EXAMINING CLASSROOM QUALITY AS A MODERATOR BETWEEN PRE-KINDERGARTEN PARTICIPATION AND SCHOOL READINESS

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Human Development & Family Studies

West Lafayette, Indiana

August 2019

THE PURDUE UNIVERSITY GRADUATE SCHOOL
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ACKNOWLEDGMENTS

I would first like to thank my co-advisors, Drs. James Elicker and Sara Schmitt, who have been instrumental to my development during my graduate training and to the completion of this thesis. Jim, your introduction to the world of child care quality and education has ignited a passion in me to continue working at the intersections of early childhood program evaluation, policy, and practice. Sara, thank you for readily and gracefully mentoring me as one of your students and teaching me the ropes of academia, from theory to professional development. Oftentimes, I would leave your office feeling energized and motivated. I am thankful for your continued mentorship. I would also like to acknowledge Dr. David Purpura for his writing advice and thoughtful questions that deepened my thinking. Finally, I would like to thank Dr. Katrina Schmerold; your demonstration of kindness in research and your scaffolding as I was navigating my work on the pre-k project are traits I hope to carry into my future line of work.

A warm thank you to my cohort-mates and friends in the HDFS department. Whether it was in an office or during writing group, you all cultivated interesting and safe spaces to process our learning and thinking while also making time for laughter, exploration, and sisterhood. To my encouraging parents, welcoming family, and dear friends near and far: thank you for reminding me to be myself and to keep in touch with my roots.

Last, but certainly not least, I would like to thank Kevin, my life partner. Thank you for your immense support through this entire experience, from the small reassurances to always keeping me grounded. We achieved important milestones at this stage in our lives, from both earning our graduate degrees to growing as a family with the addition of our four-legged southern belle, Ellie Mae.

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ABSTRACT

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Degree Received: August 2019
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The current study examined the extent to which associations between participation in a targeted state-funded pre-kindergarten (pre-k) program and children's literacy, numeracy, executive function (EF), and social-emotional skills were moderated by the quality of teacher-child interactions. Data came from an evaluation of a state-funded pre-k program including children enrolled in pre-k and those in a matched comparison group. The sample consisted of 558 children (M_{age} = 57.74 months) from two cohorts (48.9% female; 43.7% African American; 0.8% Asian; 32.3% European American; 12.4% Hispanic; 10.4% Multiracial). Children's school readiness assessments and teacher surveys were collected during fall and spring of the preschool year. Research assistants assessed teacher-child interactions using the Pre-K Classroom Assessment Scoring System (CLASS; Pianta, La Paro, Hamre, 2008) once in the winter of the preschool year. Two-level multilevel linear models were conducted for each school readiness domain and included a variety of control variables. Results suggested that emotional support, classroom organization, and instructional support did not significantly moderate the relation between pre-k participation and literacy, numeracy, EF, and social-emotional skills.

INTRODUCTION

School readiness skills such as emergent literacy, executive function (EF), social-emotional skills, and early numeracy are foundational skills that children need to develop in preschool in order to succeed in kindergarten and beyond (Romano, Babchishin, Pagani, & Kohen, 2010). State-funded pre-kindergarten (pre-k) programs serve as platforms for promoting children's school readiness skills, as these programs are specifically tailored to prepare children for entry to kindergarten (Early et al., 2005). Additionally, research shows that there are significant impacts of some of these programs on children's school readiness skills (Gormley, Gayer, Phillips, & Dawson, 2005; Gormley, Phillips, & Gayer, 2008; Lipsey, Farran, Bilbrey, Hofer, & Dong, 2011; Weiland & Yoshikawa, 2013; Wong, Cook, Barnett, & Jung, 2008). The quality within state-funded pre-k programs can also shape children's school readiness skills (Burchinal et al., 2008; Howes et al., 2008; Mashburn et al., 2008). Further, emerging research suggests that aspects of quality may act as moderators between state-funded pre-k participation and school readiness because quality may amplify the effect of the pre-k program, thus enhancing children's school readiness skills even more. For instance, in one study, the association between participation in one universal, state-funded pre-k program and children's literacy and numeracy was stronger when classroom quality (specifically instructional support) was higher (Johnson, Markowitz, Hill, & Phillips, 2016). Although this study established classroom quality as a moderator, replication research is needed utilizing a sample of children in an income-targeted pre-k program (i.e., not a sample of children in a universal pre-k program) to explore whether these findings generalize. Further, research is needed that extends these analyses to non-academic school readiness outcomes, such as EF and social-emotional skills. Thus, the goal of the current study was to test classroom quality as a moderator to examine whether the association between participation in a targeted state-funded pre-k program and children's early numeracy, literacy, social-emotional skills, and EF varied depending on the level of instructional support, emotional support, and classroom organization.

School Readiness

Based on the skills beget skills hypothesis, which states that early skills act as a foundation upon which later skills are built (Cunha & Heckman, 2007), it is important to foster children's school readiness skills (i.e., skills developed before entry to formal schooling). School readiness skills are pivotal not only for children's future academic achievement, but also for myriad other outcomes relating to health, educational attainment, income, and social adaptation (Pagani & Fitzpatrick, 2014; Moffitt et al., 2011). Broadly, school readiness is defined as the cognitive (e.g., mathematics), social-emotional, physical, dispositional, and linguistic (e.g., emergent reading) skills that prepare children for the social and academic demands of primary school, with EF as a recent addition (Halle, Hair, Burchinal, Anderson, & Zaslow, 2012). In particular, preschoolers' early mathematics, emergent literacy, attention skills (a component of EF), and social-emotional skills are shown to be some of the strongest predictors for later academic achievement (Duncan et al., 2007; Jones, Greenburg, Crowley, 2015). Although school readiness is operationalized to encompass many skills (Halle et al., 2012), the current study is focused primarily on EF, social-emotional skills, literacy, and early numeracy primarily because these early skills are particularly important for later academic achievement (Duncan et al., 2007; Jones et al., 2015).

Executive function. EF is foundational for acquiring academic skills and is a key predictor of healthy development (Blair & Raver, 2015). Working memory, cognitive flexibility, and inhibitory control are the three main cognitive processes that comprise EF (Blair, 2016).

Working memory is the ability to remember, understand, and process information; cognitive flexibility is the ability to maintain attention, ignore external stimulation, and multitask; and inhibitory control is the ability to refrain from natural impulses (McClelland, Cameron, Wanless, & Murray, 2007). Every day classroom behaviors such as completing tasks, organizing spaces, standing in line, planning future behavior, and communicating and listening to peers and teachers are supported by EF (McClelland et al., 2007). Although some recent studies have shown that EF is multidimensional (e.g., working memory and inhibitory control are distinct; Lerner & Lonigan, 2014), most researchers posit that EF is a unidimensional construct during the preschool years (ages 3 to 5) consisting of the integration of the three skills (Allan & Lonigan, 2011; Hughes, Ensor, Wilson, & Graham, 2009; Wiebe, Espy, & Charak, 2008).

EF development accelerates around ages 3 to 4, suggesting that this age bracket is a sensitive period for developing these skills and is worth investigating in a classroom context (Anderson, 2002; Miller, 2011). Rapid growth in EF skills during this time frame can be explained from a neurobiological perspective because the area responsible for EF (the prefrontal cortex) undergoes considerable structural changes between ages 3 and 5 (Garon, Bryson, & Smith, 2008). This rapid growth in EF can also be explained using the Cognitive Complexity and Control (CCC) theory (Frye, Zelazo, & Burack, 1998). Researchers using the CCC theory maintain that as children grow and develop, the ability to control cognitions and the ability to understand complex rules strengthens incrementally (i.e., as age increases so does children's ability to control their emotional, cognitive, and behavioral process and navigate complex rules; Zelazo, Muller, Frye, & Marcovitch, 2003). The CCC theory supports growth of EF during the preschool age.

Much of the research on early EF has focused on its association with short- and long-term academic achievement. Within the preschool year, researchers have found a connection between early EF skills and academic performance (Welsh, Nix, Blair, Bierman & Nelson, 2010). Although the development of EF occurs most rapidly between ages 3 and 5 (Anderson, 2002), the relation between early EF and academic achievement is not confined to early childhood. Some findings suggest that children who have higher EF in preschool and kindergarten have better math and reading abilities in elementary, middle, high school, and college (Best, Miller, & Naglieri, 2011; McClelland, Acock, & Morrison, 2006; McClelland, Acock, Piccinin, Rhea, & Stallings, 2013). Additionally, there are implications of EF for health. Using a longitudinal design, Francis & Susman (2009) found that children ages 3 to 5 with higher EF had lower BMI at age 12 than children who had lower EF. In addition to EF, there are other school readiness competencies, such as numeracy skills, that predict important developmental outcomes.

Early numeracy. Children's early numeracy is particularly important for more advanced mathematical skills in kindergarten and primary school (Jordan, Kaplan, Ramineni, & Locuniak, 2009). Numeracy is comprised of numbering, relations, and arithmetic operations. Numbering is the ability to count (e.g., one-to-one counting, subitizing, cardinality), relations is the understanding of the connections between numbers and sets (e.g., set comparison), and arithmetic operations is the early understanding of the rules regarding addition and subtraction (Purpura & Lonigan, 2013). Numeracy has been identified as especially important to foster in preschool because early numeracy skills set the foundation for the ability to do algebra, fractions, and measurement, which are all important milestones in 8th grade curricula (National Mathematics Advisory Panel, 2008).

Children's development of numeracy skills occurs through a learning trajectory wherein children sequentially learn new concepts by connecting them to past knowledge (Sarama & Clements, 2009). The trajectory begins during informal experiences (i.e., prior to the entry of formal schooling) when children practice early mathematical concepts through play that is typified by symbols and activities (e.g., block play) rather than conventional writing practices (Ginsburg, 1977). There are three overlapping phases of informal numeracy development: foundational skills (e.g., set comparison and verbal counting); meaningful numbering skills (e.g., one-to-one counting, subitizing, and linking cardinals to words); and operations on verbal numbers (e.g., story problems; Krajewski & Schneider, 2009). Later in the numeracy trajectory, children are able to recognize simple numerical notation (e.g., signs for addition, subtraction, and equal) and solve operations with Arabic numbers, which is attributed to numeral knowledge, a key mechanism that begins to develop in preschool (Purpura, Baroody, & Lonigan, 2013).

Early numeracy skills predict children's short- and long-term outcomes and are an integral part of school readiness (Jordan et al., 2009). For example, informal numeracy skills have been shown to be related to formal math skills that begin in kindergarten and extend from first through third grade (Aunio & Niemivirta, 2010; Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Jordan et al., 2009; Jordan, Glutting, & Ramineni, 2010; Jordan, Kaplan, Locuniak, & Ramineni, 2007). In addition to short term effects, the benefits of strong early numeracy knowledge uniquely predict children's mathematical achievement in middle and high school (Geary, 2011; Siegler et al., 2012). Moreover, there is evidence to suggest that children who are already at risk (e.g., from families with low income) who also have a low number knowledge in the beginning of kindergarten, are at a heightened risk for developing math difficulties by the start of primary school (Jordan, Kaplan, Olah, & Locuniak, 2006).

Early literacy. Early literacy is another foundational skill essential for later reading as well as other academic outcomes (Lonigan, Burgess, Anthony, 2000; Lonigan & Shanahan, 2009). There are three basic facets of early literacy: print awareness, oral language, and phonological awareness (Pullen & Justice, 2003). Print awareness refers to children's ability to recognize the written alphabet/language, to understand the direction of words/sentences, and to conceptualize print. Oral language encompasses the range of children's vocabulary and knowledge of grammar. Phonological awareness is defined as children's ability to "blend" and "segment" (i.e. manipulate) language, typically exercised through rhyming and alliteration (Pullen & Justice, 2003).

The acquisition of literacy is characterized on a developmental continuum that starts in early childhood and continues into elementary school (Whitehurst & Lonigan, 1998). Early reading-related skills begin to develop around preschool and are often described as "emergent literacy skills" (Whitehurst & Lonigan, 1998). These emergent literacy skills are precursors for more advanced reading skills required in elementary school (Kendeou, Van den Broek, White, & Lynch, 2009). In 2009, the National Reading Panel determined that alphabet knowledge (i.e., recognizing and knowing sounds of letters) and comprehension (i.e., understanding the meaning of words) were the basic pre-reading skills necessary for children to be able to fully read and write (Lonigan & Shanahan, 2009), and it is during the preschool years that children begin to acquire these skills.

Early literacy is considered an important part of school readiness because it sets the foundation for children to be able to read and write (Lonigan & Shanahan, 2009). Preschool emergent literacy skills have been shown to strongly predict the degree of reading proficiency in elementary school (Kendeou et al., 2009; Scarborough, Dobrich, & Hager, 1991). Specifically, letter knowledge and phonological sensitivity have been shown to distinctly predict decoding in grade school (Lonigan et al., 2000). Further, children who do not develop early literacy skills are at risk for academic failure (Cabell, Justice, Konold, & McGinty, 2013). In addition to early literacy, social-emotional school readiness competencies need to be considered because they also predict other important developmental outcomes.

Social-emotional skills. Children's social-emotional skills in early childhood predict their future academic success and a host of other well-being outcomes (Jones et al., 2015). Although social-emotional skills encompass both social behaviors and emotion recognition/regulation, they are often considered a single dimension (Kagan, Moore, Bradekemp, 1995). Social competence refers to the ability to build positive relationships and successfully interact with peers, parents, and teachers (Rubin, Bukowski, & Parker, 1980). Emotional competence includes the ability to identify, display, and regulate one's emotions, as well as relate to others' emotions (Saarni, 1990). Some examples of children exhibiting social-emotional skills in the classroom include interactions with peers (e.g., sharing toys), empathizing (e.g., perspective taking), and regulating one's emotions when given instruction.

Given that children's entry to preschool may be the first time they are interacting with adults (excluding family) and peers, it is an important context for the development of social-emotional skills. Drawing from developmental theory, it is posited that children have an innate social disposition making them capable of behaviors such as friendship, empathy, cooperation, and generosity (Da Ros-Voseles & Fowler-Haughey, 2007), thus affecting their social interactions. Social interactions may also in turn influence and enhance children's social-emotional capacity in a reciprocal nature (Gagnon & Nagle, 2004).

There are many correlates of social-emotional skills. For example, one study found that positive peer interactions during play were associated with increased engagement in academic activities and positive attitudes toward learning (Coolahan, Fantuzzo, Mendez, McDermott, 2000). However, children's social-emotional skills are not only important in early childhood. From a long-term perspective, it has been demonstrated that children's social connectedness at age 5 is related to their well-being in early adulthood (Olsson, McGee, Nada-Raja, & Williams, 2013).

In summary, a strong body of literature illustrates the importance of developing early skills due to their strong impact on later academic achievement, as well as other developmental outcomes. The context, whether it be the home or classroom environment, in which children are developing these skills, matters. Because a majority of children in the United States are enrolled in some type of child care (U.S. Department of Education, 2016), early skill building occurs in a classroom context (Hamre & Pianta, 2007) within pre-k programs.

State-Funded Pre-K Programs

Early literacy, numeracy, EF, and social-emotional competence are malleable skills that are impacted by children's early experiences specifically within the context of state-funded pre-k (Weiland & Yoshikawa, 2013). State-funded pre-k programs are organized with specific missions of instilling school readiness skills within children, and are monitored by state governments (Early et al., 2005). Compared to enrollment in the early 2000s, which was approximately 700,000 preschoolers nationwide (Barnett, Hustedt, Robin, & Schulman, 2003), in 2017, 43 states were collectively serving 1.5 million 4-year-olds in state-funded pre-k programs (Friedman-Krauss et al., 2018). Whereas the term "preschool" can apply to a number of different settings, providers, and age ranges, state-funded pre-k programs are distinct because of their specific regulations that are linked to state policies (Friedman-Krauss et al., 2018). According to the National Institute for Early Education Research (NIEER), state pre-k programs: 1) are funded by the state, 2) are child-focused, 3) primarily serve children ages 3 to 4, 4) fund learning opportunities for children at least two days a week, 5) are typically not designed for children with disabilities, but will provide services when needed, 6) can supplement Head Start, and 7) are separate from state subsidized child care, although integration with the state subsidy system is accepted (Friedman-Krauss et al., 2018). Features of state-funded pre-k programs such as physical structure (e.g., licensed homes, child care centers, faith-based ministries, public schools), population served (e.g., universal, targeted), and program requirements (e.g., curricula, teacher education, teacher coaching) vary because each state is free to develop its own approach (Friedman-Krauss et al., 2018).

Impacts of state-funded pre-k on school readiness. Decades of research has documented the impacts of state-funded pre-k participation on children's school readiness skills. According to the compensatory hypothesis (Sameroff & Chandler, 1975), preschool experiences may be particularly beneficial to children from low-income backgrounds because they may compensate for a lack of skill building opportunities prior to preschool entry. Indeed, there are some notable state-funded pre-k evaluations that have been done in states such as Massachusetts, Oklahoma, North Carolina, and Georgia, as well as 11 additional states included in the samples of both the National Center for Early Development and Learning (NCEDL)'s Multi-State Study of Pre-Kindergarten and the State-Wide Early Education Programs (SWEEP) study (Early et al., 2005). Overall, these single-state and multi-state evaluations suggest that state-funded pre-k programs impact children's language and literacy the most, followed by less substantial effects on children's mathematics and social-emotional skills, and some small emerging effects on children's EF (Early et al., 2005; Gormley, et al., 2005; Gormley et al., 2008; Gormley Jr, Phillips, Newmark, Welti, & Adelstein, 2011; Hustedt, Barnett, Jung, & Friedman, 2010; Hustedt, Barnett, Jung, & Thomas, 2007; Lipsey, Farran, & Durkin, 2018; Peisner-Feinberg, 2017; Weiland & Yoshikawa, 2013; Wong et al., 2008). However, it should be noted that not all early education experiences will compensate; some state evaluations have not found significant effects on children's phonological awareness, social-emotional skills, or early mathematical skills (Barnett, Lamy, & Jung, 2005; Gormley & Gayer, 2005; Wong et al., 2008).

Maintenance of quality standards. One of the most critical differences in program variation is maintenance of quality standards (Barnett et al., 2003), which may explain some of the mixed findings of various states' pre-k programs on children's outcomes. Some state-funded pre-k programs align their quality standards to NIEER's New Quality Standards Checklist (e.g., small teacher-child ratios, teacher education qualifications, curriculum adherence, and professional development; Friedman-Krauss et al., 2018) in order to maintain high classroom quality. Another method for maintaining high classroom quality in state-funded pre-k programs is by organizing structural quality standards into a tiered quality system such as a Quality Rating and Improvement System (QRIS; Barnett et al., 2017), which includes the same (or similar) benchmarks as NIEER. Yet, of the 43 current state-funded pre-k programs, about half do not organize their quality standards using a QRIS (Barnett et al., 2017). QRISs are a tool used to systematically measure the quality of child care and early education programs in order to improve quality standards and assign official quality levels; a provider typically must meet all low level criteria before moving up a level (Tout et al., 2010). Some of the most common standards used to define quality levels in states' QRISs include, but are not limited to, state child care licensing (including health and safety standards), providing a stimulating learning environment, family partnerships, staff qualifications, regular staff in-service training, national accreditation, evidence based curricula, staff-child ratio, and group size (Tout et al., 2010). In Indiana, for example, QRIS level 1 consists of basic health and safety standards required by licensing, level 2 includes a nurturing and educationally focused learning environment, level 3 includes use of a written curriculum, and level 4 is awarded upon achieving national accreditation (Elicker et al., 2013; Elicker & Ruprecht, in press).

Emerging research shows that children who attend higher QRIS-rated early care and education programs outperform children in programs with lower QRIS levels on school readiness outcomes such as language comprehension, word decoding, alphabet knowledge, phonological awareness, and EF in the preschool year (Elicker et al., 2017; Sabol & Pianta, 2015). The rationale behind situating state-funded pre-k within QRISs is that children will receive high quality early education experiences, which would theoretically lead to better preparation for formal schooling. However, findings from research examining effects of QRIS level on child outcomes are mixed. In one study, teacher-child interactions were a stronger predictor of child outcomes than QRIS level (Sabol, Hong, Pianta, & Burchinal, 2013). In general, there is a strong body of research that supports teacher-child interactions, a subset of classroom quality, as a key mechanism in shaping children's school readiness skills (Burchinal et al., 2008; Howes et al., 2008; Mashburn et al., 2008). Therefore, it is important to consider the role that classroom quality plays in impacting children's school readiness.

Classroom Quality

Classroom quality is commonly conceptually divided into structural components and process components (Cassidy, Hestenes, Hegde, Hestenes, & Mims, 2005). Governable aspects of classrooms (e.g., class size, teacher education, and curriculum) are referred to as structural quality (Vandell & Wolfe, 2000). Process quality is defined as children's day-to-day experiences in the classroom or child care facility, and can be measured using global scales (i.e., scales that observe spaces for language, reasoning, social development, and creativity), or it can be measured with interaction scales (i.e., scales that measure exchanges between children and teachers; Vandell & Wolfe, 2000). Teacher-child interactions are a predominant part of how the field measures process quality because they are a key mechanism for children's learning (Pianta, Hamre, & Allen, 2012). Teacher-child interactions facilitate development of children's social, emotional, and cognitive abilities (Pianta et al., 2005). The National Institute of Child Health and Human Development study of early care (NICHD; 2006) defined high quality teacher-child interactions as "positive care-giving" (e.g., friendly attitude, responding to students' comments, asking thoughtful questions, praising students, and eliminating negative interactions). Though some evidence suggests that classrooms with strong structural features impact gains in children's school readiness, language skills, and social behavior (Vandell & Wolfe, 2000), evidence shows that process quality, measured through teacher-child interactions, is a stronger predictor of children's outcomes (Howes et al., 2008; NICHD Early Child Care Research Network [ECCRN], 2002).

There are many short- and long-term effects on children's school readiness associated with teacher-child interactions in preschool. Within the preschool year, studies suggest that teacher-child interactions are significantly related to increases in literacy development, EF, social competence, and early mathematics (Downer et al., 2012; Hamre, Hatfield, Pianta, & Jamil, 2014; Hatfield, Burchinal, Pianta, & Sideris, 2016). Teacher-child interactions are also associated with language acquisition, social competence, and literacy skills in kindergarten (Burchinal et al., 2008), and mathematics and reading outcomes from 1st through 4th grade

(Dickinson & Porche, 2011; Lehrl, Kluczniok, & Rossbach, 2016). Beyond early childhood, children who experienced better teacher-child interactions in preschool have been shown to have higher middle school test scores (Anderson & Phillips, 2017), to have higher grades in high school, and are more likely to attend college (Vandell, Burchinal & Pierce, 2016). In recent years, specific domains of teacher-child interactions have been identified, along with their associations with specific school readiness outcomes.

Teacher-child interactions. Many measures of teacher-child interactions exist in the literature. Some of the notable measures include the Caregiver Interaction Scale (CIS; Arnett, 1989), the Observational Record of the Caregiving Environment (ORCE; NICHD ECCRN, 1996), and the Early Childhood Environment Rating Scale-Revised (ECERS-R; Harms, Clifford, & Cryer, 1998). The CIS observes different interaction styles between teachers and children and is comprised of four domains: sensitivity, harshness, detachment, and permissiveness. The original factor structure of the CIS is rarely replicated (Colwell, Gordon, Fujimoto, Kaestner, & Korenman, 2013) making it a less reliable measure of teacher-child interactions. The ORCE records the number of back-and-forth exchanges between teachers and children and the quality of the teachers behavior relative to children's behavior (NICHD ECCRN, 1996). One short coming of the ORCE is it often analyzed with the same sample (Perlman et al., 2016), raising the question: to what extent are the associations between ORCE and children's outcomes generalizable to other samples. Finally, the ECERS-R considers both structural and process aspects of the classroom such as the degree to which teachers foster children's vocabulary and tailor their teaching to individual children. Results from a recent meta-analysis demonstrated that the strength of associations between the ECERS-R and children's outcomes is weak (Brunsek et al., 2017), suggesting it is not the best measure of quality that is important for children's outcomes.

A prominent and recent framework to measure teacher-child interactions is with the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008), which is used in many studies that test whether teacher-child interactions predict children's school readiness skills (Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Downer et al., 2012; Hu et al., 2017; Leyva et al., 2015). Although the CLASS is a global measure of classroom quality, teacher-child interactions constitute a large portion of it. The CLASS measure has three domains: emotional support, classroom organization, and instructional support (La Paro, Pianta, & Stuhlman, 2004). The creators of CLASS theorized that each domain would be linked specifically to a certain facet of children's school readiness skills (e.g., a teacher's emotional support would predict children's social-emotional development; Downer, Sabol, & Hamre, 2010), often referred to as within-domain pathways. There is also emerging evidence for cross-domain pathways in which a CLASS domain relates to a skill that was not originally theorized. For instance, studies suggest that emotional support may be related to children's academic skills in addition to their social competence (Hamre et al., 2014; Howes et al., 2008; Leyva et al., 2015). Although there is evidence to support both within and cross domain relations, there is more evidence to support within domain relations.

Emotional support. Emotional support, as defined in the CLASS measure, refers to a teacher's positive attitude, low negativity, high sensitivity, and regard for students' perspectives (Pianta et al., 2012). The development of the emotional support domain stems from Bowlby's (1969) attachment theory. Attachment pioneers posited that through a trust-building process between children and their caretakers, children feel confident in exploring their surrounding environment knowing that they have a secure base to which they can return (Bergin & Bergin, 2009). Some of the mechanisms through which building trust occurs are caregiver sensitivity, awareness, and responsiveness toward children's requests for help and other needs signals (Bergin & Bergin, 2009). The emotional support domain contains indicators such as the degree of teacher's sensitivity and responsiveness to a child's needs and cues (Mashburn et al., 2008), which aligns with the trust-building process in attachment theory.

Studies exploring emotional support and children's outcomes primarily have focused on children's social-emotional development, and there is evidence that higher emotional support predicts better social-emotional adjustment in preschoolers (Hamre et al., 2014; Mashburn et al., 2008). There is also some evidence of emotional support predicting children's academic skills. For instance, scholars have found that children in classrooms where teachers are rated highly on emotional support demonstrate gains in literacy skills during the preschool year (Downer et al., 2012; Hamre et al., 2014; Howes et al., 2008; Leyva et al., 2015). One study yielded findings that sensitive teaching was significantly associated with children's math ability in preschool (Trawick-Smith, Swaminathan, & Liu, 2016). The rationale for these findings may be that teacher's emotional support facilitates children's positive attitudes and motivation toward learning, and as such, students may feel more comfortable and confident during challenging mathematical and literacy tasks which may facilitate growth in these skills (La Paro et al., 2004).

Some studies also show evidence for an association between emotional support and children's EF (Hamre et al., 2014; Hatfield et al., 2016; Merritt, Wanless, Rimm-Kaufman, & Cameron, 2012; Pianta, La Paro, Payne, Cox, & Bradley, 2002). Emotional support may bolster children's EF through mobilization of children's autonomy. For example, teachers who encourage student-led activities, permit movement, and incorporate student ideas that diverge from the lesson plan may increase children's "perceived control" (i.e., autonomy), which may be associated with heightened attention and inhibitory control (Skinner, Zimmer-Gembeck, & Connell, 1998). Furthermore, the parenting literature suggests that positive and warm parenting cultivates stronger EF skills within children because the children feel a sense of autonomy which increases their awareness and control of their behavior (Merz, Landry, Montroy, & Williams, 2017). Teachers who engage in these same behaviors may also be supporting the development of children's EF.

***Classroom organization*.** Another important component of teacher-child interactions is classroom organization, which is characterized as teachers establishing routines, being proactive in the regulation of disruptive behavior, helping children be productive, and providing engaging materials (La Paro et al., 2004). The domain of classroom organization derives from theories on effective teaching, which posits that effective teachers organize behavior, time, and attention (Yates & Yates, 1990). Classroom organization parallels this triad by focusing on traits such as managing behavior, providing engaging learning formats in order to minimize static time, and establishing consistent and predictable daily routines (Pianta et al., 2012). From a within-domain perspective, classroom organization should be expected to be linked to children's EF, and particularly inhibitory control (Hu et al., 2017; Rimm-Kaufman, Curby, Grimm, & Brock, 2009). This is likely because children exhibit better attentional and behavioral skills when classroom environments are highly engaging and functioning smoothly, and are led by teachers who use appropriate behavior management techniques (Emmer & Stough, 2001). Additionally, there is emerging evidence that classroom organization is associated with both early literacy and numeracy (Downer et al., 2012; Levya et al., 2015). Classroom organization may be linked to literacy and numeracy because maximized learning time and stimulating learning formats (indicators of classroom organization) more efficiently and effectively promote children's engagement with learning, which is associated with academic skill development (Downer et al., 2010).

Instructional support. Instructional support is the last domain within the CLASS measure that taps into teacher-child interactions. The manner in which a teacher initiates and maintains conversations with children, models language, and fosters children's concept development is defined as instructional support (La Paro et al., 2004). The instructional support domain is influenced by Vygotskian theory related to scaffolding, which is a process that begins with a teacher assessing a child's ability level during a challenging task, and in turn provides resources or asks questions to help the child achieve the learning goal in order to promote higher-order thinking (Davis & Miyake, 2004; Vygotsky, 1991). Another strategy that teachers may implement within the instructional support domain is feedback loops wherein teachers ask "why" and "how" questions rather than "what" questions during conversation, teaching, or reading. Feedback loops allow conversations between teachers and students to be fluid and flowing, and interactively balanced, rather than teacher-directed, rote and curt. Further, when teachers engage in more open-ended questions, they cultivate children's language and higher-order cognitive skills, including their ability to relate across concepts (National Research Council, 2000).

Theory on the link between instructional support and academic outcomes states that children learn best when facts are meaningfully connected to their own life and across subjects, and when teachers scaffold during academically challenging moments (Vygotsky, 1991). There is some evidence to support this theory wherein instructional support is related to growth in children's language, literacy, numeracy, and EF (e.g., inhibitory control) during the preschool year (Downer et al., 2012; Howes et al., 2008; Hu et al., 2017; Leyva et al., 2015; Mashburn et al., 2008). In summary, there is evidence that aspects of teachers' interactions with children such as emotional support, classroom organization, and instructional support are related to early literacy, numeracy, EF and social-emotional skills; however, it is important to acknowledge that findings on these associations are mixed.

In many studies, the magnitude of associations between process quality and children's school readiness skills is small, and in some cases, null (Keys et al., 2013; Leyva et al., 2015; Schmitt, Pratt, Korucu, Napoli, & Schmerold, 2018). For instance, some researchers have not found significant within-domain associations between emotional support and children's social-emotional development (Keys et al., 2013; Hu et al., 2017), between instructional support and mathematics and literacy (Burchinal et al., 2008), and between classroom organization and EF (Hatfield et al., 2016; refer to Figure 1 & 2 for the significant and null effects mapped out). However, many of the studies analyzing the effects of quality on school readiness have used samples that contained universal pre-k programs, which fund children with a broad range of socio-economic statuses (SES). Recent research suggests that classroom quality may matter more for children from low-income families (Keys et al., 2013). It is also possible that children participating in "targeted" state-funded pre-k (i.e., programs that only fund children from families with low incomes) may benefit more from high quality experiences because their home resources are lacking or not sufficient enough to stimulate development of school readiness skills (Sameroff & Chandler, 1975). Yet, no research has explored whether participation in a targeted state-funded pre-k program may interact with classroom quality to affect children's school readiness skills. It is possible that children who participate in a targeted state-funded pre-k programs that are rated higher on the QRIS and experience higher classroom quality benefit the most in terms of their school readiness.

Moderating Role of Teacher-Child Interactions

Teacher-child interactions may moderate the relations between pre-k participation, particularly a targeted pre-k program affiliated with higher QRIS rankings, and school readiness skills. It may be that the relation between pre-k participation and school readiness is stronger for children who experience higher quality teacher-child interactions. Teacher-child interaction quality may interact with some of the features of pre-k programs such as research-based curriculum (Pianta, Mashburn, Downer, Hamre, & Justice, 2008), national accreditation (Dinehart, Manfra, Katz, & Hartman, 2012), and QRIS level (Jeon, Buettner, & Hur, 2014) to produce enhanced school readiness outcomes. Although the factors that are integral to pre-k could benefit students, the benefits are expected to be maximized when teacher-child interactions are of high quality, a program aspect not necessarily explicitly measured in state-funded pre-k policy.

Currently, there is some evidence to support this moderating hypothesis. For example, recent threshold analyses suggest that children enrolled in state-funded pre-k programs experience greater gains in math, literacy, and EF when instructional support, classroom organization, and emotional support met certain thresholds of high quality (Burchinal et al., 2010; Hatfield et al., 2016). Further, in a recent study, Johnson et al. (2016) found that instructional support moderated relations between pre-k participation and children’s school readiness. Specifically, children who participated in pre-k and who experienced higher levels of instructional support benefited the most in terms of their early mathematics and literacy development. They did not find evidence for emotional support or classroom organization as moderators. The Tulsa Pre-K program, which was examined in the Johnson et al. (2016) study, was universal (i.e., served all children regardless of SES), required teachers to meet specific requirements (e.g., all head teachers must have a B.A. degree, must be certified in early childhood education, and must be paid the same as elementary school teachers; Gormley et al., 2005), and based quality standards on NIEER's New Quality Standards Checklist, rather than organizing them into a QRIS (Friedman-Krauss et al., 2018).

The current study replicated and extended the study conducted by Johnson et al. (2016) in a number of ways. First, the pre-k program analyzed in current study exclusively served children from low-income families, whereas the pre-k program examined in the Johnson et al. (2016) served all children regardless of family income. Testing quality as a moderator with a solely low-income sample is important because emotional support and classroom organization may emerge as significant moderators because low-income children may benefit more from high quality (Keys et al., 2013). Second, the current study used data from an evaluation of a state-funded pre-k program that is explicitly linked with QRIS. There is some evidence that higher-rated state-funded pre-k providers participating in QRIS produce larger gains on children's school readiness skills than lower-rated providers (Elicker et al., 2017; Sabol & Pianta, 2015). Such a partnership may have the potential to produce stronger school readiness skills because children may demonstrate even greater gains when they experience two indicators of high quality (e.g., higher QRIS level and better teacher-child interactions). Third, this work extended previous research by including non-academic indicators of school readiness, EF and social-emotional skills, in the statistical models. Because EF and social-emotional skills are associated with academic achievement and later developmental outcomes (Blair & Raver, 2015; Jones et al., 2015), it is important to understand the extent to which pre-k participation and strong teacher-child interactions work together to promote these skills.

The Present Study

The current study aim was to examine whether the effects of participation in a state-funded pre-k program (relative to a comparison group) on children's school readiness skills varied as a function of the level of instructional support, classroom organization, and emotional support children experience. It was posited that the impacts of pre-k participation are significant only if classrooms are above the threshold of high quality on the CLASS domains. Utilizing data from a larger evaluation of a state-funded pre-k program, there were three primary questions:

Question 1. Is the relation between pre-k participation and children's literacy, EF, and social-emotional skills moderated when teachers meet or exceed the threshold of emotional support?

Hypotheses 1, 2, & 3. Based on previous research showing prevalent cross-domain predictions from emotional support to literacy and EF (Downer et al., 2010), it was hypothesized that pre-k participation (relative to a comparison group) would be related to gains in literacy (Hypothesis 1) and EF (Hypothesis 2) when emotional support was high. Additionally, according to the within-domain CLASS framework (Downer et al., 2010), it was hypothesized that pre-k participation would be related to larger gains in social-emotional skills when the levels of emotional support were high (Hypothesis 3).

Question 2. Is the relation between pre-k participation and children's EF moderated when teachers meet or exceed the classroom organization threshold?

Hypothesis 4. Second, according to the CLASS within-domain framework (Downer et al., 2010) and research showing that children from low-income families benefit more from quality (Keys et al., 2013; Sameroff & Chandler, 1975), it was hypothesized that pre-k participation would be related to larger gains in EF when the levels of classroom organization were high (Hypothesis 4).

Question 3. Is the relation between pre-k participation and children's literacy and numeracy moderated when teachers meet or exceed the instructional support threshold?

Hypotheses 5 & 6. Finally, based on prior findings that children gain school readiness skills only when classrooms are rated high in quality (Burchinal et al., 2010; Hatfield et al., 2016; Johnson et al., 2016), it was hypothesized that pre-k participation would be related to larger gains in early numeracy (Hypothesis 5), and literacy (Hypothesis 6) when the level of instructional support was high.

METHOD

Participants

The current study was conducted using data from a larger study evaluating Indiana's state-funded pilot pre-k program, On My Way (OMW) Pre-K. OMW is a voluntary state-funded pre-k program that is a targeted system for children from low-income families that operates in five counties and serves families living 127% or below the federal poverty income line (Elicker et al., 2017). Using a voucher system, parents may choose to send their child to any OMW approved provider. Pre-existing early care and education providers, if they qualify as OMW providers, are allowed to integrate the pre-k program into their existing program. To become an approved OMW provider, schools need to be rated at least a level 3 on Indiana's 4-level QRIS. OMW teachers are not required to obtain a bachelor's degree, though they are required to have a Child Development Associate Credential or an equivalent degree in early childhood education, and clock at least 45 hours of professional development before they begin. As a part of the QRIS level 3 and 4 standards, there are also requirements for implementation of a curriculum that promotes children's literacy, socio-emotional development, cognitive skills, and language. The curriculum is advertised in newsletters and parent meetings and is used in daily practice such as lesson plans and child assessments. Children who bring OMW vouchers to a qualified program may be integrated with children who are not enrolled in OMW, or a provider may offer classrooms that are entirely reserved for children enrolled in OMW.

The sample for this study consisted of 558 children from two cohorts. Children ranged in age from 45 to 71 months ($M = 57.75$, $SD = 3.71$) at the beginning of the study and were primarily English-speaking. Refer to Table 1 for detailed demographic information for the full sample, the OMW Pre-K group, and the comparison group. On average, there were 4 children in OMW classrooms (n = 90) with a range of 1 to 20 OMW children per classroom including those not part of OMW. In comparison classrooms (n = 47), the average number of children in a classroom was 4 with a range of 1 to 7 children per classroom.

Sampling protocol for cohort 1. To obtain the OMW sample for cohort 1, researchers: 1) determined the proportionate number of children to sample in each county; 2) determined how many children to sample in each type of program (e.g., child care center licensed, child care center unlicensed, family child care home licensed, unlicensed, registered child care ministry, and public school preschool); 3) determined the number of full day and half day children to sample; and 4) randomly selected providers within each category type. The goal number of providers per county were calculated to reflect the percentage of OMW slots that were available in that county. Of the 154 original OMW providers, 37 were randomly selected and all agreed to participate. Within the 37 OMW providers, parents of 276 children agreed to participate and were included in the study. Thus, the final sample size for cohort 1 OMW was 276. Children were distributed among 57 OMW classrooms, which was the number of OMW teachers in the study; classrooms were not considered to be in the study unless a teacher signed a consent form.

Obtaining samples for the non-pre-k comparison group was similar to the sampling protocol as the OMW group except for a few notable steps. Instead of randomly selecting children from the randomly selected providers, researchers solicited participation from all age-eligible children who were attending child care that was rated by QRIS as level 0 (not participating in QRIS) or level 1 (lowest rated level, equivalent to state license) and paying with CCDF vouchers in each randomly selected program. It was important to select only children receiving CCDF vouchers in order to create a comparison group that was matched in terms of income and need, and these programs were likely what children would be receiving if OMW had not existed. In addition, it is nearly impossible to sample a comparison group of children with no preschool enrollment, therefore selecting child care programs rated 0 and 1 on QRIS is the closest to “no child care”. Twenty-one randomly selected comparison providers agreed to participate and parents of 95 children provided consent. Thus, the final sample size for cohort 1 comparison group was 95. Thus, the final sample size for cohort 1 was 371 (OMW = 276, comparison = 95).

Sampling protocol for cohort 2. To obtain the OMW sample for cohort 2, a list of approved OMW programs (n = 260) in each of the five counties including the number of pre-k slots for children was provided by the Indiana Family and Social Services Administration (FSSA). This list was sorted by county, then using a random number generator, the target number of schools was randomly selected per county. After this process, the selected schools were examined to also ensure that every provider type was represented (i.e., center type, QRIS level, and full day or part day status). The target number was 25 providers total. The target number of providers per county was based on the distribution of OMW slots in each county. As such, the target was 4 providers in Allen, 2 providers in Jackson, 5 in Lake, 10 in Marion, and 4 in Vanderburgh. After these criteria were verified, envelopes were sent to each of the 25 OMW providers including packets that contained personalized director and child consent forms, and OMW parent/child consent forms for the pre-k capacity for each provider. Follow-up calls were made to each of these facilities. Five ended up not participating due to reasons such as losing OMW qualifications or because there were no slots filled for children with OMW vouchers. The final sample consisted of 20 providers distributed as 4 in Allen, 2 in Jackson, 4 in Lake, 6 in

Marion, 4 in Vanderburgh. From the 20 OMW providers, 100 parent-child consent forms were returned, and all participated. The final OMW sample size for cohort 2 OMW was 100.

Sampling procedures for the cohort 2 comparison group were initially the same as for cohort 1. The list used for random selection, which was provided by the Indiana FSSA, included all CCDF children in the five counties who met the age requirements, and were attending level 0 or level 1 comparison providers. Of the original 162 comparison providers, 45 were randomly selected. The target number of comparison group providers per county (i.e., 8 for Allen, 0 for Jackson, 10 for lake, 19 for Marion, and 8 for Vanderburgh) mirrored the proportion per county of OMW, but a larger number was recruited due to low response rates experienced during recruitment for the comparison sample in cohort 1. After this process, the selected schools were examined to ensure that every provider type was represented (i.e., center type, QRIS level). This sampling method resulted in 71 consented comparison children. In order to obtain a sample of 100 children, all remaining comparison child care centers (*n* = 35) from the original list of 162 that were not already part of the 45 randomly selected, and that had at least four CCDF children enrolled were contacted via email, telephone calls, and in-person visits. The remaining 82 schools were excluded due to having less than four eligible children enrolled. The final sample size for cohort 2 comparison children was 87.

Procedure

Research assistant training. Sixteen research assistants were hired to administer child assessments and classroom observations. The minimum requirements to be eligible for the research assistant positions were a bachelor's degree in child development, early childhood education, or a related field; living near or in the five counties; and experience teaching or administrating in the early care and education field. Research assistants underwent a comprehensive training in administering a battery of structured, one-on-one child assessments. During this two-day training, research assistants received background information on each school readiness outcome, observed demonstrations on administering child assessments, practiced with colleagues during and after the training session, and were observed administering assessments by project staff to ensure reliability. The project manager observed the research assistants on their first day of data collection and again mid-year in the field to ensure that the assessments were being administered appropriately. Both parents and teachers received a $20 cash stipend following participation during the spring and fall assessment time points.

In addition to the direct child assessments training, the research assistants were trained on the CLASS Pre-K (Pianta et al., 2008) assessment tool by a certified Teachstone instructor. After completing the two-day Teachstone training, the research assistants received their CLASS observer certification through online reliability testing. The reliability test involved five 15-20-minute videos of teachers in the classroom interacting with children, and researcher assistants rated the teacher videos on the 9 dimensions of CLASS quality. In order to attain reliability, researchers needed to score within one point above or below the master code 80% of the time for each of the five tests, and for each dimension, 2 out of 5 of the tests needs to also be within one of the master code. All research assistants received their certificates prior to conducting the classrooms observations. To ensure reliability throughout the preschool year, the project manager conducted classroom observations alongside the research assistants mid-year and codes were compared. Further, research assistants re-certified on CLASS each year.

Data collection procedure. From September through December of the prekindergarten year, research assistants conducted child assessments that lasted approximately 60-90 minutes per child at the children's schools. In the months of January through March, the research assistants returned to observe teacher-child interactions in four 20-minute intervals using the CLASS, observing for two hours per participating classroom. Research assistants in the same county switched schools to conduct the classroom observations. Structural quality (e.g., class size, teacher-child ratios) were recorded as well during these observations. From April through June, the research assistants conducted the child assessments as they had in the fall. The data collection procedures were identical across the OMW sample and the comparison sample.

Measures

Executive function. EF was measured using the Head-Toes-Knees-Shoulders (HTKS) task (McClelland et al., 2014). All three components of EF (i.e., inhibitory control, cognitive flexibility, and working memory) are captured, yet not individually measured, in the HTKS task (McClelland et al. 2014). The HTKS task is presented to children as a game where they are asked paired combinations of four behavioral rules (i.e., ‘‘touch your head,’’ ‘‘touch your toes,’’ “touch your knees,” “touch your shoulders”; McClelland & Cameron, 2012). In the practice trials, children are first asked to mirror their behavior with the research assistant’s direction (e.g., children touch their head when the researcher says “touch your head”). Then, children are asked to respond in an opposite manner (e.g., children touch their toes when the research assistant says “touch your head”). The testing portion contains 3 sections of 10 items (30 items total) and the rules change in each section, becoming more difficult than the last. Each item is worth 2 points, but if a child self-corrects they are allotted 1 point; incorrect answers are worth 0 points. One holistic score for EF is derived from this task, and the range of possible scores on is 0-60.

Previous research has shown that the HTKS is moderately correlated with four other EF assessments with an alpha level of .001, establishing its construct and predictive validity: Dimensional Change Card Sort (r = .56), Day and Night Stroop (r = .40), Simon Says (r = .38), and Auditory Working Memory test from the Woodcock Johnson III Test of Cognitive Abilities (r = .41; McClelland et al., 2014). Test/ re-test reliability is high after administering it to same child twice within 5 to 6 months (McClelland et al., 2014).

Early numeracy. Children's early numeracy skills were assessed using the Applied Problems subtest of the Woodcock Johnson-IV (WJ-AP IV; Schrank, McGrew, Mather, Wendling, & LaForte, 2014). The WJ-AP IV assesses early mathematical operations (e.g., counting, addition, subtraction) through practical and germane story problems. There are a total of 63 items (sequenced by degree of difficulty) and children receive 1 point for each correct response. Children are asked to answer questions (total testing time is approximately 5-15 minutes) unless they reach the ceiling by making five consecutive errors at the end of a set. Studies have shown that the WJ-AP IV is reliable across subtests with reliability of .84 – .94 for ages 2 to 7 (Villarrel, 2015).

Emergent literacy. Children's emergent literacy was measured through the Letter-Word Identification subtest of the Woodcock Johnson-IV (WJ-LW IV; Schrank et al., 2014). The three main skills that the WJ-LW IV assesses are children's letter identification, word reading, and reading aloud. The WJ-LW IV consists of 76 items, with each item being worth 1 point, and takes approximately 5-15 minutes to administer. Research assistants stop administering the assessment if a child incorrectly responds to six items in a row at the end of a set. Across subtests, the Letter-Word Identification had a reliability of .84 – .94 for ages 2 to7 (Villarreal, 2015).

Social-emotional skills. Children's social-emotional skills were measured using the Social Skills subset scale of the Skills Improvement System Rating Scales (SSIS-SS; Gresham & Elliott, 2008). The SSIS-SS is a 46-item teacher report survey that captures socioemotional skills such as communication, cooperation, and empathy (e.g., “makes eye contact when talking,” “shows concern for others,” “feels bad when others are sad”; Gresham & Elliott, 2008). Teachers were asked to answer all questions by selecting the degree of frequency of each of the subdomains on a four-point scale (0 = never; 1 = seldom; 2 = often; 3 = almost always). The final score is calculated by adding together all of the item scores. The higher the score, the more social skills the child reportedly exhibits. The assessment has been reported to have strong reliability (Gresham & Elliott, 2008).

Pre-k group. A variable named “preschool group” was coded such that OMW = 1 and the comparison group = 0. The OMW group consisted of children attending pre-k programs rated 3 or 4 on the QRIS, and the comparison group consisted of children attending non-pre-k programs rated 0 to 1 on the QRIS.

Teacher-child interaction quality. The Pre-K CLASS (Pianta et al., 2008) was used as an index of teacher-child interactions. In order to test the hypotheses, the Pre-K CLASS was scored in two different ways: continuous and dichotomized (based on cutoffs identified in the field).

CLASS continuous. The CLASS measure is divided into three subscales: emotional support (positive climate, negative climate, teacher sensitivity, regard for students’ perspectives), classroom organization (behavior management, productivity, instructional learning modalities), and instructional support (concept development, quality feedback loops, and language modeling; La Paro et al., 2004). Each scale is rated on a 7-point Likert continuum where higher scores indicate better quality (7, 6 = high, 5, 4, 3 = medium, 1, 2 = low). There was high internal consistency for all 3 CLASS domains: emotional support ($\alpha = .85$), classroom organization ($\alpha = .85$), and instructional support ($\alpha = .88$; La Paro et al., 2004). The CLASS instrument is moderately correlated with the Early Childhood Environmental Rating Scale-Revised (r = .52 for emotional support, r = .40 for instructional support; La Paro et al., 2004), which is widely-used global scale for classroom quality in the field. The CLASS measure has been shown to be related to EF, social-emotional skills, literacy, and numeracy (Downer et al., 2012; Hamre et al., 2014; Hatfield et al., 2016). The CLASS procedure involves a sequence of four 20-minute observations with 10 minutes of coding after each observation. The three class domains comprise nine dimensions that each receive a score from the 7-point Likert scale. Each set of dimensions were averaged, and the average represented the score for each of the three CLASS domains. Each of the domain scores of the four intervals were averaged to produce a final domain score.

CLASS Threshold. Recent findings suggest that main effects of teacher-child interactions are not enough to predict children's outcomes. Rather, teachers need to meet high cutoffs on observational scales before their teaching makes a meaningful impact on children's school readiness (Burchinal et al., 2010; Burchinal, Vernon-Feagans, Vitiello, Greenberg, & Family Life Project Key Investigators, 2014; Hatfield et al., 2016); therefore, the CLASS domains were dichotomized to be either above or below a specific threshold. The numbers for dichotomization were determined based on the sample distribution for CLASS and past research that has identified theoretically valid thresholds for the CLASS (i.e., 5 for classroom organization and emotional support; Burchinal et al. 2010). Although the CLASS manual deems high quality as scores above 5, instructional support was dichotomized at 2.5 because instructional support was generally low for this sample (M = 2.35), and past research has used an identical centering convention (e.g., Burchinal et al., 2010). Thus, for emotional support and classroom organization, classrooms that were below the threshold (scores of 4.99 or lower) were coded as 0 and classrooms that met the threshold (scores 5.00 or above) were coded as 1. For instructional support, classrooms that were below the threshold (scores of 2.49 or lower) were coded as 0 and classrooms that met the threshold (scores of 2.50 or above) were coded as 1. Both the continuous CLASS (range = 1-7) and the dichotomized CLASS (below threshold = 0; met threshold = 1) were entered as main effects, as two-way interactions with each other, and as a three-way interaction with each other and the preschool group variable. The coefficient of the three-way interaction mimics the technique of spline regression used in previous CLASS threshold studies (e.g., Burchinal et al., 2010; Hatfield et al., 2016) because it provides results for whether the relation between pre-k and school readiness is moderated when teachers meet or exceed the CLASS threshold.

Covariates. Age, gender, race and ethnicity, children's fall scores (for the relevant outcome measure), cohort, and parent monthly income (continuous variable) were entered into all analytical models as covariates. Age was calculated using the date of assessment and children's date of birth. Information on children's gender and parent income was collected via demographic surveys distributed to parents at the start of the study. These covariates were entered into all of the models because past research has indicated that these variables are associated with children's skills (Davis-Kean, 2005; Foster, Lambert, Abbott-Shim, McCarty & Franz, 2005; Wanless et al., 2013).

Analytic Strategy

A series of two-level multilevel linear models using the PROC MIXED function in SAS software Version 9.4 (SAS Institute, 2017) were conducted for each school readiness domain to account for children being nested within classrooms (Raudenbush & Bryk, 2002). In addition, because CLASS scores are fixed within a classroom, all child-specific variables were considered level 1 variables, and all CLASS and preschool group variables were considered level 2 variables. Using a multilevel framework, the study sought to answer three research questions (refer to Figure 3 for a conceptual diagram):

Question 1. Is the relation between pre-k participation and children's literacy, EF, and social-emotional skills moderated when teachers meet or exceed the threshold of emotional support?

Hypotheses 1, 2, & 3. Emotional support moderates the effect of pre-k participation on children's literacy, EF, and social when teachers meet or exceed an emotional support score of 5.

Question 2. Is the relation between pre-k participation and children's EF moderated when teachers meet or exceed the classroom organization threshold?

Hypothesis 4. Classroom organization moderates the effect of pre-k participation on children's EF when teachers meet or exceed classroom organization scores of 5.

Question 3. Is the relation between pre-k participation and children's literacy and numeracy moderated when teachers meet or exceed the instructional support threshold?

Hypotheses 5 & 6. Instructional support moderates the effect of pre-k participation on children's early numeracy and literacy when teachers meet or exceed instructional support scores of 2.5.

Prior to running the models, descriptive statistics were examined to check for skewness, linearity of relations, normality, and model assumptions were checked. During the calculation of the descriptive variables, it was determined that the WJ-LW IV for fall and spring was heavily skewed (i.e., kurtosis = 8.00) because nine children's scores were 3SDs above the mean. Even after a log transformation in an attempt to normalize the distribution of WJ-LW IV scores, the kurtosis remained high at 5.00. Therefore, in an attempt to meet the assumption of normal distribution, the scores for the WJ-LW IV were winsorized (i.e., replaced with the highest score within the range of scores that do fall within 3 SD above the mean; Dixon & Yuen, 1974). The PROC MIXED command handles missing data by ignoring cases with missing variables on the independent variable and using maximum likelihood estimation for the dependent variables (refer to Table 3 for the number of children missing for each variable). On average, more than 75% of the key study variables were retained, but social-emotional skills had the most missing data (i.e., approximately 20%). All of the variables were standardized for ease of interpretation.

An unconditional model (i.e., a model with no predictors) of each school readiness domain was run in order to identify the proportion of variance attributed to between classroom variation, referred to as intra-class correlations (ICCs). The ICCs were calculated by dividing the between group variance by the total variance (i.e., between group and residual variance): $(\frac{\mu_{0j}}{\mu_{0j}+r_{ij}})$. Within classroom variation for each school domain was calculated by subtracting the ICC from one (i.e., 1 - ICC).

The final conditional models included all of the level 1 covariates, the main effect of pre-k group, main effects of both the continuous CLASS and dichotomous CLASS domains that corresponded theoretically to the outcome (instructional support, emotional support, and classroom organization), the interaction between pre-k group and the continuous CLASS, the interaction between pre-k group and the dichotomous CLASS domain, the interaction between the continuous and dichotomous CLASS variables, and the three-way interaction between pre-k group, continuous CLASS, and dichotomous CLASS. This model mimics a spline technique to analyze whether the continuous CLASS variable moderates the relation between pre-k group and children's outcomes above and below the CLASS threshold (Burchinal et al., 2010; Hatfield et al., 2016). The basic conditional model was modeled as:

$$\text{Spring Score}_{ij} = \beta_{0j} + \beta_{1j}(\text{Age}_{ij}) + \beta_{2j}(\text{Income}_{ij}) + \beta_{3j}(\text{Fall Score}_{ij}) \ldots + r_{ij} \qquad (1)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Group}_j) + \gamma_{02}(\text{CLASS}_j) + \gamma_{03}(\text{CLASSthresh}_j) + \gamma_{04}(\text{Group}_j * \text{CLASS}_j) + \gamma_{05}(\text{Group}_j * \text{CLASSthresh}_j) + \gamma_{06}(\text{CLASS}_j * \text{CLASSthresh}_j) + \gamma_{07}(\text{Group}_j * \text{CLASS}_j * \text{CLASSthresh}_j) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10} \qquad (2)$$

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

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

where each child's (i) school readiness domain in a given classroom (j) is equal to the sum of an average intercept-level of the particular school readiness domain across classrooms (γ_{00}), the average effect of all of the covariates (except gender and cohort) on the school readiness outcome (γ_{10} through γ_{50}), the main effect of preschool group (relative to the comparison group) on the particular school readiness outcome (γ_{01}), the main effect of continuous CLASS on the particular school readiness outcome (γ_{02}), the main effect of the dichotomous CLASS on the particular school readiness outcome (γ_{03}), the interaction between preschool group and continuous CLASS on the particular school readiness outcome (γ_{04}), the interaction between preschool group and dichotomous CLASS on the particular school readiness outcome (γ_{05}), the interaction between the continuous and dichotomous CLASS on the particular school readiness outcome (γ_{06}), the three-way interaction between preschool group, the continuous CLASS, and the dichotomous CLASS on the particular school readiness outcome (γ_{07}), a classroom specific error term for the intercept level of the particular school readiness outcome (μ_{0j}), and the residual error (r_{ij}).

RESULTS

Descriptive Statistics

Descriptive statistics for the primary study variables across preschool groups are presented in Table 1 (means, standard deviations range, skew, and kurtosis). *T*-tests were conducted to test for differences between pre-k and comparison children on demographic variables, fall skills, and spring skills. *T*-tests revealed that children in the comparison group had higher parent monthly income than children in the pre-k group, $t(543) = 4.35$, $p < .001$. Children in the comparison group scored significantly higher on both the fall, $t(546) = 6.21$, $p < .001$, and spring literacy assessments, $t(504) = 4.53$, $p < .001$. Further, children in the pre-k group scored significantly higher on social-emotional skills in both the fall, $t(533) = -3.47$, $p < .001$, and in the spring, $t(443) = -4.18$, $p < .001$. A chi-square test of independence was performed to examine whether there were differences in children's race and ethnicity. Results indicated that there was significantly more non-white children in the comparison sample than the pre-k sample , $X^2 (4, N = 554) = 71.98$, $p < .001$.

In terms of descriptive statistics for teacher-child interaction data, the mean for classroom organization was higher in the comparison sample, whereas the means for emotional support and instructional support were higher in the pre-k sample. However, only emotional support was statistically significantly higher in the pre-k group than the comparison group, $t(540) = -2.87$, $p < .01$. Sixteen children were in classrooms where CLASS data were not collected.

Correlations among all the variables are presented in Table 2. For both fall and spring, there was a significant negative association between pre-k and literacy, and a positive significant association between pre-k and social skills. Further, classroom organization was positively related to children's fall and spring literacy scores, and fall and spring EF scores. Instructional support was negatively related to children's fall and spring numeracy scores, and fall and spring EF scores.

Multilevel Models

Unconditional models were run in order to calculate ICCs, which indicated that 34% of the variance in literacy was attributed to between classroom differences, 18% for numeracy, 13% for EF, and 38% for social skills. Next, two-level multilevel linear models were conducted for each school readiness domain and included a variety of control variables including age at time 1, gender, parent monthly income, race/ethnicity, relevant fall score, and cohort. The CLASS domains were entered separately into each model.

Hypotheses 1, 2, & 3. Emotional support did not moderate the association between pre-k participation and literacy (β = 0.05, SE = 0.31), EF (β = -0.56, SE = 0.03), and social-emotional skills (β = -0.23, SE = 0.52).

Hypothesis 4. Classroom organization did not moderate the association between pre-k participation and EF (β = 0.05, SE = 0.38).

Hypotheses 5 & 6. Instructional support did not moderate associations between pre-k participation and literacy (β = 0.09; SE = 0.33) and numeracy (β = 0.33, SE = 0.29).

Overall, there were no significant interactions in the models (i.e., emotional support with literacy, EF, and social-emotional skills; classroom organization with EF; and instructional support with literacy and numeracy; see Tables 4, 5 and 6). A lack of significant interactions is inconsistent with the hypotheses of this study.

DISCUSSION

The aim of the current study was to examine whether facets of teacher-child interactions moderated relations between participation in a state-funded pre-k program and a constellation of children's school readiness skills (e.g., literacy, numeracy, EF, and social-emotional skills). The study sought to complement and contribute to the growing research efforts aimed at understanding under what conditions state-funded pre-k programs may optimize the development of children's school readiness skills (Phillips et al., 2017). Although previous research has found that instructional support moderates the relation between pre-k participation and both literacy and numeracy (Johnson et al., 2016), there is a lack of evidence on whether these findings generalize to low income samples, non-academic school readiness indicators, and other facets of teacher-child interactions such as emotional support and classroom organization. The current study addresses these gaps by using a sample of children from a targeted state-funded pre-k program, including non-academic dependent variables, and evaluating emotional support and classroom organization as moderators in addition to instructional support. Despite the novelty of this study, none of the hypotheses were supported. These finding were inconsistent with previous research that has explored teacher-child interactions as moderators of the association between pre-k participation and school readiness (Johnson et al., 2016). The following sections will be centered on theoretical and methodological explanations for the non-significant and findings.

Theoretical Interpretations

A few theoretical reasons may help explain why hypotheses were not supported in this study. One reason why this study was not able to replicate the results from Jonson et al. (2016) may be due to programmatic differences between the two pre-k programs in each of the studies.

The Tulsa Pre-K program requires teachers to hold B.A. degrees, to be certified in early childhood education, and to be paid the same as public school teachers (Gormley et al., 2005). Further, Tulsa's pre-k program has a high score on NIEER's New Quality Standards Checklist (score = 7/10; Friedman-Krauss et al., 2018) in addition to its high scores on the CLASS measure. For instance, the average scores for emotional support, classroom organization, and instructional support were 5.23, 4.96, and 3.21, respectively (Phillips, Gormley, & Lowenstein, 2009). For reference, Indiana's OMW Pre-K program has a score of 3/10 on NIEER's New Quality Standards Checklist (Friedman-Krauss et al., 2018) and scores slightly lower on the CLASS. Specifically, the average CLASS scores in Indiana's pre-k program were 5.27 for emotional support, 4.53 for classroom organization, and 2.35 for instructional support. Therefore, it appears that teacher-child interactions may moderate the association between pre-k participation and school readiness only when both programmatic aspects of pre-k and teacher-child interaction are of high quality. It may be that because teachers in Indiana have fewer high-quality programmatic aspects of pre-k on which to capitalize, they have a weaker platform for enhancing their interactions with children. For example, pre-k teachers in Indiana may not have as many opportunities to receive professional development support that may help optimize their interactions. Furthermore, some Indiana pre-k teachers may lack the content and teaching knowledge usually obtained through receiving a B.A. degree related to early childhood, which may hinder them from enacting high-quality interactions.

Another interpretation is that the effects of a state-funded pre-k program simply do not vary as a result of the quality of teacher-child interactions. Other classroom processes, such as domain-specific instruction or the use of evidence-based curricula with fidelity of implementation, not included in this study, may be more important to consider. For example, the quality of literacy instruction may strengthen the association between pre-k and children's literacy outcomes. It may be that children's literacy development is stronger when teachers explicitly teach children about sentence structure, sounds of letters, the logical flow of the alphabet, and meaning and comprehension (Justice, Mashburn, Hamre & Pianta, 2008) in the context of a state-funded pre-k program. Similarly, high quality implementation with fidelity of evidence-based curricula may moderate the association between pre-participation and children's outcomes. For instance, research has shown that children whose teachers effectively use evidence-based mathematics curriculum (e.g., Building Blocks; Clements & Sarama, 2007a) outperform children whose teachers use the schools' standard curriculum (not mathematics-specific) on mathematics and other school readiness outcomes (Clements & Sarama, 2007b).

In addition to instruction and curriculum, it may be that teacher educational levels or characteristics play an important role in the relation between pre-k participation and school readiness. In terms of teachers' educational backgrounds, it may be that education level would moderate the association of pre-k participation and school readiness. Results of one study suggest that children had better school readiness skills when their teachers had more advanced educational backgrounds (Burchinal, Cryer, Clifford, & Howes, 2002). In terms of teachers' personal characteristics, teachers' stress, emotional exhaustion, and work satisfaction have been found to influence teacher-child interactions (Jeon, Buettner, & Grant, 2018), which all ultimately may impact children's school readiness skills (Jeon, Buettner, & Snyder, 2014). On the one hand, pre-k participation may not positively influence children's school readiness skills if teachers' stress and emotional exhaustion is high and job satisfaction is low. On the other hand, the effect of pre-k participation may be stronger if teachers' perceptions of their careers are positive. Relatedly, past research has shown that teachers' EF may support the development of school readiness skills (Jennings & Greenberg, 2009), so teacher's EF may also be important to consider in future moderation analyses. It is possible that when children are participating in high quality pre-k programs (i.e., rated highly on a QRIS) and have a teacher who displays skills that represent high EF (e.g. ability to inhibit their reactivity to student's misbehavior, complete multiple classroom tasks simultaneously, and shift their attention to a changing classroom context), they experience the greatest gains in their school readiness skills.

The effects of pre-k may also vary depending on children's characteristics. For instance, children's entry skills may be important to consider. In one study, researchers found that the relation between pre-k attendance and school readiness skills was stronger for children who entered preschool with low skills (Ehrlich et al., 2014). According to the compensatory hypothesis (Sameroff & Chandler, 1975), preschool experiences may be particularly beneficial to children who have low skills because they may compensate for little to no skill building opportunities prior to preschool entry. Thus, incorporating potential moderating effects by child characteristics will be important in subsequent studies.

Methodological Interpretations

In addition to theoretical considerations, there may also be methodological reasons for the null effects. For example, in this study, the measure of teacher-child interactions was limited to one, global assessment, the Pre-K CLASS. Although this measure is still considered the "gold standard" of classroom quality assessments, a number of limitations of the measure have been identified. For example, despite the fact that all research assistants in the current study met reliability standards at the beginning of data collection, there is possibility for coder drift over time as has been shown with researchers coding classroom observation sessions with a different measure (Marston, 1978). Moreover, CLASS reliability standards are somewhat low in that during the initial certification process research assistants watch five videos and are considered reliable when they score within one point of the master code 85% of the time (Burchinal, 2018). This leaves room for some level of subjectivity in scoring and may not equate to strong reliability across raters. Indeed, results from one study suggest that reliability was less frequently achieved when more stringent reliability criteria are utilized (e.g., rater matches scores exactly to the master code; Sandilos & DiPerna, 2011). Research also suggests that other factors (e.g., season, classroom composition) may affect reliability in CLASS scoring (Booren, Downer, & Vitiello, 2012; Buell, Han, & Vukelich, 2017; Vitiello, Booren, Downer, & Williford, 2012). For example, one study demonstrated that CLASS scores are higher during the spring (Buell et al., 2017).

Measuring global teacher-child interactions versus individual child-level quality is also important to consider in the context of a state-funded pre-k program. Although it may be useful to measure quality at this global level, it is unlikely that every individual child experiences the same level of quality. For example, research has shown that children experience differential teacher-child relationships based on their characteristics such as behavior problems and EF (Baker, Grant, & Morlock, 2008; McKinnon & Blair, 2018). Thus, it may be more useful to consider individual level quality using measures like the individualized CLASS (i.e., inCLASS; Downer, Booren, Lima, Luckner, & Pianta, 2010) when examining associations among pre-k and children's school readiness.

In sum, the results of the current study suggest that the effect of a state-funded pre-k program on children's school readiness is not enhanced by teacher-child interactions. From a broader perspective, the results of the study give reason for field to continue illuminating the "black box" question that seeks to understand which aspects of pre-k programs can boost children's school readiness (Phillips et al., 2017). Therefore, more research is needed to explore other potential moderators of the effects of pre-k participation on children's school readiness skills. Other potential variables, such as domain-specific instruction, teacher characteristics, and child characteristics may serve to strengthen the impacts of pre-k more than teacher-child interactions. Additionally, the field needs to revamp the way in which classroom quality studies are conducted by tapping into children's individual experiences in the classroom and addressing issues of reliability.

Limitations & Future Directions

This study adds to the literature investigating the moderating role of classroom quality between pre-k participation and children's school readiness; however, a few limitations must be noted. First, the CLASS variable was dichotomized. Past methodological literature has indicated that dichotomizing continuous variables is linked to a loss of variability and power (MacCallum, Zhang, Preacher, & Rucker, 2002). However, in a study analyzing justifications of dichotomizing continuous variables, researchers stated that dichotomizing is easier for interpretation and valid when the field has identified theoretically valid cut off points, or thresholds in the measure (DeCoster, Iselin, & Gallucci, 2009), which is the case for the CLASS variable. Nonetheless, in the current study, post-hoc analyses were run with CLASS as a continuous variable, and the pattern of results remained the same (i.e., largely null results).

Another issue important to note with the CLASS measure is that none of the outcomes in the fall and spring were significantly related to emotional support. Also, significant correlations between instructional support and numeracy and EF were negative, and classroom organization was only correlated with literacy and EF. This may mean that there are issues with how well the

CLASS measure captures the types of interactions in preschool thought to be related to children's outcomes.

The final limitation is related to missingness. Missing data is a concern because it may produce biased estimates, lower statistical power, and allow researchers to make invalid conclusions about findings (Acock, 2005). The statistical program in this study, SAS, attempts to address this issue in part by performing maximum likelihood estimation on dependent variables, which is more appropriate than listwise deletion. It should be noted however, that in some models there is as little as 75% of the sample retained. Therefore, future studies will need to use more robust methods for addressing missingness such as full information maximum likelihood.

Conclusion

Recently, there has been a call to examine the conditions under which state-funded pre-k programs may have the greatest impact on children's school readiness skills (Phillips et al., 2017). The current study contributed to this need by examining the extent to which participating in both pre-k and having teachers who meet high quality thresholds on their interactions with children is related to greater growth in school readiness skills, compared to children not participating in pre-k. The non-significant findings suggest that teacher-child interactions may not be important factors that strengthen the relation of pre-k participation on school readiness. Perhaps, other aspects of children's educational environments would be more salient moderators. Given the results of this study, there is still a need to continue examining what features of pre-k bolster children's school readiness.

Table 1. *Means, standard deviations, and demographic information for key study variables*

	Full sample (N = 558)						OMW Pre-K (n = 376)	Comparison (n = 182)	T-tests
	M (SD)	N	Minimum	Maximum	Skew	Kurtosis	M (SD)	M (SD)	
Age in months	57.74 (3.71)	558	44.84	70.62	.03	-.67	57.70 (3.58)	57.83 (3.98)	$t(556) = 0.39$
Parent Monthly Income	1,508 (892)	545	0.00	5540	.36	.24	1,396 (917)	1,747 (788)	$t(543) = 4.35$***
Emotional Support (1-7)	5.19 (1.00)	542	2.81	6.81	-.51	-.69	5.27 (0.95)	5.00 (1.09)	$t(540) = -2.87$**
Classroom Organization (1-7)	4.54 (1.11)	542	1.00	6.67	-.74	.46	4.53 (1.08)	4.59 (1.17)	$t(540) = 0.57$
Instructional Support (1-7)	2.31 (0.89)	542	1.00	5.25	.67	-.32	2.35 (0.83)	2.21 (1.01)	$t(540) = -1.63$
Fall Outcomes									
Literacy	7.43 (4.39)	548	0.00	21.00	.61	.22	6.65 (4.00)	9.06 (4.71)	$t(546) = 6.21$***
Numeracy	10.05 (3.78)	542	0.00	20.00	-.24	.33	10.02 (3.90)	10.10 (3.54)	$t(540) = 0.21$
Executive Function	11.48 (15.20)	547	0.00	59.00	1.09	-.06	11.25 (15.16)	11.94 (15.34)	$t(545) = 0.49$
Social-Emotional Skills	3.03 (0.51)	535	1.41	4.00	-.19	-.47	3.08 (0.50)	2.92 (0.49)	$t(533) = -3.47$***
Spring Outcomes									
Literacy	9.57 (4.95)	506	0.00	26.00	1.01	1.85	8.93 (4.13)	11.09 (6.27)	$t(504) = 4.53$***
Numeracy	11.77 (3.58)	507	0.00	21.00	-.17	.47	11.67 (3.58)	12.01 (3.60)	$t(505) = 0.98$
Executive Function	18.62 (18.53)	491	0.00	60.00	.52	-1.11	18.70 (18.63)	18.66 (18.35)	$t(489) = 0.06$
Social-Emotional Skills	3.12 (0.53)	445	1.80	4.00	-.32	-.62	3.20 (0.53)	2.96 (0.48)	$t(443) = -4.18$***
	%						%	%	
Gender		558							
Male	51.1%						50.8%	51.6%	
Female	48.9%						49.2%	48.4%	
Race & Ethnicity		554							
Asian	0.8%						1.3%	--	
African American	43.7%						32.2%	67.6%	

Table 1 continued

Hispanic	12.4%		14.1%	8.8%
European American	32.3%		41.8%	12.6%
Multiracial	10.4%		10.6%	9.9%
Unknown	0.4%		--	1.1%

Table 2. *Bivariate correlations among key study variables*

Measures	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Age in months	--										
2. Gender	-.04	--									
3. Race & Ethnicity	.00	.02	--								
4. Parent Monthly Income	-.01	.07	-.00	--							
5. Preschool Group	-.02	-.01	.29***	-.18***	--						
6. Cohort	-.02	.06	-.09*	.15***	-.21***	--					
7. Class Organization	.12**	.00	.12**	-.03	-.02	.01	--				
8. Emotional Support	.10*	.01	.14**	-.05	.12**	-.09*	.74***	--			
9. Instructional Support	.03	-.02	-.01	-.10*	.07	-.05	.58***	.57***	--		
10. Fall Literacy	.21***	-.07	-.07	.05	-.26***	.02	.18***	.05	-.02	--	
11. Fall Numeracy	.25***	-.09*	.18***	-.01	-.01	.04	.04	-.02	-.10*	.53***	--
12. Fall EF	.19***	-.12**	.19***	.02	-.02	.03	.09*	-.00	-.08*	.35***	.50***
13. Fall Social Skills	.17***	-.20***	-.08	-.05	.15***	-.19***	-.01	.05	.03	.14***	.23***
14. Spring Literacy	.21***	-.10*	-.09*	.01	-.20***	-.05	.18***	-.05	-.07	.79***	.45***
15. Spring Numeracy	.24***	-.07	.18***	.00	-.04	.01	.05	-.04	-.11**	.50***	.72***
16. Spring EF	-.17**	-.05	.20***	.00	-.00	.06	.09*	-.01	-.09*	.37***	.55***
17. Spring Social Skills	.09	.14**	-.10	-.00	.19***	-.18***	.03	.03	.02	.10*	.14**
	12.	13.	14.	15.	16.	17.					
12. Fall EF	--										
13. Fall Social Skills	.14***	--									
14. Spring Literacy	.34***	.15***	--								
15. Spring Numeracy	.50***	.16***	.48***	--							
16. Spring EF	.64***	.13**	.33***	.54***	--						
17. Spring Social Skills	.06	.57***	.15***	.12**	.04	--					

Table 3. *Number of children and percent missing for key variables in the study*

	N	%
Age in months	0	0.00
Parent Monthly Income	13	2.33
Gender	0	0.00
Race & Ethnicity	2	0.36
Fall Literacy	10	1.79
Fall Numeracy	16	2.87
Fall Executive Function	11	1.97
Fall Social-Emotional Skills	23	4.12
Spring Literacy	52	9.34
Spring Numeracy	51	9.14
Spring Executive Function	67	12.01
Spring Social-Emotional Skills	113	20.25
Emotional Support	16	11.68
Classroom Organization	16	11.68
Instructional Support	16	11.68

Table 4. *Emotional support models predicting literacy (N = 480), executive function (N = 466), and social skills (N = 411)*

	Literacy		Executive Function		Social Skills	
	Estimate	*SE*	*Estimate*	*SE*	*Estimate*	*SE*
Fixed effects						
Intercept	0.33	0.25	-0.02	0.24	-0.59	0.44
Age (in months)	0.03	0.03	0.03	0.037	-0.03	0.04
Monthly Income	0.00	0.03	0.00	0.036	0.00	0.04
Fall Score on outcome	0.76***	0.03	0.59***	0.04	0.50***	0.04
Gender	-0.06	0.05	0.03	0.07	-0.00	0.07
Race & Ethnicity	-0.06	0.07	0.17*	0.08	-0.04	0.09
Cohort	-0.07	0.08	0.09	0.08	-0.09	0.13
Preschool Group	-0.34	0.27	0.26	0.25	0.58	0.49
Emotional Support	-0.10	0.16	0.05	0.16	-0.29	0.27
ES Threshold	-0.43	0.25	-0.46	0.26	0.54	0.45
Group*Emotional Support	-0.02	0.22	0.27	0.21	0.10	0.38
Group*ES Threshold	0.61	0.33	-0.06	0.32	-0.33	0.57
Emotional Support*ES Threshold	0.05	0.24	0.29	0.25	0.36	0.41
Group*ES*ES Threshold	0.05	0.31	-0.56	0.30	-0.23	0.52
Random effects						
Intercept variance	0.07***	0.03	0.00	-	0.22***	0.05
Residual variance	0.29***	0.02	0.56***	0.04	0.45***	0.04

Note. Standardized estimates presented. **p* < .05, ***p* < .01, ****p* < .001.

Table 5. *Classroom organization model predicting EF* (N = 466)

	Executive Function	
	Estimate	*SE*
Fixed effects		
Intercept	-0.17	0.16
Age (in months)	0.04	0.04
Monthly Income	0.00	0.04
Fall Score on outcome	0.62***	0.04
Gender	0.05	0.07
Race & Ethnicity	0.19*	0.08
Cohort	0.11	0.08
Preschool Group	-0.06	0.13
Classroom Organization	0.15	0.12
CO Threshold	-0.15	0.27
Group*Classroom Organization	-0.17	0.14
Group*CO Threshold	0.05	0.38
Classroom Organization*CO Threshold	0.02	0.27
Group*Classroom Organization*CO Threshold	0.05	0.38
Random effects		
Intercept variance	0.00	0.02
Residual variance	0.58***	0.04

Note. Standardized estimates presented. *p < .05, **p < .01, ***p < .001.

Table 6. *Instructional support models predicting* literacy (N = 480) and numeracy (N = 476)

	Literacy		Numeracy	
	Estimate	*SE*	*Estimate*	*SE*
Fixed effects				
Intercept	0.10	0.17	0.12	0.15
Age (in months)	0.03	0.03	0.06	0.03
Monthly Income	-0.00	0.03	0.02	0.03
Fall Score on outcome	0.75***	0.03	0.68	0.03
Gender	-0.05	0.05	0.02	0.06
Race & Ethnicity	-0.07	0.07	0.14	0.07
Cohort	-0.10	0.08	-0.04	0.07
Preschool Group	0.13	0.17	-0.14	0.15
Instructional Support	-0.20	0.17	-0.01	0.15
IS Threshold	0.27	0.41	0.40	0.38
Group*Instructional Support	0.21	0.22	-0.01	0.19
Group*IS Thresh	-0.46	0.44	-0.50	0.41
Instructional Support*IS Thresh	-0.03	0.27	-0.27	0.25
Group*Instructional Support*IS Thresh	0.09	0.33	0.33	0.29
Random effects				
Intercept variance	0.09***	0.02	0.01	0.02
Residual variance	0.29***	0.02	0.46***	0.03

Note. Standardized estimates presented. *p < .05, **p < .01, ***p < .001.

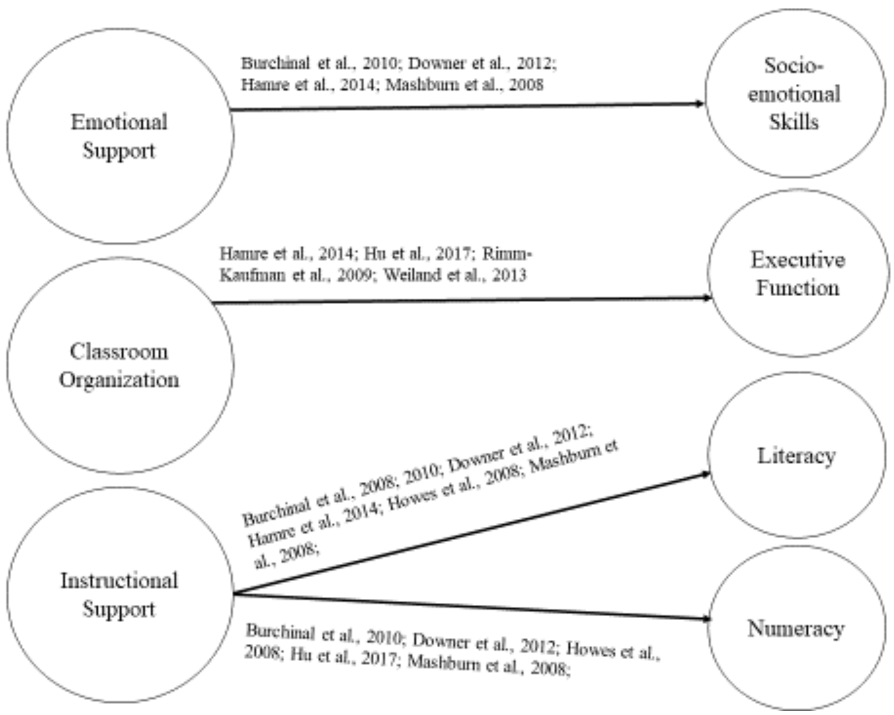

Figure 1. *Studies that show significant associations between CLASS domains and school readiness outcomes*

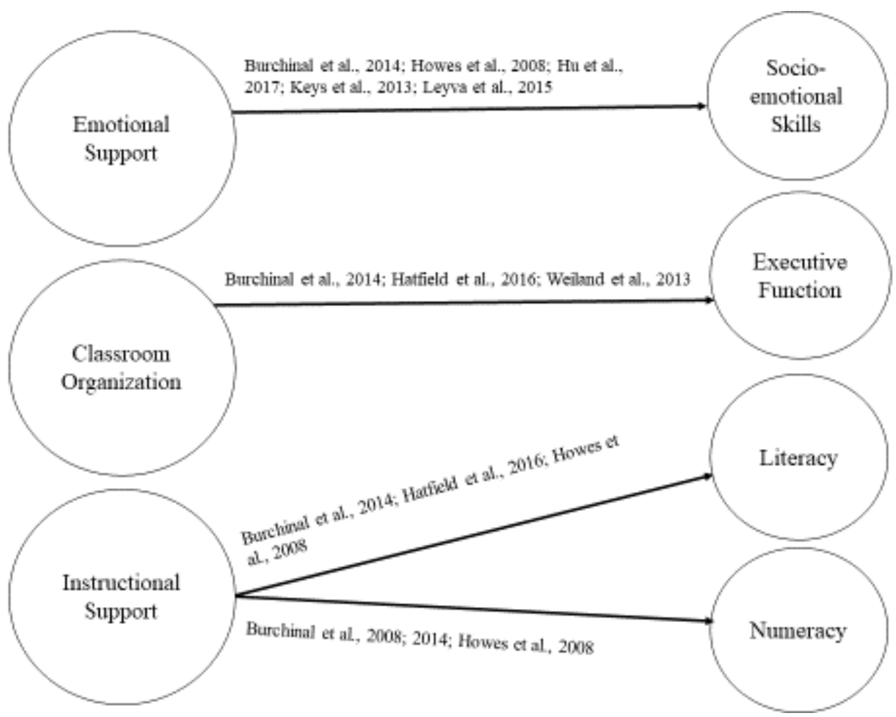

Figure 2. *Studies that show null associations between CLASS domains and school readiness outcomes*

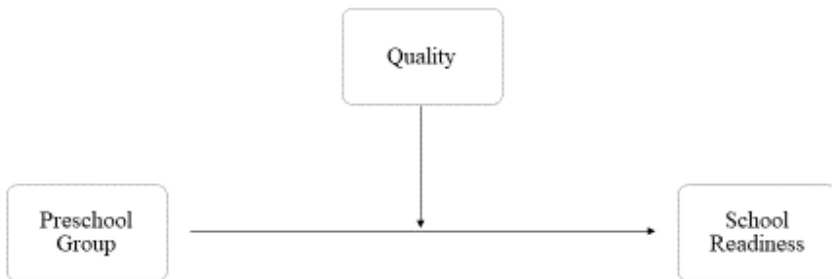

Figure 3. *Conceptual framework for the current study where the relation between pre-k participation and children's school readiness is moderated by classroom quality*

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APPENDIX

Table 7. *Number of OMW and Comparison children in counties recruited in Cohort 1 & 2*

	Cohort 1		Cohort 2	
	OMW	Comparison	OMW	Comparison
Allen	46	9	19	2
Jackson	32	0	10	0
Lake	65	43	17	33
Marion	80	28	33	35
Vanderburgh	53	15	21	17

Table 8. *Number of children in classrooms that met or did not meet CLASS thresholds*

	OMW		Comparison	
	Met Threshold	Unmet Threshold	Met Threshold	Unmet Threshold
Emotional Support	241	135	89	77
Classroom Organization	127	249	71	95
Instructional Support	162	214	39	127