 1.81$, $p < .01$). Performance in the spring did not differ by age, gender, or ethnicity. Children made an average of 10.32 ($SD = 8.4$) statements over the course of the assessment. There was a moderate correlation between questions and statements ($r = .42$, $p < .01$).

Inquiry in response to a request. Children were directly requested to ask a question about each of the three pictures. Children were prompted 3 times for each picture to ask a question about the picture. In response to these 9 total requests, children generated an average of .62 (*SD* = 1.5) statements. Questions in response to a request were correlated with spontaneous questions (r =.34, p < .01).

Multilevel Modeling

An unconditional model revealed that eight percent of the variance was attributed to classroom-level factors, justifying further analyses to explain this variance. When fall inquiry scores along with demographic covariates of age, gender, and ethnicity were entered as Level 1 predictors, fall inquiry scores significantly predicted spring inquiry scores, controlling for demographic covariates (β = .070, p <.01). To make coefficients interpretable, significant logit coefficients are exponentiated to create Incidence Rate Ratios (*IRR =1.07*, p <.01; Raudenbush & Bryck, 2002). For a one unit increase in number of questions in the fall, the expected number of questions in the spring increases by 7%. Inquiry outcomes did not significantly differ by gender, age, and ethnicity. See Table 3.

Next, Level 2 predictors of Emotional Support and Instructional Support were entered to examine the main effects of these variables of spring inquiry outcomes. Emotional Support did not significantly predict average performance on the spring inquiry assessment (β = .94, p = n.s). Instructional Support also did not significantly predict average performance on the spring inquiry assessment (β = 1.09, p = n.s). Finally, cross-level interactions were examined between Emotional Support and Instructional Support with gains in inquiry skills. A cross-level interaction effect was found for

Emotional Support (β = .05, p = .027) but not Instructional Support (β = -.02, p = n.s.). The relationship between fall and spring inquiry was significantly moderated by Emotional Support in the classroom; for children who displayed higher inquiry skills at the beginning of the year, gains in inquiry made by end of the year were greater when the child was enrolled in a classroom with high levels of Emotional Support. See Figure 2.

Inquiry and school readiness. It was hypothesized that inquiry would predict school readiness gains over the course of the year. However, the lack of variability in inquiry skills made it impossible to truly examine those relationships. In the fall, 41.4% of children did not ask any questions and 72% asked between 0 and 5 questions. Bivariate correlations revealed that the number of questions asked in the fall was significantly correlated with fall vocabulary ($r = .164$, $p < .01$) as well as spring vocabulary ($r = .146$, $p = .011$). Inquiry was not correlated with science, math, listening comprehension, or alphabet knowledge. The number of statements children made in the fall correlated with fall science, math, and vocabulary outcomes, as well as spring vocabulary outcomes. The number of statements children made in the spring also correlated with fall science, math, and vocabulary outcomes, as well as spring vocabulary and math outcomes. Questions generated in response to a request in the fall correlated with spring listening comprehension outcomes. For school readiness outcomes, see Table 4. For all correlations, see Tables 5 and 6.

Multilevel regression analyses revealed that the number of questions asked in the fall did not significantly predict gains in school readiness, controlling for demographic covariates. To further examine the relationship between inquiry and vocabulary, a binary variable was created to dichotomize fall inquiry scores into two groups: those who did not ask any questions and those that asked one or more question. When this binary variable was entered into multilevel model as a Level-1 predictor, results indicated that children who asked at least one question in the fall made significantly greater gains in vocabulary over the school year than children who did not, controlling for age, gender, and ethnicity (β = 7.45, p = .039). Age significantly predicted gains in vocabulary (β = .50, p <.01). Gender and ethnicity were not significant predictors. Emotional Support and Instructional Support were not found to moderate the relationship between inquiry and vocabulary. For classroom level outcomes, see Table 7.

Chapter 4

Discussion

Spontaneous Inquiry

The present study examined the use of explanatory questions by children in Head Start, the changes in that skill over the course of the year, and the role of teacher practices in children's change in inquiry. Results revealed that children asked few explanatory questions when presented with novel stimuli. In the beginning of the school year, forty percent of children did not ask questions, and only 10% of children asked more than 5 questions over the course of the assessment. The results also revealed that children generated more statements than questions about the stimuli. This finding suggests that children were verbal, engaged in the task, and were interested in the stimuli. While statements serve a function in getting the attention of an adult and engaging in conversation, asking a question elicits new information and extends understanding. Change in performance on the EIA revealed that children made significant gains in explanatory inquiry over the course of the school year. By the end of the year, 70% asked at least one question, while 30% still asked no questions. Although a large proportion of children still asked few or no questions, the significant increase in children's performance lends support to the malleability of this skill.

The EIA has not been used in other populations; therefore, direct comparisons cannot be made to other samples. However, numerous studies performed with middle income preschoolers repeatedly find that children ask many explanatory questions in similar situations (Chouinard, 2007; Frazier, Gelman, & Wellman, 2009; Henderson, 1984; Mills, Legare, Bills, & Mejias, 2011). Although replication is needed to draw more decisive conclusions, these findings identify a potential gap in the use of explanatory questions and provide a much-needed foundation for further research into this topic with children from low-income homes.

Much research and policy now identifies science –based curricula as a successful way to increase critical thinking and higher level teacher-child dialogue while incorporating literacy and math learning (French, 2004; Fuccillo, 2011; Gelman, Brenneman, Macdonald, &Román; 2009; Greenfield, Jirout, Dominguez, Greenberg, Maier, & Fuccillo, 2009; Grissmer, Grimm, Aiyer, Murrah, & Steele; 2010). Such recommendations commonly identify "asking a question" as the first step to engaging in scientific investigation. These findings suggest that this first, foundational step may not be happening in these classrooms. Children served by Head Start are among those who are most in need of comprehensive curricula that improve learning by strengthening domain-general learning skills that improve academic readiness. If children are not asking questions, they are missing out on the rest of the benefits that learning driven by the scientific method can provide.

Inquiry in Response to a Request

In addition to testing the spontaneous generation of explanatory questions, the EIA examined the extent to which children generated questions when a direct request to ask a question about particular stimuli was made. This component was added to the EIA as a result of pilot work that revealed that children rarely asked questions when asked to do so, often making a descriptive statement about the picture instead. Results supported the observations made during pilot work; given nine requests to ask a question about a picture, children generated an average of .5 questions in the fall, and .6 in the spring.

Children generated significantly more statements than questions in response to the requests. Although these results are preliminary and require further investigation, they may suggest that children do not understand the request, are unsure of what a "question" is, or are highly uncomfortable asking questions. Anecdotal data from a number of the assessments lends support to these suspicions. In the spring, three children asked what a question is, 11 children stated that they had already asked a question in response to repeated requests (after having made a statement), and one child said that she does not know what a question is. For children who are getting ready to enter kindergarten, this can have implications on their participation in classroom activities or the ability benefit from invitations to ask questions by a teacher.

Role of Teacher Practices

In addition to examining the gains in inquiry skills over time, the current project also examined the role of teacher practices in these gains. Specifically, the moderating role of Emotional Support and Instructional Support, as captured by the CLASS observation tool, was examined.

Emotional support. Emotional Support encompasses the level of positive climate, negative climate, teacher sensitivity, and regard for children's perspectives. Because children who feel comfortable with and supported by the adult may be more likely to engage in discussion and learning, it was hypothesized that an emotionally supportive classroom environment would positively impact children's inquiry skills over the course of the school year. Cross-level interaction analyses revealed that children who started the year with higher levels of inquiry made significantly greater gains when enrolled in classrooms with higher levels of Emotional Support. While more research is needed, this finding suggests that emotionally supportive classroom environments more successfully reinforced children's inquiry over the course of the school year in a way that increased use of questions in the spring.

Importantly, emotional support in the classroom significantly affected gains on an inquiry assessment conducted in a one-on-one format outside of the classroom. This implies that the effects of daily learning in an emotionally supportive environment builds or encourages inquiry in a way that results in increased use of questions beyond classroom activities or interactions with the child's teacher. The underlying mechanisms for this finding require further investigation. One possible explanation is that children who were made to feel comfortable expressing their curiosity in the classroom also felt more comfortable doing so with the assessor at the end of the school year. It is also possible that children whose inquiry was supported by the teacher asked questions more often, thereby practicing, being positively reinforced for, and gaining more proficiency in posing explanatory questions.

This finding makes an important contribution to the literature on inquiry as well as that on teacher practices. It highlights the malleable nature of inquiry skills, and suggests that when the classroom provides an environment in which the child feels safe expressing his or her curiosity, children are able to utilize and develop their inquiry skills to a greater extent. This adds to the growing literature on the benefits of Emotional Support in early childhood classrooms and highlights the importance of supporting classroom practices pertinent to this domain. Across Head Start programs, the CLASS is now used as a mandatory assessment of teacher practices and a tool for professional development (Improving Head Start for School Readiness Act of 2007, Section 641A, Paragraph 2, Subparagraph F). As such, these findings have important implications for programs such as Head Start that aim to close the achievement gap by providing high-quality education for children at risk.

Instructional support. Previous studies have found that higher levels of Instructional Support, measured by classroom observations of concept development, quality of feedback, and language modeling, is related to higher academic outcomes for children in those classrooms. For this reason it was hypothesized that children in classrooms with higher Instructional Support would make greater gains in inquiry than children in classrooms with lower levels. The results of this study did not confirm this hypothesis; no direct effect or moderation effect of Instructional Support on inquiry gains was detected. While this finding did not support the hypothesis, further inquiry into this relationship is merited. The CLASS instrument measures Instructional Support on a 7 point scale. However, our findings show that on average, classrooms in our sample scored a 2.2 on this measure, with little variability across classrooms (See Table 7). Such low scores and ranges make detecting an effect by classroom highly unlikely even if such an effect exists.

The indicators that comprise the subdomains of concept development and quality of feedback are measured by the degree to which the teacher extends conversation, creates feedback loops in discussions, and facilitates language use. Existing findings that highlight the benefits of Instructional Support as well as the potential benefits of inquiry-guided learning make it clear that further investigation into this relationship can benefit teachers and children in Head Start classrooms. Questions are a natural part of conversation and language; it is, therefore, important to examine the occurrence of questions made by teachers as well as by students, in classrooms with more variation in levels of Instructional Support. Additionally, assessing child-generated inquiry before and after an intervention that is specifically aimed at increasing instructional support may provide insights into the relationship between this aspect of classroom quality and children's inquiry.

Inquiry and School Readiness

One of the goals of this study was to examine the relationship between children's use of explanatory questions and school readiness outcomes. Although it was hypothesized that higher inquiry skills would predict higher readiness outcomes across domains of learning, the data only partially support this hypothesis; a relationship was only found between inquiry skills and vocabulary. This is not surprising due to the fact that on average, children asked few questions during the EIA, with a substantial proportion asking no questions at all. As such, the lack of variability in the EIA data makes it difficult to find relationships with other variables. It is also possible that asking questions is not often encouraged in the classroom and children's learning in domains such as math and science is, therefore, independent of their inquiry skills. More sensitive measures of inquiry as well as classroom observations are needed to better detect these associations.

The number of statements made during the EIA in the fall correlated with vocabulary, math, and science outcomes in the fall, as well as vocabulary outcomes in the spring. The number of statements children made in the spring also correlated with fall science, math, and vocabulary outcomes, as well as spring vocabulary and math outcomes. The nature of these associations needs further investigation before any conclusions can be drawn. Nevertheless, they point to an association between verbal display of interest in novel stimuli and readiness outcomes, and may lend support to existing literature that finds a positive relationship between children's engagement and academic success (Fredricks, Blumenfeld, & Paris, 2004; Tucker et al., 2002).

Inquiry and vocabulary. When the inquiry variable was dichotomized based on whether children asked at least one question, results revealed that children who asked at least one question made greater gains in vocabulary than children who did not ask any questions during the fall inquiry assessment. This finding points to an important relationship between inquiry and language. It is possible that children who ask questions when presented with novel stimuli likely have longer conversations with adults, and may be exposed to more advanced language as the adult provides an explanation to their inquiry. While science and math lessons in preschool tend to be specific, segregated activities in a preschool classroom, all interactions have the potential to expose children to language and vocabulary. As a result, asking questions may improve a child's vocabulary even if those questions occur outside the context of formal learning. Extensive research supports the importance of literacy and vocabulary at an early age and the subsequent benefits that the development of these skills has on continued educational success (e.g.: Caro, McDonald & Willms, 2009; Entwisle, Alexander, & Olson, 2005; Magnuson & Duncan, 2006; Weatherholt, Harris, Burns, & Clement, 2006). Although more detailed analyses of this relationship are needed, the finding that children who do not ask questions learn less vocabulary over the school year lends support to the importance of inquiry skills for improving school readiness.

Limitations and Future Directions

Although an extensive literature identifies child-generated inquiry as a catalyst for learning, measures that effectively capture this inquiry in preschoolers from disadvantaged backgrounds have not yet been developed. Pilot work revealed that measures successfully used with middle-income students were not appropriate for this population. For this reason, the EIA was developed. Although the EIA was more successful at eliciting explanatory questions than other measures that were pilot tested, data nevertheless revealed that, on average, children asked few explanatory questions and that a large portion of children did not ask a single question over the course of the assessment. These findings provide an important contribution to the literature and urge further research. However, floor effects and lack of variability make it difficult to look at the relationship between children's use of questions and other child- or classroom-level variables. Future research should investigate various measures of explanatory inquiry as well as use several types of measures within the same sample to compare findings. Conducting these studies with larger samples may also increase variability.

Because this assessment was conducted in a one-on-one manner by a researcher, it may not accurately reflect the use of explanatory questions when the child is in the classroom or with an adult with whom they feel comfortable. Observations of children's inquiry during various classroom activities may be more successful at capturing instances of child-generated questions. It would also be informative to obtain a measure of how often children pose explanatory questions in the home. Further, while it was found that children in more emotionally supportive classrooms make greater inquiry gains on the EIA, an assessment conducted outside the classroom, this study cannot draw conclusions about the mechanisms through which classroom environment affects children's overall use of questions. Follow-up work that investigates children's inquiry in the home, in the classroom, and on an assessment such as the EIA should be conducted to shed light on these relationships.

While this study found that children's inquiry outcomes did not vary by ethnicity, existing literature on parent-child as well as teacher-child interactions suggest that culture plays a large role in the ways in which children are taught to express curiosity and use language to access information (Callanan & Waxman, 2013; Mejía-Arauz, Roberts, & Rogoff, 2012). Behavior promoted and valued in one culture may be negatively viewed in another; while some children's questions are met with answers and positive feedback, others may be taught that asking questions of an elder is disrespectful and encouraged to learn through observation. These cultural differences may explain why assessments of inquiry successfully conducted in middle-income samples have not been successful in low-income, minority samples. Understanding the cultural norms can aid in designing assessments that more sensitively measure inquiry as well as informing teacher practices that encourage it in a culturally-appropriate manner.

The primary goal of this project was to measure child-generated explanatory questions and to examine gains in this type of inquiry over the year. Statements were also recorded during the assessment as an additional measure of curiosity and engagement in the task, but questions, not statements, were the focus of the design and administration of the EIA. Children's statements may provide valuable information about the children's response to unfamiliar stimuli and warrants further discussion. Future work using the EIA should focus of the development of a protocol that specifically outlines strategies for responding to and recording various types of statements made by the children. In addition, the EIA can be used to examine other, non-verbal displays of curiosity, such as the number of times a child physically picks up and examines an object, how many objects the child chooses to interact with, etc. Finally, it would be of interest to examine the relationships between these various displays of curiosity as well as develop an aggregate score of curiosity that can be looked at in association with other child- or teacher-level variables.

Another goal of this work was to examine teacher practices that affect children's inquiry. The CLASS has been found to be a valid, reliable tool that captures teacher practices integral for a healthy, successful classroom learning environment. Additionally, many Head Start centers now use the CLASS as an assessment tool in their centers, making the findings from this study directly applicable to Head Start administrators. However, studies have repeatedly shown that Head Start classrooms score low in the Instructional Support domain. For this reason, a more detailed examination of the interactions that define that domain may be necessary to capture the variability in these teacher practices. This can then be used to look at classroom-level effects of these practices on children's gains in explanatory inquiry as well as associations with other outcomes.

Conclusion

Research consistently finds that children in poverty score lower on measures of school readiness and fall further behind over time. Asking questions is a learning tool that, if used effectively, can initiate informative discussion, fill knowledge gaps, and sustain interest in a topic. The aim of the current study was to examine the extent to which low-income preschoolers use explanatory questions. The finding that children rarely asked explanatory questions when presented with novel, unfamiliar objects signals that preschoolers in this demographic are not effectively using questions to extend their learning. The finding that children who asked at least one question in the fall had higher vocabulary gains in the spring supports the association between inquiry and school readiness. As a catalyst for conversation, questions directed at a parent or teacher may provide a child with opportunities to hear more advanced language and vocabulary. Finally, the Emotional Support in a classroom was found to moderate gains in inquiry. This supports research that a warm, supportive environment makes children feel more comfortable in voicing their ideas and inquiries. Importantly, the inquiry assessment was conducted outside of the classroom; this suggests that the environment in the classroom impacted children's overall inquiry skills, not just their comfort with directing questions towards their teacher. Research to confirm this hypothesis is needed. This finding, nonetheless, adds to the literature that highlights the multitude of benefits created by a supportive instructional environment and the role that teachers have in shaping young children's cognitive, social, and emotional development. The current study lays a foundation for further research and opens the discussion about inquiry skills of children from low-income, culturally diverse backgrounds and the role of teachers in supporting the use and development of this important learning tool.

References

Administration on Children, Youth and Families. (2008, August 19). Information memorandum: Classroom Assessment Scoring System (CLASS). Log No. ACF-IM-HS-08-11. Retrieved April 14, 2012, from http://eclkc.ohs.acf.hhs.gov/hslc/Professional%20Development/ Staff%20 Development/Teaching%20Teams/resour_ime_011_0081908.html.

Alexander, K., Entwisle, D., & Kabbani, N. (2001). The dropout process in life course perspective: Early risk factors at home and school. *Teachers College Record*, *103*(5), 760-822. doi:10.1111/0161-4681.00134.

Berland, L. K., & McNeill, K. L. (2010). A learning progression for scientific argumentation: Understanding student work and designing supportive instructional contexts. *Science Education*, *94*(5), 775-793. doi:10.1002/sce.20402

Blank, S., & Covington, M. (1965). Inducing children to ask questions in solving problems. *Journal of Educational Research*, *59*(1), 21-27. Retrieved from PsycINFO database.

Brenneman, K., Stevenson-Boyd, J.S., & Frede, E. (2009). Math and science in preschool: Policies and practice. *Preschool Policy Matters*, *19*. New Brunswick, NJ: National Institute for Early Education Research.

Bodrova, E. & Leong, D. (2007). *Tools of the Mind: The Vygotskian approach to early childhood education (2nd edition)*. Upper Saddle River, NJ: Pearson.

Brown, A.L., & Kane, M.J. (1988) Preschool children can learn to transfer: Learning to learn and learning from example. Cognitive Psychology, 20(4), 493 -523

Bruner, J. (1984). Interaction, communication, and self. *Journal of the American Academy of Child Psychiatry, 23*(1), 1-7. doi:10.1097/00004583-198401000-00001

Burchinal, M., Howes, C., Pianta, R., Bryant, D., Early, D., Clifford, R., et al. (2008). Predicting child outcomes at the end of kindergarten from the quality of pre-kindergarten teacher-child interactions and instruction. *Applied Devfelopmental Science, 12*(3), 140-153.

Callanan, M., & Oakes, L. (1992). Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development*, *7*(2), 213-233. doi:10.1016/0885-2014(92)90012-G.

Callanan, M., & Waxman, S. (2013). Commentary on special section: Deficit or difference? Interpreting diverse developmental paths. *Developmental Psychology*, *49*(1), 80-83. doi:10.1037/a002974

Caro, D. H., McDonald, J., & Willms, J. (2009). Socio-economic status and academic achievement trajectories from childhood to adolescence. *Canadian Journal of Education*, *32*(3), 558-590

Chak, A. (2002). Understanding children's curiosity and exploration through the lenses of Lewin's field theory: On developing an appraisal framework. Early Child Development and Care, 172(1), 77-87. doi:10.1080/03004430210874

Chak, A. (2007). Teachers' and parents' conceptions of children's curiosity and exploration. *International Journal of Early Years Education*, *15*(2), 141-159. doi:10.1080/09669760701288690

Chak, A. (2010). Adult response to children's exploratory behaviours: An exploratory study. *Early Child Development and Care*, *180*(5), 633-646. doi:10.1080/03004430802181965

Chin, C., Brown, D. E., & Bruce, B. C. (2002). Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education, 24*(5), 521-49.

Chin, C., & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education, 44*(1), 1. Retrieved from http://search.proquest.com/docview/222853779?accountid=14585

Chin, C., & Osborne, J. (2010). Supporting argumentation through students' questions: Case studies in science classrooms. *Journal of the Learning Sciences*, *19*(2), 230-284. doi:10.1080/10508400903530036.

Chouinard, M. (2007). Children's questions: A mechanism for cognitive development. *Monographs of the Society for Research in Child Development*, 2007;72(1):vii-ix, 1-136.

Courage, M. (1989). Children's inquiry strategies in referential communication and in the game of twenty questions. *Child Development*, *60*(4), 877. doi:10.1111/1467-8624ep9676156.

Curby, T. W., LoCasale-Crouch, J., Konold, T. R., Pianta, R. C., Howes, C., Burchinal, M., & ... Barbarin, O. (2009). The relations of observed pre-K classroom quality profiles to children's achievement and social competence. *Early Education and Development*, *20*(2), 346-372.

Dickinson, D. K., & Smith, M. W. (1994). Long-term effects of preschool teachers' book readings on low-income children's vocabulary and story comprehension. *Reading Research Quarterly, 29*(2), 104-122.

Dillon, J.T. (1988). *Questioning and teaching: A manual of practice*. NewYork: Teacher’s College.

"Domain 4: Science." The Head Start Leaders Guide to Positive Child Outcomes. HHS/ACF/ACYF/HSB. 2003. English.

Dyasi, H. (2001). What Children Gain from Learning through Inquiry. Published in Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom. Published in *Division of Elementary, Secondary, and Informal Education, Directorate for Education and Human Resources, National Science Foundation.* http://www.nsf.gov/pubs/2000/nsf99148/pdf/nsf99148.pdf

Engel, S., & Randall, K. (2009). How teachers respond to children's inquiry. *American Educational Research Journal*, *46*(1), 183-202. doi:10.3102/0002831208323274

Engel, S. (2011). Children's need to know: Curiosity in schools. *Harvard Educational Review*, *81*(4), 625-645.

Entwisle, D., Alexander, K., & Olson, L. (2005). First grade and educational attainment by age 22: A new story. *American Journal of Sociology*, *110*(5), 1458-1502. doi:10.1086/428444.

Flammer, A. (1981). Towards a theory of question asking. *Psychological Research*, *43*(4), 407-420. doi:10.1007/BF00309225.

Frazier, B., Gelman, S., & Wellman, H. (2009). Preschoolers' search for explanatory information within adult-child conversation. *Child Development*, *80*(6), 1592-1611. doi:10.1111/j.1467-8624.2009.01356.x.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of educational research, 74(1), 59-109.

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. Early Childhood Research Quarterly, 19(1), 138-149.

Fuccillo, Janna (2011). Cognitively-challenging instruction in Head Start classrooms: Variation across contexts and effects on child outcomes. HS Grant # 90YR0036/01.

Gelman, R., & Brenneman, K. (2012). Moving young "scientists-in-waiting" onto science learning pathways: Focus on observation. In J. Shrager, S. Carver (Eds.) , *The journey from child to scientist: Integrating cognitive development and the education sciences* (pp. 155-169). Washington, DC US: American Psychological Association. doi:10.1037/13617-008

Gelman, R., Brenneman, K., Macdonald, G., & Román, M. (2009). *Preschool pathways to science (PrePS): Facilitating scientific ways of knowing, thinking, talking, and doing.* Baltimore, MD: Brookes Publishing.

Greenfield, D.B., Dominguez, M.X., Greenberg, A.C., Fuccillo, J.M., Maier, M.F., & Penfield, R. (2010). Lens on Science: *development and initial validation of an Item Response Theory-based assessment of preschool science knowledge and process skills*. Manuscript in preparation.

Greenfield, D. B., Jirout, J., Dominguez, X., Greenberg, A., Maier, M., & Fuccillo, J. (2009). Science in the preschool classroom: A programmatic research agenda to improve science readiness. *Early Education and Development*, *20*(2), 238-264.

Greif, M. L., Kemler Nelson, D. G., Keil, F. C., & Gutierrez, F. (2006). What do children want to know about animals and artifacts? Domain-specific requests for information. *Psychological Science*, *17*(6), 455-459. doi:10.1111/j.1467-9280.2006.01727.x

Grissmer, D., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world: Two new school readiness indicators. *Developmental Psychology*, *46*(5), 1008-1017. doi:10.1037/a0020104

Gopnik, A. (1998). Explanation as orgasm. *Minds and Machines*, *8*(1), 101-118. doi:10.1023/A:1008290415597.

Hackmann, H., & Engel,S (2002) Curiosity in context: The classroom environment examined. Unpublished honors thesis; Williams College.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD US: Paul H. Brookes Publishing.

Hamre, B. K., & Pianta, R. C. (2005). Can instructional and emotional support in the first-grade classroom make a difference for children at risk of school failure? *Child Development, 76*(5), 949-967.

Henderson, B. (1984). Social support and exploration. *Child Development, 55*(4), 1246–1251.

Hickling, A. K., & Wellman, H. M. (2001). The emergence of children's causal explanations and theories: Evidence from everyday conversation. *Developmental Psychology,* 37, 668– 683.

Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., et al. (2008). Ready to learn? children's pre-academic achievement in pre-kindergarten programs. *Early Childhood Research Quarterly, 23*(1), 27-50.

Huebner, C. E., & Meltzoff, A. N. (2005). Intervention to change parent-child reading style: A comparison of instructional methods. *Journal of Applied Developmental Psychology, 26*(3), 296-313.

Improving Head Start for School Readiness Act of 2007. 42 U.S.C.A. § 9801. Institute of Education Sciences, The National Board for Education Sciences (2010). Director's Final Proposed Priorities for the Institute Of Education Sciences. Retrieved April 14, 2012 from http://www.govtrack.us/congress/billtext.xpd?bill=h110-1429

Ibanez Molinero, R., & García-Madruga, J. (2011). Knowledge and question asking. *Psicothema*, *23*(1), 26-30.

King, A. (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain. *American Educational Research Journal*, *31*(2), 338-368. doi:10.2307/1163313.

Klahr, D. (2000). *Exploring science: The cognition and development of discovery processes*. Cambridge, MA US: The MIT Press.

Kuhn, D., & Pease, M. (2008). What needs to develop in the development of inquiry skills? *Cognition and Instruction*, *26*(4), 512-559. doi:10.1080/07370000802391745.

Lareau, A. (2003). *Unequal childhoods: Class, race, and family life.* Berkeley: University of California Press.

Linn, R. L., & Slinde, J. A. (1977). The determination of the significance of change between pre- and posttesting periods. Review of Educational Research, 47(1), 121-150.

Magnuson, K., & Duncan, G. (2006). The role of family socioeconomic resources in the black-white test score gap among young children. *Developmental Review*, *26*(4), 365-399. doi:10.1016/j.dr.2006.06.004.

Mashburn, A. J., Pianta, R. C., Hamre, B. K., Downer, J. T., Barbarin, O. A., Bryant, D., Burchinal, M., Early, D. M. and Howes, C. (2008), Measures of classroom quality in prekindergarten and children's development of academic, language, and social skills. Child Development, 79: 732–749. doi: 10.1111/j.1467-8624.2008.01154.x

Martin, V. L., & Pressley, M. (1991). Elaborative-interrogation effects depend on the nature of the question. *Journal of Educational Psychology*, *83*(1), 113-119. doi:10.1037/0022-0663.83.1.113

Martinello, M.L. (1998). Learning to question for inquiry. *The Educational Forum,* 62, 164-71.

McCartney, K., Burchinal, M. R., & Bub, K. L. (2006). Best practices in quantitative methods for developmentalists. *Monographs of the Society for Research in Child Development, 71*, 1-145.

McDermott, P., Fantuzzo, J., Waterman, C., Angelo, L., Warley, H., Gadsden, V., et al. (2009). Measuring preschool cognitive growth while it's still happening: The learning express. *Journal of School Psychology*, *47*(5), 337-366. doi:10.1016/j.jsp.2009.07.002.

Mejía-Arauz, R., Roberts, A. D., & Rogoff, B. (2012). Cultural variation in balance of nonverbal conversation and talk. *International Perspectives in Psychology: Research, Practice, Consultation*, *1*(4), 207.

Mills, C. M., Legare, C. H., Grant, M. G., & Landrum, A. R. (2011). Determining who to question, what to ask, and how much information to ask for: The development of inquiry in young children. *Journal of Experimental Child Psychology*, *110*(4), 539-560. doi:10.1016/j.jecp.2011.06.003

Muthen, L.K., & Muthen, B.O. (2010). *Mplus user's guide: Sixth edition*. Los Angeles, CA: Muthen & Muthen.

National Assessment of Educational Progress (2009). The Nation's Report Card: Trial Urban District Assessment Reading 2009 Retrieved June 4, 2010, from http://nces.ed.gov/nationsreportcard/pdf/dst2009/2010459.pdf

Nayfeld, I. (2011) The Inquiry Game: Assessing Inquiry Skills in Low-Income Preschoolers" *Open Access Theses*. Paper293.http://scholarlyrepository.miami.edu/oa_theses/293

Nayfeld, I., Fuccillo, J., & Greenfield, D. B. (2013). Executive functions in early learning: Extending the relationship between executive functions and school readiness to science. *Learning and Individual Differences*.

Nayfeld, I., Brenneman, K., & Gelman, R. (2011). Science in the classroom: Finding a balance between autonomous exploration and teacher-led instruction in preschool settings. *Early Education And Development*, *22*(6), 970-988. doi:10.1080/10409289.2010.507496

Neuman, S., & Celano, D. (2006). The knowledge gap: Implications of leveling the playing field for low-income and middle-income children. *Reading Research Quarterly*, *41*(2), 176-201. doi:10.1598/RRQ.41.2.2.

Newman, R. (1998). Adaptive help seeking: A role of social interaction in self-regulated learning. *Strategic help seeking: Implications for learning and teaching* (pp. 13-37). Mahwah, NJ US: Lawrence Erlbaum Associates Publishers.

OHS Summit: On the Road to School Readiness. HHS/ACF/OHS. 2011. English.

Palincsar, A., & Brown, A. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, *1*(2), 117-175. . doi:10.1207/s1532690xci0102_1.

Perry, M., VanderStoep, S. W., & Yu, S. L. (1993). Asking questions in first-grade mathematics classes: Potential influences on mathematical thought. *Journal Of Educational Psychology*, *85*(1), 31-40. doi:10.1037/0022-0663.85.1.31

Piaget, J., & Inhelder, B. (1969) *The psychology of the child*. New York, NY: Basic Books, Inc.

Pianta, R., Howes, C., Burchinal, M., Bryant, D., Clifford, R., Early, D., & Barbarin, O. (2005) Features of pre-kindergarten programs, classrooms, and teachers: Do they predict observed classroom quality and child-teacher interactions? *Applied Developmental Science, 9,* 144-159.

Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2008). *Classroom assessment scoring system™: Manual K-3*. Baltimore, MD US: Paul H Brookes Publishing.

Ram, A. (1991). A theory of questions and question asking. *Journal of the Learning Sciences*, *1*(3-4), 273-318. doi:10.1207/s15327809jls0103&4_2.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Application and data analysis methods* (2nd ed.). Newbury Park, CA: Sage.

Raudenbush, S.W., Bryk, A.S, & Congdon, R. (2004). HLM 6 for Windows [Computer software]. Lincolnwood, IL: Scientific Software International, Inc.

Risley, T., & Hart, B. (2006). Promoting early language development. *The crisis in youth mental health: Critical issues and effective programs, Vol. 4: Early intervention programs and policies* (pp. 83-88). Westport, CT US: Praeger Publishers/Greenwood Publishing Group.

Roehrig, G.H.; Dubosarsky, M., Mason, A.; Carlson, S., & Murphy, B., (2011). We look More, listen more, notice more: Impact of sustained professional development on Head Start teachers' inquiry-based and culturally-relevant science teaching practices. *Journal of Science Education and Technology*, 20(5), 566-578.

Rogoff, B. (1991). Social interaction as apprenticeship in thinking: Guided participation in spatial planning. *Perspectives on socially shared cognition* (pp. 349-364). Washington, DC US: American Psychological Association. doi:10.1037/10096-015.

Rule, A. (2007). Mystery boxes: Helping children improve their reasoning. *Early Childhood Education Journal*, *35*(1), 13-18.

Schwabe, A., Olswang, L., & Kriegsmann, E. (1986). Requests for information: Linguistic,cognitive, pragmatic, and environmental variables. *Language, Speech, and Hearing Services in Schools*, *17*(1), 38-55.

Skinner, E., & Belmont, M. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology*, *85*(4), 571-581. doi:10.1037/0022-0663.85.4.571.

Skinner, E., Kindermann, T., Connell, J., & Wellborn, J. (2009). Engagement and disaffection as organizational constructs in the dynamics of motivational development. *Handbook of motivation at school* (pp. 223-245). New York, NY US: Routledge/Taylor & Francis Group.

Stipek, D. J., Feiler, R., Byler, P., Ryan, R., Milburn, S., & Salmon, J. M. (1998). Good beginnings: What difference does the program make in preparing young children for school? *Journal of Applied Developmental Psychology, 19*(1), 41-66.

Spybrook, J., Bloom, H., Congdon, R., Hill, C., Martinez, A., & Raudenbush, S. (2011). Optimal Design Plus Version 3.0.

Tizard, B, & Hughes, M. (1984) *Young children learning*. Cambridge, MA: Harvard University Press.

Tucker, C. M., Zayco, R. A., Herman, K. C., Reinke, W. M., Trujillo, M., Carraway, K., ... & Ivery, P. D. (2002). Teacher and child variables as predictors of academic engagement among low-income African American children. *Psychology in the Schools*, *39*(4), 477-488.

Valdez-Menchaca, M. C.,&Whitehurst, G. J. (1992). Accelerating language development through picture book reading: A systematic extension to Mexican day care. *Developmental Psychology, 28,* 1106–1114.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Trans.). Cambridge, MA: Harvard University Press. (Original work published in 1930).

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development*, *65*(2), 606-621. doi:10.2307/1131404.

Weatherholt, T., Harris, R., Burns, B., & Clement, C. (2006). Analysis of attention and analogical reasoning in children of poverty. *Journal of Applied Developmental Psychology*, *27*(2), 125-135

Table 1

Descriptive Statistics of Child Level Variables for Explanatory Inquiry Assessment

	N	Mean	SD	Minimum	Maximum
Fall					
Questions	367	3.79	5.09	0.00	25.0
Statements	367	5.88	5.65	0.00	32.00
Questions Req.	350	0.50	1.42	0.00	13.00
Statements Req.	350	6.72	3.31	0.00	20.00
Spring					
Questions	345	5.93	7.42	0.00	39.00
Statements	345	10.32	8.39	0.00	59.00
Questions Req.	343	0.62	1.51	0.00	10.00
Statements Req.	342	9.65	4.01	0.00	23.00

Table 2

Bivariate Correlations between Fall and Spring Outcomes on Explanatory Inquiry Assessment

	1	2	3	4	5	6
1. Fall Qs	-	.366**	.376**	.180**	.317**	.108*
2. Spring Qs	.366**	-	.201**	.420**	.117*	.343*
3. Fall Statements	.376**	.201**	-	. 362**	-.036	.033
4. Spring Statements	.180**	.420**	. 362**	-	.028	.102
5. Fall Request Qs	.317**	.117*	-.036	.028	-	.071
6. Spring Request Qs	.108*	.343**	.033	.102	.071	-

** *p* < .01

Table 3

Multilevel Modeling Results for Final Model

Fixed Effect	Coefficient	Standard error	*t*-ratio	*d.f.*	*p*-value
Intercept, β_0					
Intercept, γ_{00}	1.661	0.103	15.988	34	<0.001
Emotional Support, γ_{01}	-0.066	0.107	-0.618	34	0.541
Instructional Support, γ_{02}	0.086	0.129	0.669	34	0.508
Ethnicity slope, β_1					
Intercept, γ_{10}	-0.087	0.094	-0.916	256	0.360
Gender slope, β_2					
Intercept, γ_{20}	0.104	0.112	0.930	256	0.353
Age slope, β_3					
Intercept, γ_{30}	0.008	0.006	1.304	256	0.193
Fall Inquiry slope, β_4					
Intercept, γ_{40}	0.070	0.0121	5.654	34	<0.001
Emotional Support, γ_{41}	0.050	0.021	2.315	34	0.027
Instructional Support, γ_{42}	-0.026	0.020	-1.325	34	0.194

Table 4

Descriptive Statistics of Child Level Variables for School Readiness Measures

	N	Mean	SD	Minimum	Maximum
Fall					
Alphabet Knowledge	322	189.75	51.70	74.92	311.90
Vocabulary	322	181.06	53.01	62.39	307.43
Math	322	180.23	45.25	72.57	308.10
Listening Comp.	322	186.50	47.64	75.59	266.85
Science	346	200.89	44.84	71.50	320.00
Spring					
Alphabet Knowledge	304	223.52	48.45	74.92	334.36
Vocabulary	304	211.94	45.98	62.39	311.10
Math	304	216.44	41.65	72.57	311.09
Listening Comp.	304	210.40	38.13	75.59	273.37
Science	337	214.71	45.78	81.50	332.00

Table 5

Bivariate Correlations between Explanatory Inquiry and Fall Readiness Outcomes

	Science	Alphabet Knowledge	Vocabulary	Math	Listening Comp.
Fall Qs	.076	.013	.164**	.046	.083
Spring Qs	.072	-.042	.063	.035	.065
Fall Statements	.162**	.089	.184**	.156**	.095
Spring Statements	.116**	.083	.128*	.122*	.092
Fall Request Qs	.091	-.040	.075	.022	.042
Spring Request Qs	.049	.009	.065	.038	.098

** $p < .01$
* $p < .05$

Table 6

Bivariate Correlations between Explanatory Inquiry and Spring Readiness Outcomes

	Science	Alphabet Knowledge	Vocabulary	Math	Listening Comp.
Fall Qs	-.058	-.016	.146*	.011	-.037
Spring Qs	.028	.002	.085	.036	-.004
Fall Statements	.077	.081	.130*	.091	.091
Spring Statements	.053	.069	.191*	.139*	.087
Fall Request Qs	-.038	.040	.060	.013	.119*
Spring Request Qs	.056	.020	.047	.086	.088

* $p < .05$

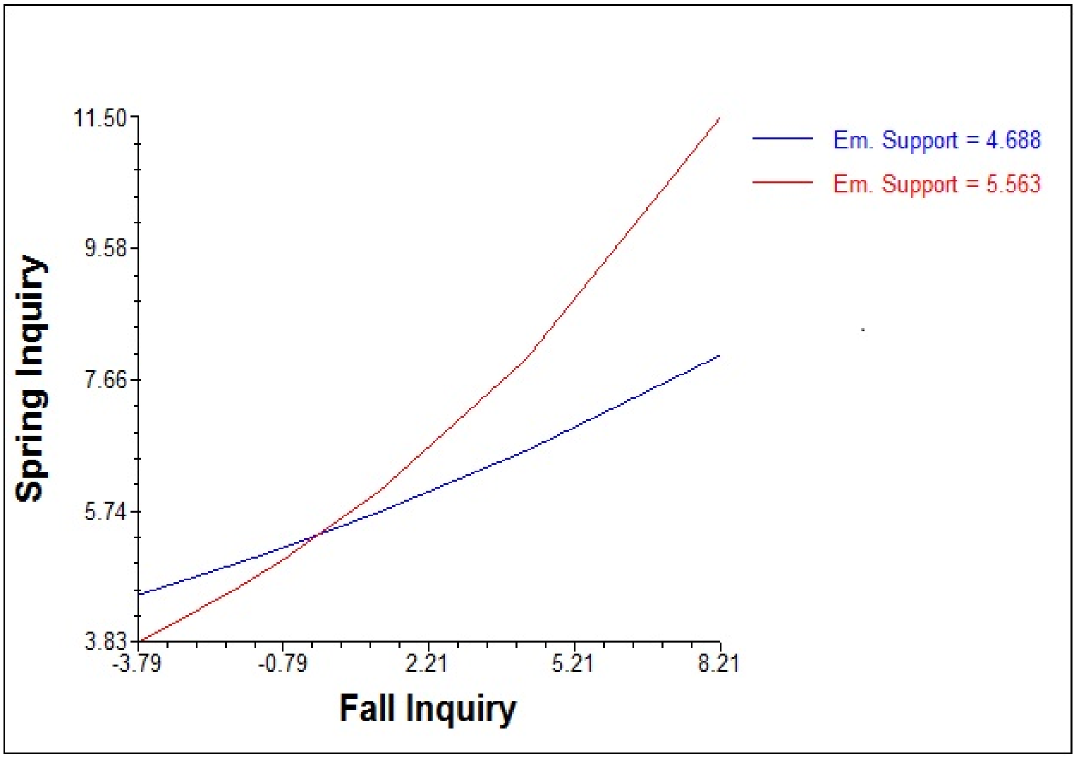
Table 7

Descriptive Statistics of Classroom Level Variable

	N	Mean	SD	Minimum	Maximum
Emotional Support	37	5.09	.75	2.88	6.38
Instructional Support	37	2.19	.60	1.08	3.42

	Form A	Form B
Items		
1.	empty M&Ms wrapper	magnet fishing rod
2.	paper cup with holes	picture of house with winking dog
3.	picture of banana cheerleader	toy glasses and nose
4.	puzzle watch	zip-lock bag with ketchup, ring, string
5.	origami banana with shapes	mini notebook
6.	empty bubble bottle	teabag
7.	plastic leaves	crayon box with penny inside
8.	pick-up sticks	camel and rhino glued together
9.	golf score keeper	two crayon halved taped
10.	three crayons taped together	paperclips link
Magic School Bus Book Covers		
1.	Inside a Beehive	Hops Home
2.	Blows Its top	In the Time of the Dinosaurs
3.	Meets the Rot Squad	Sees Stars

Figure 1. Items and book covers used in Explanatory Inquiry Assessment.



*Fall inquiry scores are group-centered

Figure 2. Cross-level interaction between inquiry gains and classroom Emotional Support.