EXAMINING THE RELATIONSHIP OF EARLY LITERACY SKILLS AND COGNITIVE SELF-REGULATION TO KINDERGARTEN READINESS OF PRESCHOOL STUDENTS

by

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Title: Examining the Relationship of Early Literacy Skills and Cognitive Self-Regulation to Kindergarten Readiness of Preschool Students

Every year, millions of preschool-age children make the transition into kindergarten. This transition from preschool to kindergarten can be difficult for children who have not mastered the basic school readiness skills involved in a successful transition. Although school readiness is broadly defined and involves several basic skills, the present study focuses on the specific contribution of cognitive self-regulation and early literacy skills. The present study examined the effects of preschool progress in cognitive self-regulation and early literacy skills on kindergarten readiness using descriptives, Pearson correlations, analysis of variance, and multilevel growth modeling. Three research questions are described and utilized. *Research question 1* examined the growth in early literacy and cognitive self-regulation skills across the preschool year, *research question 2* examined the relationship between early literacy and cognitive self-regulation skills, and *research question 3* examined differences in student skills across three sites. Participants included preschool students, ages 4 to 5, from three different school districts. Early literacy and cognitive self-regulation data were collected at the beginning, middle and end of the preschool year. Overall, results yield a better understanding of the relationship between early literacy and cognitive self-regulation

skills in preschool students and how community-level factors affect these skills in order to better support early intervention in preschools. More specifically, results of the first research question indicated that students made growth in both early literacy skills and cognitive self-regulation skills across the preschool year, and scores in the beginning of the preschool year were significantly correlated with scores at the end of the preschool year. Results of the second research question indicated a strong relationship between early literacy skills and cognitive self-regulation across the preschool year, and results of the third research question highlighted differences in growth rates across sites. Possible mediating variables are described in the discussion. Limitations of the study and future research directions are discussed.

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CHAPTER I

INTRODUCTION

Every year, millions of preschool-age children make the transition into kindergarten. This transition from preschool to kindergarten can be difficult for children who have not mastered the basic school readiness skills involved in a successful transition. School settings place several new demands on children such as requiring them to participate in well-regulated activities, comply with rules, maintain behavioral inhibition, develop positive relationships with peers and adults, cope with emotions, and master many novel early literacy and numeracy skills.

Many young children enter school without the basic skills that are needed to succeed in kindergarten (Rimm-Kaufman et al., 2000). In fact, according to a national survey of kindergarten teachers, as many as half of all students enter kindergarten without the necessary academic or social skills considered critical to a successful transition (Rimm-Kaufman et al., 2000).

Children who lack these basic skills are more likely to display academic and social difficulties and, as a result, perform poorly in school in comparison to their counterparts who demonstrate the requisite social, emotional and academic skills (Arnold et al., 1999; Joseph & Strain, 2003; McLelland, Morrison & Holmes, 2000; O'Neil, Welsh, Parke, Wang & Strand, 1997). Without intervention, these difficulties can lead to more significant emotional and behavioral problems throughout childhood (Campbell 1995; Olson & Hoza, 1993). Additionally, students from low-income families are often much less prepared to begin school and are more likely to demonstrate underachievement in comparison to their more affluent peers (Lutkus, Rampey, & Donahue, 2005).

An increased focus on school readiness at both the federal and state level made explicit the need to support children in gaining the cognitive, academic, social, emotional, and behavioral competencies needed for positive outcomes in elementary school (Bowman, Donovan, & Burns, 2001). At the federal level, the No Child Left Behind Act (NCLB, 2001) is an example of the emphasis that has been placed on increasing academic outcomes for students, especially literacy skills. This task can be challenging due to the high number of students at risk for reading failure, as an increasing number of children are entering the school system without sufficient exposure to language and forms of print (Spira et al., 2005).

A Model of School Readiness

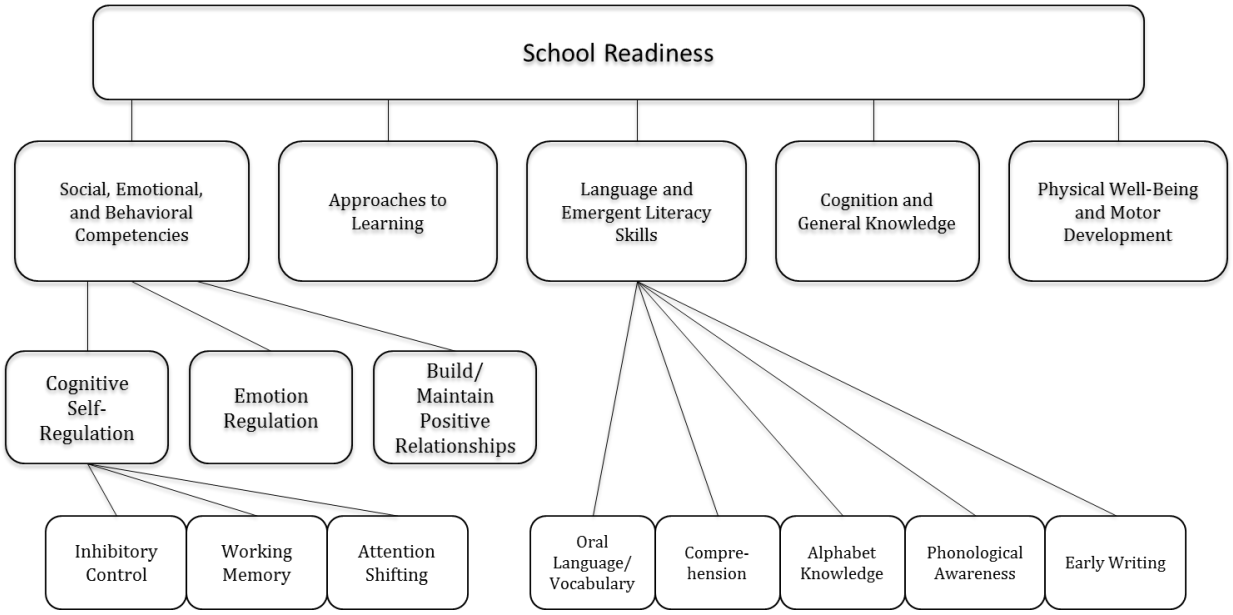
In general, school readiness refers to a child's social and academic skills that are associated with preparation for formal schooling (De Feyter & Winsler, 2009). The model of school readiness used in this research is illustrated in Figure 1. The five domains of school readiness in the model are adapted from the framework proposed by the National School Readiness Indicators Initiative (2005). The domains include: (a) social, emotional, and behavioral competencies; (b) approaches to learning; (c) language and emergent literacy skills; (d) cognition and general knowledge; and (e) physical well-being and motor development. Others (e.g., De Feyter & Winsler, 2009; Ready at Five, 2014) might use a somewhat different framing of school readiness and may use different terms or definitions for the constructs.

Social, Emotional and Behavioral Competencies. The National School Readiness Indicators Initiative (2005) describes the domain of social, emotional and behavioral competencies as combining two interrelated components; (a) social development and (b)

emotional development. Social development refers to a child's skills in peer interactions as well as their capacity for self-regulation (National School Readiness Indicators, 2005). Emotional development considers a child's skills in understanding and relating to others as well as interpretation and understanding of their own emotions (National School Readiness Indicators, 2005).

Figure 1.

Conceptual Model of School Readiness



5 Domains Adapted From:

(2005, February). Getting Ready: Findings from the National School Readiness Indicators Initiative A 17 State Partnership (p. 14).

Researchers and policy makers often highlight the necessity of social-emotional competence for success in the transition to kindergarten and into the subsequent early elementary school years. This attention prompted a growing body of research over the past several decades to focus on the social-emotional needs of young children and the long-term effects of early childhood experiences, including the contribution to positive

behavioral outcomes (Fantuzzo et al., 2007; Joseph & Strain, 2003).

The social-emotional competencies young children gain early in their life provide a foundation on which they will access school and develop future skills (Fantuzzo et al., 2007; Joseph & Strain, 2003), and student behavioral skills account for a substantial proportion of children's early academic achievement (Hindman, Skibbe, Miller & Zimmerman, 2010). For example, social-emotional skills and positive relationships with peers and adults can promote classroom learning. Learning-related skills, such as responsibility, self-regulation, and independence are a valuable indicator of school success throughout elementary school (McClelland, Acock & Morrison, 2006), and children's understanding of emotions at a young age can be predictive of academic outcomes several years later (Izard et al., 2001). Therefore, researchers often acknowledge the social-emotional and behavioral foundations for cognitive development during early childhood (Denham et al., 2003), as these skills provide the foundation for a child's success at adapting to the challenging, and sometimes novel, preschool and kindergarten environments.

Due to the overlapping relationship between social-emotional competencies and behavioral outcomes (Fantuzzo et al., 2005), they can be studied jointly as intervention in early childhood is often similar regardless of whether a student is displaying behavioral challenges or has social-emotional risks (i.e. see the Pyramid Model; Hemmeter et al., 2011). Social-emotional and behavioral skills encompass multiple domains of skills. One domain of skills that is particularly relevant to school settings is self-regulation.

Self-regulation is a complex construct that describes an individual's capacity to regulate emotions, cognition and behaviors (Calkins, 2007), and therefore can be

conceptualized as including two sub-categories. These two categories are (a) cognitive self-regulation (Fuhs, Farran & Nesbitt, 2013), sometimes referred to as behavioral regulation (e.g. McClelland et al., 2007), which encompasses inhibitory control, working memory and attention shifting and (b) emotion regulation, which involves temperamental reactivity, or emotional responding to internal or external environmental changes (Rothbart, Sheese, Rueda & Posner, 2011).

The general concept of self-regulation, involving both cognitive self-regulation and emotion regulation, when measured in childhood, has been associated with long-term healthy behavior in adulthood (Moffitt et al., 2011). The growing evidence of long-term impacts of self-regulation shows the necessity of better understanding how young children acquire such skills. However, less is known about how these self-regulatory skills contribute to academic skills prior to kindergarten (McClelland et al., 2007), and this gap in the literature has prompted a growing interest in the role of self-regulation in early childhood settings (Cole, Martin, & Dennis, 2004).

Some argue that an accurate description and measurement of emotion regulation and cognitive self-regulation competencies in young children are central to understanding the processes through which children learn in formal school settings (Blair, 2002; Blair & Razza, 2007). Variability in emotion regulation and cognitive self-regulation skills can be documented in preschool, and represent critical variables in school preparation in early childhood (Bodrova & Leong, 2006; Bronson, 2000). Some researchers suggest that how well a child demonstrates cognitive and emotion regulation skills affects the ways in which children interact with peers and teachers in the classroom and, therefore, social functioning is an effect (Miller, Gouley, Seifer, Dickstein & Shields, 2004). This

describes one of the many possible mediators involved in self-regulation processes. In the present study, the concept of cognitive self-regulation (Fuhs, Farran & Nesbitt, 2013) will be focused upon due to its strong relationship with academic achievement (McClelland et al., 2007), therefore making it highly relevant to the overall construct of school readiness.

Cognitive self-regulation. Cognitive self-regulation is often considered a learning-related skill (McClelland, Acock & Morrison, 2006), as it is found to be highly predictive of academic achievement (Turner et al., 2012). And children who lack cognitive self-regulation are often considered to be at risk for peer rejection and low levels of academic achievement (Cooper & Farran, 1988; McClelland, Morrison, & Holmes, 2000).

Cognitive self-regulation involves three component skills, which are inhibitory control, working memory, and attention shifting, all of which uniquely contribute to the overarching model of cognitive self-regulation (Fuhs, Farran, & Nesbitt, 2013).

Inhibitory control. Inhibitory control is defined as voluntarily inhibiting or regulating behavioral responses (Dowsett & Livesey, 2000). It is identified as a primary skill involved in controlling behavior (Rennie, Bull & Diamond, 2004), which allows children to inhibit an inappropriate response to a problem and intentionally apply a more appropriate response (Dowsett & Livesey, 2000).

Working memory. Working memory is defined as holding one concept in mind while manipulating another concept (Cowan, 2008). Working memory helps children to remember and follow directions, as well as to plan solutions to a problem.

Attention shifting. Attention shifting, sometimes referred to as cognitive flexibility (e.g. Scott, 1962), allows students to think about two concepts and simultaneously switch

between tasks when explicitly told a rule to follow. Attention shifting helps students to focus on specific aspects of a problem or task, which has major impact on a child's ability to learn within the classroom as it measures explicit rule following and adapting to change or showing flexibility when rules change.

Cognitive self-regulation includes all three of these concepts; inhibitory control, working memory, and attention shifting. When applied to the classroom setting, cognitive self-regulation captures the child's ability to produce appropriate behavioral actions in response to contextual environmental factors and academic or social demands within a school setting. It is useful to conceptualize these cognitive self-regulation skills that are important for early achievement as a learning-related construct (McClelland, Acock, & Morrison, 2006). Learning related skills stem from a child's executive function skills, such as attention, memory and inhibitory control, as well as reflect the behavioral manifestation of these skills, like listening and following directions (McClelland, Acock & Morrison, 2006).

Cognitive self-regulation is a valuable predictor of school success throughout elementary school (McClelland, Acock & Morrison, 2006). Early cognitive self-regulation has been identified as a key predictor of both current and later academic achievement (Blair, 2002; Blair & Razza, 2007; Duncan et al., 2007; McClelland & Morrison, 2003; McClelland, Acock, & Morrison, 2006). Children with higher levels of cognitive self-regulation in kindergarten also have higher levels of academic achievement from kindergarten through sixth grade (McClelland, Acock, & Morrison, 2006).

Cognitive self-regulation at the preschool level has been identified as an early marker for later academic achievement (Mischel et al., 2011). In fact, cognitive self-

regulation skills in preschool are associated with higher vocabulary, literacy and numeracy outcomes (McClelland et al., 2007). Early cognitive self-regulation may also have continued effects on a child's academic skills as cognitive self-regulation measured at age four predicts academic achievement through elementary school and all the way to college (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013; Mischel et al., 2011).

Currently, the international literature base is expanding as researchers begin to identify cognitive self-regulation as a critical component of school readiness and an important predictor of academic and social competence (e.g., Blair & Razza, 2007; Gestsdottir & Lerner, 2007). This body of literature has encouraged education policies in Europe to call for an increased understanding of cognitive self-regulation in early childhood, with the goal of increasing equity in education (Leseman, 2009).

Further, increasing evidence suggests that cognitive self-regulation skills are malleable and can be taught. Children receiving interventions affecting cognitive self-regulation show significant gains in both cognitive self-regulation and academic skills (Connor et al., 2010; Raver et al., 2011; Tominey & McClelland, 2011). These results provide preliminary evidence for the malleability of cognitive self-regulation during the preschool years, and the possibility of teacher behaviors and additional interventions that will support the learning of cognitive self-regulation skills in early childhood.

Emotion regulation. Knowledge and regulation of emotions such as effortful control are also encompassed under social, emotional and behavioral competencies. Emotion regulation reflects the ability to allow for behavioral and emotional changes during emotionally-reactive situations. In early childhood, persistence during challenging situations and tolerating frustration are examples of emotion regulation. Early education

settings can be useful in teaching young children with regulation difficulties how to understand their emotions and adjust reactions to environmental stimuli (Tobin, Sansosti, & McIntyre, 2007).

Build/maintain positive relationships. Children benefit from both positive relationships with their peers as well as with adults in their life. Research supports the idea that children benefit from positive peer interactions, and in early childhood, friendships build self-esteem and self-confidence, and foster a sense of security (Manaster & Jobe, 2012). Building positive relationships with young children is often considered a foundational component of good teaching (Joseph & Strain, 2003). Positive adult-child relationships can foster a child's cooperation, motivation, and future school-related outcomes (Webster-Stratton, 1999).

Approaches to Learning. The National School Readiness Indicators Initiative (2005) describes the domain involving approaches to learning as a child's inclination to use various skills and knowledge. This could include motivational aspects of learning and the enthusiasm, curiosity, and persistence on difficult tasks (National School Readiness Indicators, 2005). Many of the domains included in the present model of school readiness overlap and reinforce one another (National School Readiness Indicators, 2005). This is particularly notable as it is likely that a child's ability to persist on tasks is directly related to their cognitive self-regulation skills.

Language and Emergent Literacy Skills. The language and emergent literacy domain includes oral language and vocabulary skills, comprehension, alphabet knowledge, phonological awareness, and early writing skills. Many of these skills are considered to be good predictors of later reading achievement and other academic

outcomes. Language and early literacy skills are also identified as critical school readiness skills and are essential for future development in reading proficiency and writing skills, as well as overall academic success in school (Teale & Sulzby, 1986; Whitehurst & Lonigan, 1998). Early literacy skills are key to broad academic success (Lonigan, Burgess & Anthony, 2000; Strickland & Riley-Ayers, 2006), as reading is a pre-requisite for many other academic skill areas encountered in later grades. Those supporting academic preschool programs argue that early exposure to text and print concepts supports later literacy development and as a result, long-term academic success (Burchinal, Peisner-Feinberg, Pianta & Howes, 2002).

Reading competence in later elementary school grades is influenced by proficiency in foundational skills in beginning reading (National Reading Panel, 2000), and many of these early literacy skills are developing during the preschool years. Therefore, the present study will focus upon early literacy skills due to the foundation they provide for all future academic skills.

Oral language and vocabulary skills. Vocabulary and receptive and expressive communication skills are included in the construct of oral language and vocabulary skills (National School Readiness Indicators, 2005). Children exposed to a rich language environment in the early years acquire a significantly larger vocabulary (Hart & Risley, 1995) and an overall better capacity for using language to interact with others (National School Readiness Indicators, 2005).

Vocabulary and oral language are both strongly connected to later reading success and in preschool may not be distinguishable from comprehension skills. Children who develop strong oral language skills during preschool establish a critical foundation for

later reading achievement (Storch & Whitehurst, 2002), as vocabulary knowledge is highly related to reading proficiency and overall academic success (Storch & Whitehurst, 2002).

Comprehension. Comprehension is the ultimate goal of reading achievement. In an early childhood setting, comprehension is defined as listening comprehension, which involves understanding the meaning of words an individual hears and demonstrating the ability to relate the words and infer meaningful connections between events. Ideally, listening comprehension enables a child to understand what is said to them, remember it, discuss it, and retell what was said in their own words.

Alphabet knowledge. Alphabet knowledge, or alphabetic principle, refers to a child's familiarity with letter forms, names, and corresponding sounds (Piasta, Purpura & Wagner, 2010) and is a strong predictor of later reading success (Adams, 1990). Although knowledge of letter names is not necessary for reading achievement, preschool and kindergarten students with poor knowledge of letter names and sounds are more likely to struggle with learning to read (O'Connor & Jenkins, 1999). For this reason, alphabet knowledge is considered an important achievement for young children, and many state and national organizations identified this as a critical goal (e.g. National Association for the Education of Young Children, 1998; U.S. Department of Health and Human Services & Administration for Children and Families, 2003).

Phonological awareness. Phonological awareness involves the ability to detect, manipulate, and analyze the auditory aspects of spoken language, such as identification of syllables, onsets, and rimes, or the ability to distinguish or segment words or phonemes,

independent of meaning (NELP, 2008). Phonological awareness is considered to be a strong predictor of both reading and spelling success (Weinrich & Fay, 2007).

Early writing skills. Writing is a key component of literacy development, and many children begin drawing, scribbling, and copying letters long before they understand what the letters mean. All of these activities encourage writing awareness and promote their skills in preparation for reading. Although early writing skills are important to emergent literacy skills, it will not be focused upon in the present study, as writing skills are not critical foundational skills in promoting reading success, which is the focus of the present study.

Cognition and General Knowledge. The domain of cognition and general knowledge refers to thinking, problem-solving skills, abstract thought, and mathematical concepts (National School Readiness Indicators, 2005). Through cognitive development, children learn to observe, note similarities and differences, ask questions, and independently solve problems (National School Readiness Indicators, 2005).

Physical Development. Although physical development is not a focus of the present study, it is often included in many models of school readiness (School Readiness Indicators Initiative, 2005), as it encompasses several unique components of school readiness including health status, growth, and disabilities (School Readiness Indicators Initiative, 2005). This area can also include physical abilities such as gross and fine motor skills (School Readiness Indicators Initiative, 2005).

Early Intervention/ Prevention Focus

Schools are increasingly being utilized as sites for prevention and early interventions. Evidence suggests that school-based interventions can have beneficial

effects in promoting positive outcomes (Caprara et al., 2014). Successful prevention and early intervention efforts in school settings could reduce the occurrence of behavioral disorders, as well as, the associated impairments to education and, later, career attainment.

The Role of Preschool in Prevention. Early childhood represents a critical time period for children to learn social and emotional skills, as emotional and behavioral problems during preschool often persist as children transition to school (Izard et al., 2001). Deficits in these skills are linked to poorer school performance (Raver, 2002), and children who have behavioral difficulties at the start of their school experience are at risk for poor academic and social outcomes (Huffman, Mehlinger, & Kerivan, 2001).

Studying both early literacy and cognitive self-regulation skills within a preventive framework is critical for preschool students, as it provides the opportunity to identify skill deficits early and therefore intervene early. Without intervention, early onset behavior problems can lead to academic failure, grade retention, difficulties with peers, and at a later time, substance abuse and school dropout (Gadow & Nolan, 2002; Jimerson, Egeland, Sroufe & Carlson, 2000; Mendez, Fantuzzo, & Ciccetti, 2002; Vitaro, Laroque, Janosz & Tremblay, 2001). Thus, prevention and early intervention for young children who are at risk for displaying poor cognitive self-regulation and early literacy skills is essential.

Preventive interventions supporting prosocial behaviors are most effective in supporting schools to prevent, reduce, and manage chronic problem behaviors, but early identification of individuals who need such support is critical (Sprague & Walker, 2000). When intervention is not provided in the early school years, many social-emotional

problems are less responsive to intervention after the age of eight (Walker, Ramsey, & Gresham, 2004).

There is also the opportunity for large-scale impact, as 57% of three to five year olds were attending preschool in 2005 (Child Trends Databank, 2006). Additionally, more than 80% of American children attend preschool in the year prior to kindergarten (Barnett et al., 2010), highlighting the opportunity to intervene and better prepare students for the kindergarten transition.

The Role of Cognitive Self-Regulation in Early Literacy. The present study will focus on the specific contribution of cognitive self-regulation and early literacy skills because of the unique relationship between these two critical concepts and the likelihood of an interaction effect on kindergarten readiness. For example, it is possible that the level of early literacy skills a student has depends upon their level of cognitive self-regulation skills, such that it impacts their readiness for kindergarten. Further, cognitive self-regulation skills are particularly relevant within school contexts as they allow children to adapt successfully to the new demands of a classroom environment. Teachers report that the majority of their students lack the necessary self-regulatory competencies needed to be successful in the classroom, such as displaying the ability to follow directions (Rimm-Kaufmann et al., 2000), and students enter school with vastly different levels of cognitive self-regulation (Foulks & Morrow, 1989; McClelland, Acock & Morrison, 2006),

Cognitive self-regulation involves attention shifting, working memory, and inhibitory control (Fuhs, Farran & Nesbitt, 2013). Researchers in the field have found that the ability to focus and shift attention predicts children's academic achievement

(Blair & Razza, 2007), and strong working memory has been shown to relate to better reading and math skills (Gathercole & Alloway, 2008). Further, individual differences in inhibitory control account for substantial variability in children's academic outcomes (Clark, Pritchard & Woodward, 2010). The demands of schooling require that all of these constructs work together (Blair, 2002).

Cognitive self-regulation skills are acquired rapidly during the preschool years, and little is known about the mechanism through which early cognitive self-regulation predicts and influences emergent academic achievement. Understanding the process through which cognitive self-regulation is associated with early literacy skills, in particular, is key in supporting young children to acquire both skills. Understanding this mechanism is critical to early intervention support as previous research indicates that children in kindergarten with higher levels of cognitive self-regulation achieved higher gains in reading all the way through second grade (McClelland, Acock, & Morrison, 2006). In other words, the effect of early literacy instruction depended upon the level of cognitive self-regulation skills. This suggests that children with greater cognitive self-regulation may benefit from instruction in early literacy skills differently and therefore make better progress in early literacy skills compared to children who have lower levels of cognitive self-regulation.

Classroom- and Community-Level Effects

Although there is the potential for large-scale impact on key school readiness skills including early literacy skills and cognitive self-regulation, there is also the potential for community, preschool, and classroom effects to occur. Previous research has found that students' achievement can be attributed to factors in a range of levels such as

individual differences, classroom effects, and school-level differences (Kaya & Rice, 2010; Lamb & Fullarton, 2002). This phenomenon contributes to statistical analysis challenges as effects may be over-estimated if these other potential contributors are not modeled or controlled.

The impact of individual and systemic differences in understanding the mechanism through which early literacy skills and cognitive self-regulation skills interact with one another is particularly relevant to preschools. Preschools can look vastly different depending upon several variables such as the geographical location, school staff, program philosophy, and the curriculum that is used, among many other variables. Further, there are multiple forms of preschools present in the United States including community preschools, some of which have a religious affiliation, nursery schools, day care centers, Head start programs, and pre-kindergarten settings held within a larger school. All of these preschools structures may also display a range of emphasis for the type of skill acquisition targeted in their students, such as developmental, academic, behavioral, emotional, and/or social.

Fuhs and colleagues (2013) found that several classroom-level variables were significantly related to the gains that preschool children made in cognitive self-regulation skills over the school year. Some of these classroom-level variables included the teacher's instructional foci, the emotional climate, and the quality of instruction (Fuhs, Farran & Nesbitt, 2013). Previous research conducted at the first grade level, as well, indicated that classroom level differences including use of various curricula, teacher behavior, and environmental differences play a large role in student outcomes (Conduct Problems Prevention Research Group, 1999).

Cognitive Self-Regulation and Early Literacy Skills in Preschool. It is clear that cognitive self-regulation and early literacy skills are not independent constructs. However, little is understood about how these two key school readiness skills impact one another over time. Gaining an understanding of the interaction between early literacy skills and cognitive self-regulation in preschool students and how community-level factors affect these skills will better direct early intervention support in preschools. Additionally, it will help educators to better support the hundreds of thousands of preschoolers who are making the transition to kindergarten each year, as the field has identified the powerful influence of both cognitive self-regulation and early literacy skills on academic outcomes in elementary school. The growing awareness of the importance of cognitive self-regulation for academic and social outcomes builds the need to better understand how educators can help young children acquire these skills.

The present study examines the effects of preschool progress in cognitive self-regulation and early literacy skills on kindergarten readiness. The main effects of early literacy skills and cognitive self-regulation on kindergarten readiness are first examined. The following three research questions are addressed: (1) How did students grow in early literacy and cognitive self-regulation skills across the preschool year? (2) Is there a relationship between early literacy skills and cognitive self-regulation in preschool students? (3) Does the effect of early literacy or cognitive self-regulation skills, or the relationship between early literacy and cognitive self-regulation skills differ from one community to another?

CHAPTER II

REVIEW OF THE LITERATURE

This review of literature focuses on school readiness by specifically targeting two readiness skills critical to this study; early literacy skills and cognitive self-regulation skills. The relation of cognitive self-regulation and academic skills is briefly described, leading to the current school readiness interventions that are in place and a more exhaustive review of a few studies that are foundational to the present work. Last, the potential contributions of the present study are articulated. Overall this review provides a foundation for the present study.

School Readiness

School readiness commonly refers to a child's social and academic skills that are associated with preparation for formal schooling (De Feyter & Winsler, 2009). The present study focuses on two specific school readiness skills: early literacy skills, including comprehension, phonological awareness and alphabet knowledge, and cognitive self-regulation skills, including inhibitory control, working memory and attention shifting.

Early Literacy Skills. Early literacy skills represent a well-studied area of early achievement and intervention with findings consistently indicating that early literacy skills are critical to school readiness and later, overall academic success (Teale & Sulzby, 1986; Whitehurst & Lonigan, 1998). Reading competence in later elementary school grades is influenced by proficiency in foundational skills in beginning reading (National Reading Panel, 2000), and many of these early literacy skills are developing during the preschool years.

Cognitive Self-Regulation. Researchers focusing on cognitive self-regulation, also referred to as executive function (e.g., Blair, 2002) and behavioral regulation (e.g., Howse, Calkins et al., 2003), look at the aspects involved in problem solving, including attention shifting, working memory, and inhibitory control (Bronson, 20000; Barkley, 1997). Attention allows children to focus on a task at hand, apply working memory, and then complete a behavioral task (Barkley, 1997). Inhibitory control develops rapidly during early childhood, and is argued to play a central role in executive function, or cognitive self-regulation, during this time period (Diamond, 2002).

Relationship of Cognitive Self-Regulation and Early Literacy Skills

Early reading and math skills are consistently the strongest predictors of later academic achievement (Duncan et al., 2007). Academic skill trajectories often remain fairly stable after first grade when intervention does not take place (Lesnick et al., 2010). Because of these findings, it is critical to identify research on factors that influence the acquisition of academic skills prior to first grade (or within the preschool to kindergarten years). Cognitive self-regulation is one skill that has been noted as important for a successful transition into a more-structured environment.

Overall, previous research suggests that cognitive self-regulation plays an important role in current and later academic achievement. However, this research offers a limited idea as to whether there are underlying mechanisms that support this relationship. Montroy et al. (2014) suggests that social functioning represents one of the key mechanisms that underlie the relationship between cognitive (behavioral) self-regulation and academic achievement. The researchers describe social functioning as emotionality, empathy, prosocial behavior, social skills and problem behavior (Montroy et al., 2014).

Montroy and colleagues (2014) used Head Toes Knees Shoulders (HTKS) as a measure of cognitive (behavioral) self-regulation and portions of the social skills improvement system (SSIS) was used as a measure of social skills and problem behaviors. Additionally, literacy measures were collected using three subtests of the Woodcock Johnson Achievement (WJ-III) and math skills were examined using the Test of Early Mathematics Ability (TEMA-3). Montroy and colleagues (2014) suggested that social skills and problem behaviors separately mediated the relationship between cognitive self-regulation and growth in literacy achievement across the preschool year. The authors suggest that cognitive self-regulation is foundational in how children interact with others within their environment, which can then affect their learning.

Nesbitt, Baker-Ward, & Willoughby (2013) examined the mechanism through which cognitive self-regulation relates to academic achievement by finding that children's cognitive self-regulation in kindergarten significantly influenced their success in school. However, the authors focused on the relationship to mathematical skills rather than literacy skills. Nesbitt, Baker-Ward, & Willoughby (2013) also identified that children who were at risk for low achievement based on family socioeconomic and minority status were more likely than their peers to have lower cognitive self-regulation skills in kindergarten, which in turn contributed to lower academic achievement in first grade.

Designing School Readiness Interventions

Research suggests that cognitive self-regulation is malleable and a teachable means for improving school success. However, little is known about targeted, systematic approaches to improving these skills prior to kindergarten entry, as growth in cognitive

self-regulation skills has rarely been studied in the past. Recent research that suggests the criticality of cognitive self-regulation skills in the earlier years encouraged development of interventions to improve self-regulation in young children (e.g. Pears, Fisher & Bronz, 2007).

McClelland & Cameron (2011) recommend that interventions should be designed to target key components of cognitive (or behavioral) self-regulation at different developmental periods, which also translate to everyday contexts. This theory is based upon the view that children are active agents in their use of when to use self-regulatory strategies. Similarly, in preschool, it is possible to teach students to engage in inhibitory control, (Dowsett & Livesey, 2000), which is considered to be a critical component of cognitive self-regulation. In fact, teachers focus on many skills that are associated with cognitive self-regulation, such as following directions and learning classroom routines, waiting in a line, sitting properly in a chair, and paying attention in class.

School Readiness Interventions. Although the newly developed interventions do not solely focus on cognitive self-regulation strategies, cognitive self-regulation is encompassed as a critical component of school readiness, along with early literacy skills. Therefore, both cognitive self-regulation and early literacy skills are targeted in many new early interventions to improve school readiness. For example, the Kids in Transition to School (KITS) program, which focuses on increasing school readiness, specifically early literacy, early numeracy and social-emotional skills, has been effective in decreasing problem behavior and increasing cognitive self-regulation skills (Pears et al., 2007). The Tools of the Mind program has also been shown to increase cognitive self-regulation (Barnett et al., 2008). The Promoting Alternative Thinking Strategies

(PATHS) curriculum (Kusche & Greenberg, 1994) is another program targeted for preschool students, which has also been effective at increasing preschool student's cognitive self-regulation skills.

Chicago School Readiness Project. Other interventions designed to promote school readiness, primarily focus on teacher level variables instead. For example, the Chicago School Readiness Project (CSRP; Raver et al., 2011) implemented teacher training to develop behavior management skills and reduce teacher stress levels using an adapted version of the Incredible Years teacher training program (Webster-Stratton, Reid & Hammond, 2004). Raver and colleagues found that children in the experimental groups had significantly greater gains in cognitive self-regulation skills and academic skills than children in the control group, showing that gains were associated with classroom intervention and teacher behavior.

Project Follow Through. Although Project Follow Through was not designed to examine school readiness or cognitive self-regulation skills, it is applicable to the present study, which examines the relationship of cognitive self-regulation and early literacy skills. Beginning in 1968, the federal government was charged with identifying the most appropriate way to teach at-risk children from kindergarten through grade 3 by evaluating 22 different models of instruction. More than 200,000 children from 178 different communities were included in the study. Results of the educational experiment indicated that students who received Direct Instruction had significantly higher academic gains than students in any of the other 21 models of instruction. These students also gained higher self-esteem and self-confidence (Adams & Engelmann, 1996). Direct Instruction can be characterized as an academic intervention program that incorporates classroom

management and high rates of reinforcement to make an impact both on academic skills as well as affective skills, based on the results of Project Follow Through.

Classroom and Teacher Level Effects

When considering school readiness interventions, it is important to consider that individual child behaviors are likely related to more contextual factors such as teacher behavior and the classroom environment (Rimm-Kaufman et al., 2002). For example, in classrooms in which the teacher was characterized as being responsive to student needs, students showed less off-task behavior and more self-control compared to those who were in classrooms where the teacher was considered to not be responsive to student needs (Rimm-Kaufman et al., 2002).

Fuhs, Farran & Nesbitt (2013) conducted one of the few studies focused on the associations between classroom processes including classroom emotional climate, the proportion of observed time spent in learning opportunities and the quality of instruction provided, and gains in cognitive self-regulation skills across the preschool year. The researchers found associations between several classroom processes and gains in cognitive self-regulation skills, therefore relating such classroom behaviors to developmental gains in young children (Fuhs, Farran & Nesbitt, 2013).

Fuhs and colleagues (2013) used a battery of cognitive self-regulation measures, two of which were the measures chosen for the present study; Dimensional Change Card Sorting task and the Peg Tapping task. The other cognitive self-regulation measures that the researchers used included the Copy Design Task as a measure of sustained focus, the Corsi Block-Tapping task as a measure of working memory, and the Head Toes Knees Shoulders (HTKS) task which provides a measure of inhibitory control primarily, as well

as working memory and attention shifting. All measures were administered at two time periods; fall and spring of the preschool year.

To reduce the amount of cognitive self-regulation data, the researchers used a principal components analysis (PCA) to determine component scores for each child at each time point. Fuhs and colleagues (2013) used a series of multilevel models to examine cognitive self-regulation growth across the preschool year in relation to classroom process variables. The researchers also entered a number of covariates as fixed effects which included age, the interval between pre- and posttest, gender, ELL status, IEP status and ethnicity. Data in this study were taken from the large-scale Tools of the Mind evaluation. The researchers found lower Intraclass correlation coefficients for cognitive self-regulation than they did for academic achievement, and concluded that it is possible that teachers may have less influence on cognitive self-regulation in preschool or it is equally plausible that they do not yet know how to provide sufficient instruction to build cognitive self-regulation skills. The researchers also found that children made more gains in cognitive self-regulation in classrooms where teachers often expressed their approval of student's behavior and encouraged them to maintain this desirable behavior. Fuhs and colleagues (2013) concluded that a "well-managed classroom," or one in which the teacher is able to focus on student learning rather than redirecting student behavior, also contributed positively to cognitive self-regulation skills.

Foundational Studies

Although many interventions have been developed that may indirectly affect learning-related skills, the idea that these skills should be targeted by teachers in preschool and kindergarten classrooms (e.g. Blair & Razza, 2007) is limited due to

several unknown variables about the transition into school, such as how cognitive self-regulation and early literacy skills relate to one another at various time points throughout preschool. Few studies have examined this question.

Some researchers who have looked more closely at this relationship include Welsh and colleagues (2010), whom assessed associations between cognitive self-regulation and mathematics and literacy skills in preschool students, and found that executive functioning at the beginning of preschool predicted gains in both academic skills measured. Welsh et al (2010) also found support for a bidirectional relationship where a child's initial mathematics skills predicted gains in cognitive self-regulation skills. This finding was not supported for early literacy skills.

Similarly, McClelland et al. (2007) examined gains in cognitive self-regulation skills and literacy, vocabulary and math skills in the fall and spring of the preschool year. Results of this study indicated that children with higher cognitive self-regulation had significantly higher levels of emergent literacy, vocabulary and math skills in both the fall and spring of preschool. The researchers also found that children who had more growth in cognitive self-regulation from the fall to spring also had significantly greater gains in academic skills, compared to those students with less gains in their cognitive self-regulation skills (McClelland et al., 2007).

Fuhs et al (2014) examined changes in cognitive self-regulation skills and subsequent academic skills across the preschool year. Fuhs et al (2014) assessed cognitive self-regulation, math and literacy skills in the fall of preschool, spring of preschool and spring of kindergarten. The researchers used the cognitive self-regulation measures represented in the present study as well as some additional measures to create a

battery of cognitive self-regulation measures. The additional measures include Backward Digit Span as a measure of working memory, the Copy Design task as a measure of attention shifting, the Head Toes Knees Shoulders (HTKS) task as a measure of inhibitory control primarily, but also measures aspects of working memory and attention shifting, and the Kansas Reflection Impulsivity Scale for Preschoolers (KRISP) as a measure of inhibitory control. Subtests from the Woodcock Johnson Test of Achievement were used as a measure of academic skills, which include Applied Problems, Quantitative Concepts, Oral Comprehension, Letter-Word Identification, and Picture Vocabulary. The researchers examined the data through exploratory factor analysis and through a series of path analyses.

Fuhs et al (2014) found that cognitive self-regulation gains in preschool were significantly predictive of continued academic gains in kindergarten. However, achievement gains at the end of preschool were only slightly related to continued cognitive self-regulation gains in kindergarten. Fuhs et al (2014) also found support for a bidirectional relationship among cognitive self-regulation and achievement gains. Overall these findings suggest that cognitive self-regulation skills may promote the development of achievement skills, especially early mathematics and oral comprehension skills, during the transition to a more formal schooling environment.

The present study builds upon the work of Fuhs and colleagues (2014) by examining growth over three time points across the preschool year, focusing upon the dynamic relationship of cognitive self-regulation and early literacy skills. Fuhs et al (2014) found a more significant relationship between cognitive self-regulation skills and

mathematics than for cognitive self-regulation and language skills. The present study will specifically target early literacy skills and the relationship to cognitive self-regulation.

Conclusions

School readiness, designed to optimize student learning during the transition to formal schooling environments, has been indicated as an area of great importance. School readiness is defined in different ways, but most often includes both cognitive self-regulation and early literacy skills as critical components. Since research has outlined the importance of these components, there has been an increase in school readiness interventions targeting those skills. Only a few of these interventions emphasize and target classroom and teacher level variables. However, the current literature base does not tell us whether there is an interaction between cognitive self-regulation and early literacy skills at various time points throughout the preschool year. Instead, the current literature base tells us that both variables are important. Therefore, we are missing information that is critical for designing interventions as we do not fully understand the mechanisms through which these skills impact one another, which will help with the design and target of school readiness interventions.

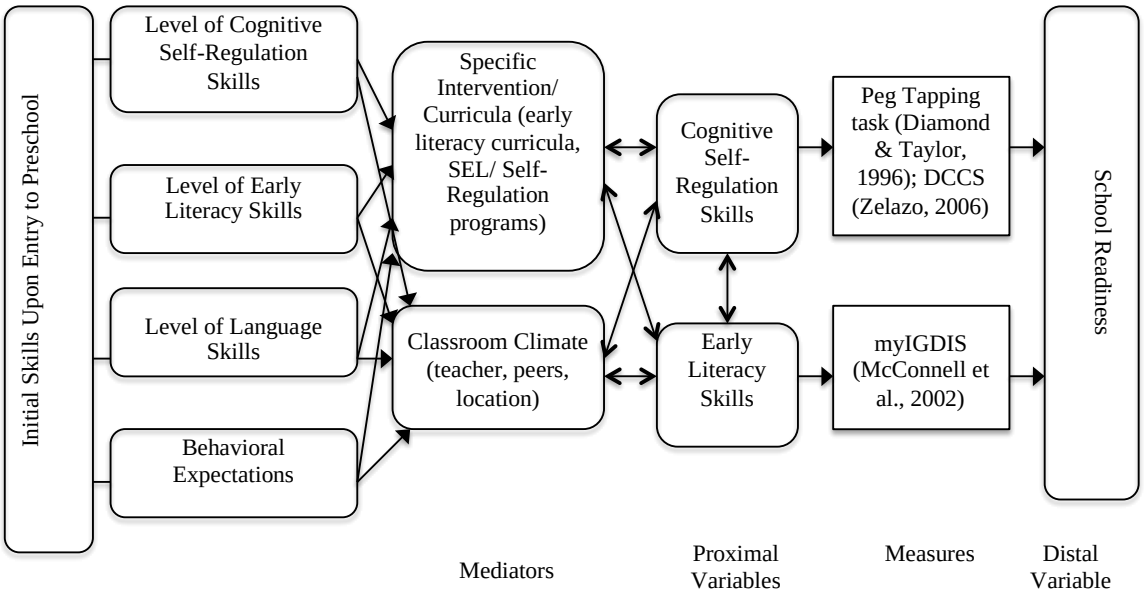
The present study attempts to fill this gap in the literature, which will lead to the beginning stages of identifying the critical features of preschool interventions targeting key school readiness skills including cognitive self-regulation and early literacy skills. Figure 2 describes the logic behind the relationship that is examined across variables of interest in the present study.

The present study examines the effects of preschool progress in cognitive self-regulation and early literacy skills on kindergarten readiness using multilevel growth

modeling over time, and addresses the growth in early literacy skills and cognitive self-regulation skills across the preschool year, as well as the relationship between early literacy skills and cognitive self-regulation in preschool students. Finally, through multilevel modeling, differences across communities are examined.

Figure 2.

Logic Model Indicating Variables Examined in the Present Study



CHAPTER III

METHODS

Participants and Setting

The study was conducted in three school districts, consisting of a total of 21 preschool classrooms, located in an urban area of the Northeast United States, a rural community in the Southern United States, and a suburban area of the Pacific Northwest. Study participants were 165 preschool students, ages 4 to 5 years. Due to missing data at pretest and posttest, results include complete data for 125 preschool students within 17 classrooms from three school districts in three different regions of the United States.

Recruitment. Upon receiving approval from the Office for the Protection of Human Subjects at the University of Oregon, the principal investigator contacted school districts to discuss the proposed study. After talking with appropriate school district personnel and obtaining institutional review board approval from the school districts, written consent forms were sent home to all of the parents of children in each participating teacher's classroom (see Appendix A). Only the students that were at least four years of age and in their final year of preschool prior to the start of kindergarten were recruited. This age group was selected because it specifically addresses the primary research questions surrounding the impact of early skills on kindergarten readiness.

Two of the preschools recruited for the study were supported by The National Institute for Direct Instruction (NIFDI), a non-profit organization dedicated to providing curricular support to schools as they implement Direct Instruction (DI) programs and to conduct and promote research on the effects of DI implementations. As part of NIFDI's evaluation process, these two sites were already administering the assessments needed for

the present study. Therefore, active consent was only needed and obtained from the site that is not supported by NIFDI. Once data collection at the two NIFDI-supported preschools was complete, IRB approval was obtained and access to the extant data was requested by the Principal Investigator.

Procedures

Measurement Procedures. Data on early literacy and cognitive self-regulation skills were collected at three time points over the course of the preschool year. All preschools started school at different time points, so data collection took place during different times across sites, but all data collection periods fell within the recommended periods for Fall, or beginning of the year (BOY), Winter, or middle of the school year (MOY), and Spring, or end of the school year (EOY). The purpose of three data collection periods is to analyze the levels of cognitive self-regulation and early literacy skills at three time points across the school year and to look for patterns in growth. Data collection at the beginning, middle, and end of the year allows for an evaluation of progress over time. The same measures of early literacy and cognitive self-regulation skills were administered at all three time periods.

Assessment Administration and Training. Self-regulation assessments were administered by the Principal Investigator at one of the sites, with classroom teachers administering the literacy measures. The other two sites utilized an administrator and retired school personnel to administer the assessments. All individuals administering the assessments were given the same training, including the Principal Investigator. The training for the early literacy assessments involved a two-hour online video module provided by the publisher of the instrument. The online module allowed for practice

administrations during and after the training. The self-regulation assessment training also involved watching an online training video provided by a research group at Vanderbilt Peabody College, who conducted a recent evaluation of self-regulation measures with preschool students (Lipsey et al., 2014). To reduce the possibility of practice effects since students were administered the same assessment across all three time points, the self-regulation assessment instruments were altered at each time point to look visually different. A different form was used at all three time points for the early literacy measures.

Description of Sites. Three sites were included in the present study. Site A is located in a suburban area of the Pacific Northwest. The site has eight Head Start classrooms, four ECEAP (state-funded) preschool classrooms, six developmental preschools, one of which is considered high needs and provides five hours per day for students with an Autism Spectrum Disorder, and one community preschool which serves students whose family's income is above the poverty line but who may benefit from early childhood services. To qualify for Head Start, families must meet or fall below the 100% of poverty income guidelines. To qualify for ECEAP, families must meet 110% of poverty level. To qualify for the developmental preschools, students must qualify for special education services. Most of the students participating in the study and at the school qualify under the category of developmental delay.

Site A uses the Providing Alternative Thinking Strategies (PATHS) curricula within all classrooms, which is described in further detail below. This preschool does not have a prescribed literacy curriculum at this point, but uses Story Champs for Head Start and ECEAP classrooms as a Tier II and ELL intervention in the classroom. Story

Champs, a teacher-delivered language curriculum, was implemented for the first time this year in the preschool.

Site B is located in a charter elementary school within an inner-city school district in the mid-Atlantic region of the United States. Site B has three preschool classrooms within the elementary school. This site has been receiving support from NIFDI for several years and is considered by NIFDI staff to have a strong implementation of Direct Instruction (DI) programs. Site B uses *Reading Mastery Signature Edition* Kindergarten Level as well as *Language for Learning*, both of which are supported by NIFDI. In addition to reading and language programs, Site B uses CHAMPS, a class-wide positive behavior support framework that is different from the Story-Champs curriculum used in Site A.

Site C is located in a rural town in the southern United States and includes three preschool classrooms. Site C began implementing *Reading Mastery Signature Edition Language* Kindergarten level at the beginning of the school year in which data were gathered. This site received support from the National Institute for Direct Instruction (NIFDI), which included assistance with implementation, guidance on formative and summative assessment, and ongoing coaching support for the teachers who were implementing the programs.

Although demographic data was not collected on each individual student participating in the study, demographic data of each school was obtained from the National Center for Education Statistics (NCES) or from the school district if this information was not available on the NCES website. Demographic data for each site is provided in Table 1, and indicates variability across all sites. Site A and B are similar in

that at least 99% of all students qualify for free and reduced lunch. However, these sites are racially quite different. Site A, located in the Pacific Northwest, has the most ethnically diverse group of students. Whereas, Site B has a large population of black students. Site C, located in the rural South is also not racially diverse, with almost all students (99%) identifying as white/Caucasian.

Table 1.

Demographic Data for Sample Based on Overall School Enrollment

CHARACTERISTIC	SITE A	SITE B	SITE C
RACE			
% AMER IND/ALASKAN	1.93%	0.16%	0%
% ASIAN/ PACIFIC ISLANDER	8.71%	0.63%	0%
% BLACK	10.32%	97.62%	0%
% HISPANIC	25.16%	1.27%	1%
% WHITE	34.19%	0.32%	99%
% MULTIRACIAL**	18.71%		
% FRL*	98.38%	99.52%	66%
% MALE	59.16%	47.86%	37.29%

Note. School demographic data obtained from National Center for Education Statistics for Site B. All other demographic data obtained directly from the site. * FRL = free and/or reduced lunches. **Site A used a different categorization of race-ethnicity than other sites by including a multiracial category.

Research Design

The study sought to examine two important aspects of kindergarten readiness: cognitive self-regulation and early literacy skills. Three areas were examined: (a) growth in these skills over the school year, (b) the relationship between cognitive self-regulation

and early literacy skills, and (c) the extent to which growth and the relationship between early literacy skills and cognitive self-regulation varied across three different communities. Descriptive statistics, bivariate correlations, analysis of variance (ANOVA) and linear growth models were used to examine these questions. The growth models looked at changes in early literacy skills and cognitive self-regulation over three time periods (beginning of preschool year, middle of preschool year, and end of preschool year).

Site of membership was measured with two dummy variables, one associated with the site in the Southern rural United States (Site C) and the other with the site in the Pacific Northwest (Site A). The mid-Atlantic site (Site B) was the omitted category. The site in which the preschools are located is included as an independent variable as there are several potential variables, such as academic or behavioral curriculum used, geographical location, and community effects that may contribute to the variance in the results by site.

Site A, located in the Pacific Northwest, receives support from a local university in implementing a social-emotional curriculum to all preschool students, titled Promoting Alternative Thinking Strategies (PATHS). The preschool level of the PATHS program is designed to promote better self-control, self-esteem, emotional awareness, problem-solving skills, social skills, and friendships in young children. The PATHS preschool program is designed for use across two years in a universal prevention model. Therefore, it is possible that this program had an impact on levels of cognitive self-regulation due to the class-wide intervention, as it is targeted to impact self-control, problem-solving skills, and social skills, which are important components of cognitive self-regulation. Previous

research documented that PATHS improved inhibitory control skills, a component of cognitive self-regulation in second and third grade students (Riggs, Greenberg, Kusche, & Pentz, 2006). However it is unknown whether this same effect would occur in preschool students.

The preschools located in the South and in the Northeast both received support from NIFDI to implement early literacy and early numeracy programs. Therefore, the sites received initial training on Direct Instruction (DI) programs, on-going coaching, and assessment support. DI is a model for teaching that emphasizes carefully planned lessons with small learning increments, clearly defined teaching tasks, and with a mastery component. The DI programs were developed by Siegfried Engelmann and colleagues, and are documented in over 40 years of literature for improving academic skills in various populations of varying ages, disabilities, and regions. It may be expected that early literacy skills would be impacted by this intervention, and possible that self-regulation skills were also impacted by the intervention, as DI is highly structured, and therefore, may contribute to self-regulation skills. With DI, students have frequent opportunities to practice inhibitory control and attention-shifting skills during the reading intervention period. The programs build in consistent and frequent feedback on performance. DI programs were also part of the largest educational experiment ever conducted, Project Follow-Through. Results of Project Follow-Through not only demonstrated that use of DI programs led to superior academic performance above all other curricula used, but also led to higher self-esteem for the students (Adams & Engelmann, 1996). These results have been described as especially powerful as some of

the other curricula examined in the study were designed to specifically target "affective skills" such as self-esteem (Adams & Engelmann, 1996).

Other community variations include geographical differences as the preschools are located in an urban area, rural area, and a suburban area. All three preschools are in districts that are considered to be low socio-economic status (SES), as measured by the rates of free and reduced lunch (FRL), although two (the Pacific Northwest and inner-city sites) have much higher rates of poverty. The schools also differ markedly in racial-ethnic composition.

Measures

Three assessment instruments were used to measure cognitive self-regulation and early literacy skills in the preschool students: the Peg Tapping Task (Diamond & Taylor, 1996), the Dimensional Change Card Sort Task (DCCS; Zelazo, 2006), and myIGDIS (McConnell, et al., 2002) (see Figure 3).

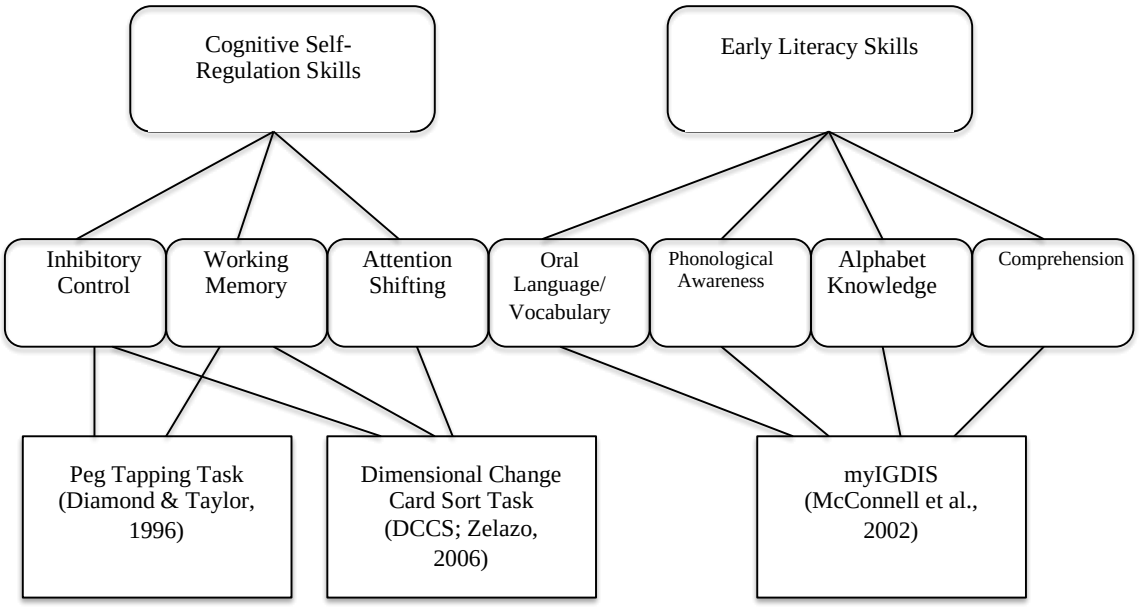
Early Literacy Skills. The Individual Growth Development Indicators (IGDIs) are a set of brief, repeatable, standardized assessments for monitoring early literacy growth in young children. They provide measures of oral language and vocabulary, phonological awareness, alphabet knowledge, and comprehension. Three IGDIs were used in the present study. See Figure 4 for a model of each measure used in the present study and its corresponding literacy construct.

IGDIs are administered in a one-on-one setting and take approximately 5 to 10 minutes to administer per child. They are often used to screen for developmental delays, monitor student progress, differentiate instruction, and evaluate interventions. Reliability and validity of individual IGDI measures are strong with one month alternate form

reliability coefficients ranging from .44 to .78 (McConnell et al., 2002; Missall & McConnell, 2004), test-retest reliability across three weeks at $r = .67$, $p < .01$ for *Picture Naming* and test-retest reliability ranging from .83 to .89 for *Rhyming.* Additionally, concurrent validity coefficients range from .34 to .81 across measures (Missall & McConnell, 2004).

Figure 3.

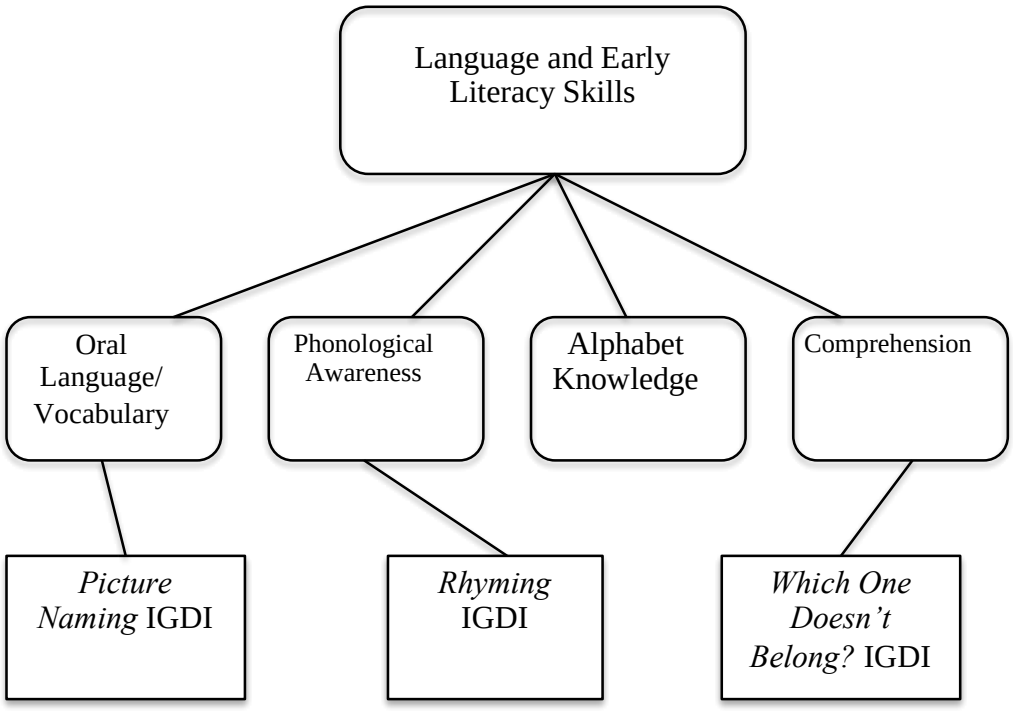
Cognitive Self-Regulation and Early Literacy Measurement Constructs



Picture Naming, Rhyming and *Which One Doesn't Belong?* were administered to all students to provide measures of early literacy skills. The *Picture Naming IGDI* provides a measure of oral language and vocabulary by measuring a child's ability to produce words correctly after being prompted by a series of photo cards. The photo cards include images of objects commonly found in a preschooler's environment, such as a sink or a book (Greenwood, Carta & McConnell, 2011). The number of correctly named cards in 1 minute is converted to a rate per minute score.

Figure 4.

IGDI Measures and Corresponding Literacy Skills



In the *Rhyming IGDI,* the child is presented with one stimulus picture across the top of the page and three additional pictures across the bottom. The examiner names each item, then tells the child to, "Point to the picture that sounds the same as the top picture." The child's score is the number of correctly identified items in 2 minutes. This provides a measure of phonological awareness.

The IGDI titled, *"Which One Doesn't Belong,"* provides a measure of comprehension skills. The child is asked to identify the picture that does not belong with the other two when prompted with three different photos. For example, a student may see images of a bus, butterfly and a car. To answer correctly, they would point to the butterfly or say "butterfly," indicating that it does not belong with the other two. The

child receives one point for every correct response provided. All IGDIs begin with demonstration and practice items to ensure students understand the task.

Cognitive Self-Regulation. Cognitive self-regulation is defined as working memory, attention shifting, and inhibitory control, (Fuhs, Farran & Nesbitt, 2013). The *Peg Tapping Task* (PT; Diamond & Taylor, 1996) provides a measure of inhibitory control and working memory, and requires children to tap once with a wooden peg when the assessor taps twice and then tap twice when the assessor taps once. The preschool students first receive two practice trials with corrective feedback if they give an incorrect response. Then they have eight opportunities to successfully apply the rules they just learned. If they were successful they have 16 additional test trials without feedback. If they are not successful, the task will be discontinued. Test trials were scored with a 0 for incorrect responses and a 1 for correct responses. A score of negative one was assigned as the score if the task was discontinued. Therefore the final scores could range from -1 to 16. Peg Tapping test-retest reliability was r = .80 (Lipsey et al., 2014).

The *Dimensional Change Card Sort task* (DCCS; Zelazo, 2006) was used to provide a measure of attention shifting and working memory. The task required that preschool students first sort a set of cards according to one dimension (e.g. red color versus blue color), then they sorted the cards according to another dimension (e.g. star shape versus a truck shape). If the students were successful in that shift, they were given a set of similar cards containing either a black border or no border around the card, and were instructed to sort by color if the card had a border or to sort by shape if the card did not have a border. The children received a score of 0 if they did not pass the initial color sort task, a 1 if they passed the color sort but not the shape sort task, a 2 if they passed the

shape sort, and a 3 if they also passed the border version of the task. All measures of cognitive self-regulation have been shown to have construct validity (e.g., Fuhs & Turner, 2012). DCCS test-retest reliability is moderate (Lipsey et al., 2014; r = .48). Although test-retest reliability is only moderate, it is a widely used tool in studies predicting achievement in young children and is also a standardized measure within the NIH toolbox (Weintraub et al., 2013).

To reduce the risk of practice effects, the stimulus for each cognitive self-regulation measure was slightly altered. Specifically, the peg was replaced by a different tapping instrument during the winter and spring data collection periods. The sorting boxes used in the DCCS were altered in color and shape during each data collection period as well.

Composite Scores

Individual measures of both early literacy skills and of cognitive self-regulation were combined to yield two composite scores; an early literacy composite score and a cognitive self-regulation composite score. Therefore, *Picture Naming* as a measure of oral language and vocabulary, *Rhyming* as a measure of phonological awareness, and *Which One Doesn't Belong* as a measure of comprehension, generated one composite score of the larger construct of early literacy skills. Additionally, *Peg Tapping*, as a measure of inhibitory control and working memory and the *Dimensional Change Card Sorting* task as a measure of attention shifting and working memory, also generated a second composite score of the larger construct of cognitive self-regulation, in order to provide an overall measure of the construct. These composite scores were generated using equal-weighted improper linear modeling. The pooled within-time standard

deviation was used for weighting each variable. Means and standard deviations for each measure are reported in Table 2 to provide descriptive statistics for each variable prior to weighting and combining into a composite score.

Table 2.

Standard Deviations and Sample Sizes for Early Literacy and Self-Regulation Measures Across Sites (n = 125)

	Fall		Winter		Spring		Pooled, within-time-of-year *SD*	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*		Weight
Early Literacy								
Pict Name	7.08	3.56	8.86	3.98	8.49	3.60	3.72	1.34
Rhyming	6.66	5.16	8.66	5.18	9.92	5.16	5.14	0.97
WODB	6.06	4.44	7.69	3.79	8.68	3.57	4.05	1.24
Self-Regulation								
Peg Tap	7.65	6.65	11.45	5.36	12.46	4.89	5.94	0.84
DCCS	1.58	0.64	1.74	0.61	1.87	0.62	0.61	8.16

Note. Range of possible scores is from 0 to 15 for early literacy measures, -1 to 16 for *Peg Tapping* and 0 to 3 for *DCCS*. All distributions approximate a normal curve.

Improper Linear Model. A proper linear model is one obtained by an optimization process, such as least squares, in which multiple variables are combined to make the best prediction of a specific outcome variable. Dawes (1979) describes such models as more reliable than clinical judgment. However, the disadvantage of a proper

linear model is that they may not provide the best prediction for a general outcome in which the outcome may be a measure of a similar construct.

Another approach is to use an improper linear model, which is not described as optimal in that the weighting structures are chosen unit or equal weighting, for example. Improper linear models are considered to be quite robust (Dawes, 1979).

The present study used a weighting procedure so that all variables would contribute equal variance to the composite. This procedure is similar to a unit-weighted improper linear modeling in which the scores are standardized so that the mean is 0 and the standard deviation is 1 and then scores are summed or averaged. In this study all variables were weighted so that they all would have a pooled, within-time-of-year standard deviation of 5. For example, all DCCS scores were multiplied by 8.16 so the pooled, within-time-of-year standard deviation of transformed scores would be 5.00. Peg tapping scores were similarly weighted by 0.84. Then, the transformed DCCS and peg tapping scores were summed to create an equally weighted composite where both variables contributed equal variance to the composite. Using this procedure, all measures contributed equal variance, but growth across year could still be modeled.

Dawes (1979) argues that this type of equally-weighted composite has the advantage of being more likely to generalize to different outcome variables presenting the same or similar constructs, and these weighted composites have substantial predictive validity across multiple fields (Bobko, Roth, & Buster, 2007). This approach is desirable considering the measures in the present study are all of a similar construct, such that they are all considered early literacy skills for the first composite score or they are all

considered cognitive self-regulation measures for the second composite score. See Appendix B for correlations used in creating the composite scores.

The approach taken in the present study is simply one method for achieving the desired analysis plan, and there are many other defensible approaches. The limitations of generating a composite score include a loss of interpretation of each individual measure. For example, one specific early literacy skill may be particularly related to cognitive self-regulation, but this approach obscures the relation of a particular skill within the relation to the composite.

Missing Data

Missing data across the school year resulted for three distinct reasons, which can be categorized as school level needs, inclement weather/loss of instructional time, and high mobility rates. Since data was collected primarily at the school level by school staff members, schools were able to make decisions as to which measures to include at the different time points during the school year. Most sites followed the recommended guidelines provided by the IGDIs authors, which include administering *Alliteration* in the Winter and Spring only and administering all other measures during the Fall, Winter, and Spring.

This was the first year of collecting curriculum-based measures for two of the sites. One site decided that administering five measures at the end of the school year was too intensive for a first year of implementation of data collection so opted to only include *Picture Naming*, *Rhyming*, and *Which One Doesn't Belong (WODB*) during the Spring collection. All of the sites, but Site A in particular, experienced a high rate of mobility in their preschool students. Therefore, some students were present for the Fall data

collection period, but then were no longer enrolled in that preschool during the Spring and/or Winter.

Based upon these events and the high number of missing data at critical time points (i.e. the beginning and end of the school year), it was decided to drop two measures: *Alliteration* and *Sound Identification*. Dropping these two measures allowed for a data set with complete data for analysis. Therefore, the total *n* dropped from 165 students to 125 students with complete data for analysis.

It was determined that the data that was missing was slightly different than what would be expected by chance as there were three significant differences involving differences in self-regulation skills. Differences in the samples included and not included in the study could be due to a few variables. Site B had a much more complete data set across all three time points in comparison to Site A, in particular. Site A is qualitatively different from the other two sites in that it contains a much more ethnically diverse sample as well as containing a variety of different classroom. See Table 3 for a description of the sample that was included in the study and the sample that was not included in the study.

Data Analytic Approach

All data were analyzed using SPSS and Stata software. Correlations, analysis of variance, and linear growth models were used to test hypotheses. Linear growth models were used because of the hierarchical structure of the data. Each time measurement of the variables is nested within each student. Multilevel linear growth models take into account this hierarchical structure by modeling separate equations at the within- and between-person levels. Linear growth modeling is a regression-based statistical method that works

with multi-level data, such as repeated measures of student performance, or repeated scores nested within individual students (Bryk & Raudenbush, 1992).

Table 3

Means, Standard Deviations, Sample Sizes, and Level of Significance for Missing Data

	Included			Not included			Test of mean difference		
Measure	*n*	*M*	*SD*	*n*	*M*	*SD*	*t'*	*df*	*p*
Pic Naming Fall	125	7.08	3.56	26	6.08	3.55	-1.31	149	.193
Rhyme Fall	125	6.66	5.16	26	5.00	4.92	-1.50	149	.136
WODB Fall	125	6.06	4.44	25	4.84	4.78	-1.23	148	.219
Peg Tap Fall	125	7.65	6.65	34	6.47	6.68	-0.92	157	.362
DCCS Fall	125	1.58	0.64	34	1.47	0.61	-0.86	157	.391
Pic Naming Winter	125	8.86	3.98	29	7.83	3.65	-1.27	152	.205
Rhyme Winter	125	8.66	5.18	25	7.08	5.82	-1.36	148	.176
WODB Winter	125	7.69	3.79	29	7.00	3.98	-0.87	152	.384
Peg Tap Winter	125	11.45	5.36	24	7.58	6.79	-3.09	147	.002
DCCS Winter	125	1.74	0.61	24	1.67	0.64	-0.57	147	.572
Pic Naming Spring	125	8.49	3.60	26	8.42	3.50	-0.08	149	.933
Rhyme Spring	125	9.92	5.16	21	8.48	5.43	-1.18	144	.241
WODB Spring	125	8.68	3.57	26	8.96	3.80	0.36	149	.718
Peg Tap Spring	125	12.46	4.89	21	9.33	6.66	-2.56	144	.011
DCCS Spring	125	1.87	0.62	21	1.57	0.60	-2.06	144	.041

Linear growth modeling allows for the examination of student scores using a research design similar to that of a Repeated Measures analysis of variance (ANOVA) or structural equation modeling (SEM), but allowing for more flexibility. For example, with

linear growth modeling, all individual students are not required to be tested at the same time points, which is often the case in schools, especially across districts. Therefore, student data can be collected on different time schedules, which is often necessary for systems-level assessment at the district level or even across districts. Linear growth modeling also allows for a relatively small number of students to be used to estimate growth parameters, in contrast to SEM (Bryk & Raudenbush, 1992).

Assumptions of HLM. As is true with all statistical analyses, assumptions must be made. Specific to Hierarchical Linear Modeling (HLM) and the present analyses, Bryk and Raudenbush (2002) state that both individual outcomes and growth parameters assume normal distributions. The second assumption described by Bryk and Raudenbush (2002) is covariance structure. HLM does not require that identical data collection occur for each subject, but instead the flexibility of the model accepts varying numbers of data points and spacing between observations. The final assumption is that each observation be measured on a common metric to allow for change in growth over time as opposed to changes in the measurement scale.

With HLM, the examination of growth using multiple data points is conceptually divided into two different stages, which are within- and between-individual stages (Bryk & Raudenbush, 1992). The primary goal of the within-individual stage is on (a) identifying an appropriate growth trajectory and then (b) estimating growth parameters based on a selected growth trajectory. Using this approach, this section includes a description of the analyses used to evaluate the data for this study and is separated by each individual research question. A series of incrementally more complex models are used to test the hypotheses.

Research Question 1: How did students grow in early literacy and cognitive self-regulation skills across the preschool year?

Research question 1 examines whether skills at the beginning of preschool are related to skills at the end of preschool. To address this question, Pearson correlations of early literacy and cognitive self-regulation skills at the beginning, middle, and end of preschool were calculated. Correlations were examined for all students across the three time points. Strength of correlations was determined through Cohen's (1988) criteria of .1 = small, .3 = medium, and .5 = large; and tests of statistical significance were examined.

Linear growth models were used to further assess the relationship of early literacy and cognitive self-regulation skills across the preschool year. Individual students do not all have a common initial status and growth rate due to individual differences in background variables (Bryk & Raudenbush, 1987). Growth models adjust for these differences, looking at growth in literacy and self-regulation in the preschool students over three data points in time. Specifically, the early literacy and cognitive self-regulation scores obtained at the beginning of the year represent the intercept of the regression equation, while the slope shows the growth as measured during the subsequent time points.

Three increasingly complex models were tested for each dependent measure (early literacy skills composite and cognitive self-regulation composite): 1) a baseline model that modeled differences between individuals in initial skills; 2) one that added the linear effect of time and 3) one that added the quadratic or curvilinear effect of time, or time squared. Model 3 is important in testing the possibility that the relationship between time and the dependent variables was curvilinear. The -2 Log Likelihood statistic, which

has a chi-square distribution, was used to examine the relative fit of the models. The magnitude and significance of the fixed effects was examined to assess the impact of time and time squared.

Research Question 2: Is there a relationship between early literacy skills and cognitive self-regulation in preschool students?

To examine the second research question, both correlation coefficients and linear growth models were again used. First, Pearson correlation coefficients between early literacy skills and cognitive self-regulation at all time points were examined. Then the growth models examined for *Research Question 1* were expanded to generate Models 4 and 5. Model 4 added cognitive self-regulation scores across the year to the model predicting early literacy skills and early literacy skill scores across the year to the model predicting cognitive self-regulation. This allowed for the examination of main effects of both time and cognitive self-regulation on early literacy skills. Next, in Model 5, the interaction effects of time and cognitive self-regulation (for the analysis of early literacy skills) and the interaction of time and early literacy skills (for the analysis of cognitive self-regulation) were examined. This model examines the possibility that the influence of cognitive self-regulation on early literacy (or early literacy on cognitive self-regulation) varies across time, or in other words, the effect of time depends upon the level of cognitive self-regulation (or early literacy skills). The -2 Log Likelihood statistic was again used to examine the relative fit of the models. The *z*-scores and significance associated with the fixed effects were also examined. If a more complex model was found not to provide a significantly better fit to the data, the simpler model was used.

Research Question 3: Does the effect of early literacy or cognitive self-regulation skills, or the relationship between early literacy and cognitive self-regulation skills differ from one community to another?

Research question 3 targets differences across sites for, as previously described, students' achievement can be attributed to various factors in a range of levels including school environments (Kaya & Rice, 2010; Lamb & Fullarton, 2002). First, descriptive statistics and correlation coefficients were calculated separately for the three sites and examined for differences in magnitude and direction. This was supplemented by a simple analysis of variance (ANOVA) of cognitive self-regulation and early literacy skills by site and calculation of the intraclass correlation coefficient (ICC) for each time period.

The ICC is the ratio of the between-cluster variance to the total variance and can be interpreted as the typical correlation found between the responses of members of the same group. Intra-class correlations can (1) provide a measure of reliability among raters or (2) provide a measure of variability in the magnitude of an effect. The present study will focus upon the second construct and use ICCs to examine community-level differences and how they possibly alter the magnitude of effects. Preschools can appear immensely different depending upon several variables, but it is unclear whether these differences affect student outcomes, so that the individual-level of analysis begins to overestimate the statistical significance of the intervention effects (Conduct Problems Prevention Research Group, 1999). Therefore, if the setting affects student outcomes and intervention effects, then intervention effects may be statistically overestimated and our conclusions may be compromised.

Two additional growth models were examined: Model 6, which added dummy

variables for site and Model 7, which added the interaction of time and site. Again, changes in the -2 Log Likelihood test were examined for goodness of fit and the fixed effect coefficients were examined to assess the significance of the independent variables. Comparison of these models let us assess the extent to which students' skill growth over time varied by site.

CHAPTER IV

RESULTS

The purpose of this study was to examine the effects of preschool progress in cognitive self-regulation and early literacy skills on kindergarten readiness. This section includes the results of the analyses described earlier. Results are reported in order of each research question.

Research Question 1 examined the growth in early literacy and cognitive self-regulation skills across the preschool year. Data were analyzed using descriptive statistics (Table 4), Pearson correlations (Table 5), and linear growth modeling.

Table 4

Descriptive Statistics for Early Literacy and Cognitive Self-Regulation Measures Across all Sites

	M	*SD*	*N*
EL FALL	7.88	4.40	125
EL WINTER	10.01	4.17	125
EL SPRING	10.67	4.05	125
SR FALL	9.69	4.68	125
SR WINTER	12.04	4.10	125
SR SPRING	13.00	3.97	125

The data in Table 4 show that average scores on the measures of early literacy and cognitive self-regulation skills increased over the course of the school year. Descriptive statistics also reveal a curvilinear relationship as scores increased rapidly from Fall to

Winter and only showed a slight increase from Winter to Spring (see Figure 5). This general trend appeared across both early literacy skills and cognitive self-regulation measures (see Figure 6). The standard deviation also decreased over time for both early literacy and cognitive self-regulation skills.

Figure 5

Mean Early Literacy Composite Score Across Sites

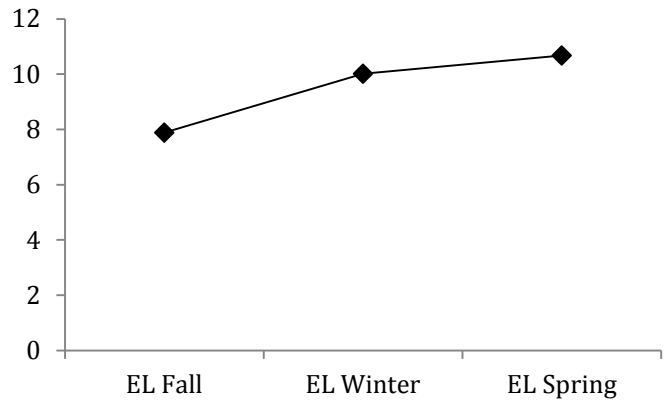
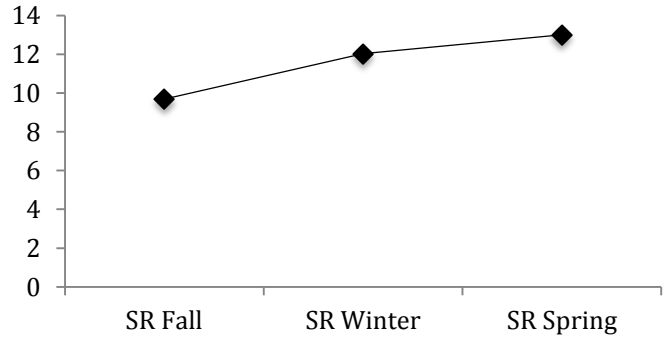


Figure 6

Mean Cognitive Self-Regulation Composite Score Across Sites



The correlations between early literacy skills (Table 5) and cognitive self-regulation skills (Table 6) over the three time periods are reported. There were strong, statistically significant ($p < .001$) positive correlations between early literacy skills across the preschool year, as well as between cognitive self-regulation skills at the beginning,

middle and end of the preschool year. All correlations were above Cohen's criteria for large effects across all three time points and were statistically significant.

Table 5

Early Literacy Skills for All Sites: Correlations (N = 125)

Measures	1	2	3
1. Early Literacy Fall	–		
2. Early Literacy Winter	.82	–	
3. Early Literacy Spring	.75	.83	–

Note. All values significant at $p < .0001$.

Table 6

Cognitive Self-Regulation Skills for All Sites: Correlations (N = 125)

Measures	1	2	3
1. Self-Regulation Fall	–		
2. Self-Regulation Winter	.64	–	
3. Self-Regulation Spring	.63	.76	–

Note. All values significant at $p < .0001$.

Table 8 reports the results of the linear growth model analysis of early literacy skills across the preschool year. Using this approach, estimates of growth parameters are referred to as "fixed effects," and variance estimates (e. g., variance of intercepts and growth rates among students) are referred to as "random effects." Therefore, estimates of fixed and random effects are reported as well as the model fit statistics for each model that was tested. Table 7 summarizes the variables used in the three models tested to answer *Research Question 1* and reports the model fit statistics. When comparing models

1, 2, and 3, each model provides a significantly better fit than the contiguous less complex model, and model 3 provides the best fit.

Table 7

Models and Fit Statistics Used to Examine Research Question 1: Early Literacy Composite

Effects and model fit	Model 1	Model 2	Model 3
Constant	X	X	X
Time		X	X
Time*time			X
-2 log likelihood	1941.46	1863.28	1847.04
Change in -2 log likelihood	-----	78.18	16.24
Change in df	-----	1	1
p-value	-----	<.001	<.001

Table 8 gives the fixed and random effects for model 3 only, the best fit model (see Appendix C for growth curve results for models 1 and 2). The fixed effects for both time and time squared are significant in model 3. This result quantifies the curvilinear relationship previously highlighted with the descriptive statistics, with more growth from the Fall to Winter, than from Winter to Spring.

Coefficients were coded as 0 for Fall, 1 for Winter, and 2 for Spring. Therefore, the significant fixed effect for the constant indicates the initial level of early literacy skills across all students and times of year. The significant fixed effect for time indicates that student's early literacy skills were improving over the year. The significant fixed effect

for time*time indicates a curve in the rate of improvement with less improvement from winter to spring than from fall to winter.

Table 8

Model 3 Growth Curve Results for Early Literacy Composite with Quadratic Effect of Time

Fixed effects	*b*	*z*	*p*-value
Constant	7.88	20.11	<.0001
Time	2.86	7.59	<.0001
Time*time	-.73	-4.16	<.0001
Random effects	**Variance estimate**	**Standard error**	***p*-value**
Constant	16.60	2.39	<.0001
Time	0.94	0.33	<.01
Covariance	-1.59	0.66	<.02
Residual	2.59	0.33	

The random effect variance estimate for the constant was significant indicating that the students' scores differed from one student to another in terms of overall level of early literacy skills. The significant variance estimate for time indicates that there was variability in student's rate of growth, with some students growing more rapidly than others. Finally, the significant, negative covariance estimate for the constant and time indicates that students who had lower overall early literacy skills tended to grow in early literacy at a more rapid rate, while those with higher overall early literacy skills tended to grow at a less rapid rate.

Table 9 summarizes the variables used in the three models tested to answer *Research Question 1* with the cognitive self-regulation composite and reports the model fit statistics. As was true with the early literacy composite, when comparing models 1, 2, and 3, each model provides a significantly better fit than the contiguous less complex model, and model 3, again, provides the best fit.

Table 9

Models and Fit Statistics Used to Examine Research Question 1: Cognitive Self-Regulation Composite

Effects and model fit	Model 1	Model 2	Model 3
Constant	X	X	X
Time		X	X
Time*time			X
-2 log likelihood	2049.78	1978.88	1970.76
Change in -2 log likelihood	-----	70.90	8.12
Change in df	-----	1	1
p-value	-----	<.001	<.001

Table 10 gives the fixed and random effects for the cognitive self-regulation composite for model 3 only, the best fit model. Fixed and random effects for models 1 and 2 are found in Appendix C. The fixed effects for both time and time squared are significant in model 3. This result, again, quantifies the curvilinear relationship found with the descriptive statistics, with more growth from the Fall to Winter, than from Winter to Spring. The significant fixed effect for the constant indicates the level of initial

cognitive self-regulation skills across all students and times of year. The significant fixed effect for time indicates that students' cognitive self-regulation skills were improving over the year. The significant fixed effect for time*time indicates a curve in the rate of improvement, with greater progress from the beginning to middle of the year than from the middle to the end of the year, at a rate similar to the progress made in the student's early literacy skills.

The random effect variance estimate for the constant was significant indicating that the students' scores differed from one student to another in terms of overall level of cognitive self-regulation skills. The significant variance estimate for time indicates that there was variability in students' rate of growth, with some students growing more rapidly than others. The significant, negative covariance estimate for the constant and time indicates that students who had lower initial cognitive self-regulation skills tended to grow in cognitive self-regulation at a more rapid rate, while those with higher initial cognitive self-regulation skills tended to grow at a less rapid rate.

Overall, results obtained from *Research Question 1* indicate that students made growth in both early literacy and cognitive self-regulation skills across the preschool year. Growth across the year demonstrated a curvilinear relationship, and scores in the beginning of the preschool year, were significantly correlated with scores at the end of the preschool year. Students also varied in their growth from one another, and the pattern for growth in early literacy tended to mirror the pattern for growth in cognitive self-regulation skills.

Table 10

Model 3 Growth Curve Results for Cognitive Self-Regulation Composite with Quadratic Effect of Time

Fixed effects	*b*	*z*	*p*-value
Constant	9.69	23.97	<.0001
Time	3.04	5.98	<.0001
Time*time	-.69	-2.90	.004
Random effects	**Variance estimate**	**Standard error**	***p*-value**
Constant	15.65	2.53	<.0001
Time	1.18	0.54	.028
Covariance	-2.20	.91	.015
Residual	4.79	0.61	

Research question 2 examined the relationship between early literacy skills and cognitive self-regulation in preschool students by examining correlations across measures as well as linear growth models where literacy skills were regressed on time and cognitive self-regulation skills and cognitive self-regulation skills were regressed on time and literacy skills.

Results indicated that the correlations between early literacy and cognitive self-regulation skills (Table 11) were consistent and above Cohen's criteria for large effects across all three time points. There were strong, statistically significant ($p < .001$) positive correlations between early literacy skills and cognitive self-regulation skills at the beginning, middle and end of the preschool year. Correlations ranged from .52 to .83. The weakest correlation (.52), which still demonstrates a large effect, was the correlation

of cognitive self-regulation skills measured in the Spring with early literacy skills measured in the Winter. All correlations are provided in Table 11.

Table 11

School Readiness Measures for All Sites: Correlations (N = 125)

Measures	1	2	3	4	5
1. Early Literacy Fall	–				
2. Early Literacy Winter	.82	–			
3. Early Literacy Spring	.75	.83	–		
4. Self-Regulation Fall	.67	.67	.69	–	
5. Self-Regulation Winter	.55	.56	.63	.65	–
6. Self-Regulation Spring	.53	.52	.60	.63	.76

Note. All values significant at $p < .0001$.

Linear growth modeling was also used to examine *Research Question 2*, and two additional models (4 and 5) were evaluated for each measure of kindergarten readiness. Table 12 indicates the variables used in models 4 and 5, as well as the model fit statistics for the analysis of early literacy skills. Results indicate that model 5 was not a statistically significant better fit than model 4. Additionally, the fixed effects coefficient with the interaction term of self-regulation and time was not significant. Thus, based on these results, only model 4 was interpreted and the remaining models for examining early literacy skills were built upon model 4. Results of the growth curve analysis for model 5 are found in Appendix D.

The fixed and random effects for model 4 are found in Table 13. The fixed effect coefficients in Model 4 indicate a very strong relationship between self-regulation skills

and overall early literacy skills. The impact of time was reduced as self-regulation skills were added to the model, although it was still significant.

Table 12

Models and Fit Statistics Used to Examine Research Question 2: Early Literacy Composite

Effects and model fit	Model 4	Model 5
Constant	X	X
Time	X	X
Time*time	X	X
Self-regulation	X	X
Self-regulation*time		X
-2 log likelihood	1820.60	1819.48
Change in -2 log likelihood	26.44	1.12
Change in df	1	1
p-value	<.0001	.289

Note: The model that included the interaction of self-regulation and time (Model 5) did not provide a significantly better fit to the data than the model that did not include this interaction (Model 4).

The variance for the random effects of the constant and time for model 4 were statistically significant, indicating that the students' initial early literacy skills differed from one student to another as did their rate of progress. However, the covariance was significant at only the .06 level indicating that the tendency for students' rate of growth to vary based on level of initial skills was markedly smaller once self-regulation was added to the model.

Table 13

Model 4 Growth Curve Results for Early Literacy Regressed on Time and Cognitive Self-Regulation

Fixed effects	*b*	*z*	*p*-value
Constant	5.41	10.28	<.0001
Time	2.09	5.04	<.0001
Time*time	-.56	-2.97	.003
Self-regulation	.25	6.04	<.0001
Random effects	Variance estimate	Standard error	*p*-value
Constant	11.01	1.95	<.0001
Time	.89	.34	<.01
Covariance	-1.09	.58	.060
Residual	2.86	0.38	

Table 14 indicates the variables used in models 4 and 5 and the model fit statistics for the analysis of cognitive self-regulation. Results indicate that model 5 was a statistically significant better fit than model 4. Additionally, the fixed coefficient with the interaction term of early literacy skills and time was statistically significant. Thus, based on these results, only model 5 was interpreted and the remaining models for examining cognitive self-regulation were built upon model 5. Results of the growth curve analysis for model 4 are found in Appendix D.

The fixed and random effects for model 5 with cognitive self-regulation regressed on time and early literacy skills are found in Table 15. The fixed effect coefficients in

Model 5 indicate a very strong relationship between cognitive self-regulation skills and overall early literacy skills.

Table 14

Models and Fit Statistics Used to Examine Research Question 2: Cognitive Self-Regulation Composite

Effects and model fit	Model 4	Model 5
Constant	X	X
Time	X	X
Time*time	X	X
Early literacy	X	X
Early literacy*time		X
-2 log likelihood	1910.94	1905.92
Change in -2 log likelihood	59.82	5.02
Change in df	1	1
p-value	<.001	<.05~~01~~

Note: The model that included the interaction of early literacy and time (Model 5) provided a significantly better fit than the model without this interaction (Model 4).

The random effect variance of the constant was statistically significant for model 5, indicating that the students' initial self-regulation skills differed from one student to another. However, the variance of the random effects of time and the covariance were not statistically significant, indicating that students' rates of growth did not differ significantly from one another.

Table 15

Model 5 Growth Curve Results for Cognitive Self-Regulation Regressed on Time and Early Literacy Skills

Fixed effects	*b*	*z*	*p*-value
Constant	5.12	8.89	<.0001
Time	2.30	3.71	<.0001
Time*time	-.20	-.78	.435
Early literacy	.58	9.35	<.0001
Early lit*time	-.10	-2.37	.018
Random effects	**Variance estimate**	**Standard error**	***p*-value**
Constant	6.29	1.52	<.0001
Time	.98	.57	.085
Covariance	-.89	.74	.229
Residual	5.30	.68	

Overall, results obtained for *Research Question 2* indicate that early literacy and cognitive self-regulation skills were strongly related across the preschool year. Students with higher cognitive self-regulation skills also had higher early literacy skills at all three time points measured. However, the impact of early literacy skills on cognitive self-regulation skills was stronger from the fall to winter than it was from the winter to spring.

Research Question 3 examined the effects of early literacy and cognitive self-regulation skills across sites. To address *research question 3,* correlations within each site were calculated and compared with each other and with the total group (see Tables 16, 17, 18). Correlations in Site A mirrored those of the total group where they were

consistent and above Cohen's criteria for large effects across the preschool year and across measures. There were strong, statistically significant ($p < .001$) positive correlations between early literacy skills and cognitive self-regulation skills at the beginning, middle and end of the preschool year (See Table 16).

Table 16

School Readiness Measures for Site A: Correlations (N = 34)

Measures	1	2	3	4	5
1. Early Literacy Fall	–				
2. Early Literacy Winter	.77	–			
3. Early Literacy Spring	.64	.77	–		
4. Self-Regulation Fall	.64	.68	.73	–	
5. Self-Regulation Winter	.59	.72	.67	.79	–
6. Self-Regulation Spring	.66	.72	.67	.75	.86

Note. All values significant at $p < .0001$.

Table 17

School Readiness Measures for Site B: Correlations (N = 49)

Measures	1	2	3	4	5
1. Early Literacy Fall	–				
2. Early Literacy Winter	.80	–			
3. Early Literacy Spring	.74	.83	–		
4. Self-Regulation Fall	.60	.59	.57	–	
5. Self-Regulation Winter	.39[1]	.34[2]	.49	.46	–
6. Self-Regulation Spring	.47	.47	.68	.61	.71

Note. All values significant at $p < .001$ unless noted. $p < .01^{1}$ $p < .05^{2}$

Correlations for Sites B and C reflect medium to large effects according to Cohen's criteria. Most values were significant at $p < .001$, except for cognitive self-regulation skills in the winter with early literacy skills in the fall ($p < .01$) and winter ($p < .05$) for Site B (see Table 17). Site C reflected similar correlations where all correlations were significant at $p < .001$ except for cognitive self-regulation skills in the spring with early literacy skills in the fall ($p < .01$), winter ($p < .05$) and spring ($p < .01$).

Table 18

School Readiness Measures for Site C: Correlations (N = 42)

Measures	1	2	3	4	5
1. Early Literacy Fall	–				
2. Early Literacy Winter	.87	–			
3. Early Literacy Spring	.86	.90	–		
4. Self-Regulation Fall	.70	.69	.77	–	
5. Self-Regulation Winter	.72	.67	.76	.78	–
6. Self-Regulation Spring	.49[1]	.39[2]	.47[1]	.57	.73

Note. All values significant at $p < .001$ unless noted. $p < .01$[1] $p < .05$[2]

Table 19

Descriptive Statistics, One-way ANOVA, and Intraclass Correlation Coefficients for Early Literacy Skills Across the Preschool Year

	SITE A		SITE B		SITE C				
TIME	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*P*	ICC
FALL	7.60	4.80	6.69	4.11	9.48	3.99	4.94	<.01	.08
WINTER	9.98	4.77	9.11	3.84	11.08	3.86	2.58	.08	.032
SPRING	10.53	4.34	10.05	3.96	11.51	3.87	1.50	.23	.009

Descriptive statistics across sites for each measure at each time period were also obtained to further assess site level differences and are reported in Tables 19 and 20. Intraclass correlation coefficients (ICC) were also calculated and are reported in Tables 19 and 20. ICCs were small and decreased across the preschool year for both early literacy and cognitive self-regulation skills.

Simple analysis of variance was calculated to look at the average scores across the three sites at all three time points (see Table 19 and 20). The differences in scores were large in the fall, but were no longer statistically significant in the spring. Results indicated that scores in Site B increased at a more rapid rate than scores in Site A and C, and ultimately caught up to scores in Sites A and C.

Multi-level linear growth modeling was also used to address *Research Question 3*. Table 21 summarizes the coefficients used in these models as well as the fit statistics for models 6 and 7. Model 6, which added dummy variables for site, provided only a marginally better fit than Model 5 (p =.08). Model 7 added interactions of site by time, and this did not provide a significantly better fit than Model 6.

Table 20

Descriptive Statistics, One-way ANOVA, and Intraclass Correlation Coefficients for Cognitive Self-Regulation Skills Across the Preschool Year

	SITE A		SITE B		SITE C				
TIME	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*P*	ICC
FALL	9.31	4.86	8.32	4.40	11.61	4.28	6.25	<.01	.105
WINTER	11.12	4.29	12.24	3.84	12.56	4.20	1.29	.280	.01
SPRING	12.65	3.92	12.84	3.73	13.46	4.32	0.44	.644	0

Table 21

Models and Fit Statistics Used to Examine Research Question 3: Early Literacy Composite

Effects and model fit	Model 6	Model 7
Constant	X	X
Time	X	X
Time*time	X	X
Self-regulation	X	X
Self-regulation*time		
Site	X	X
Site*time		X
-2 log likelihood	1814.38	1813.18
Change in -2 log likelihood	5.1	1.2
Change in df	2	2
p-value	.078	.551

Note: The model that included the interaction of site and time (Model 7) did not provide a significantly better fit than the model without this interaction (Model 6).

Fixed and random effects are reported in Table 22 for model 6. See Appendix E for growth curve results for model 7. The fixed effects for time, time*time and self-regulation were similar to those in other models. The fixed effect associated with Site A was not significant, while the effect associated with Site C indicated that students at this site had significantly higher literacy skills.

Table 22

Model 6 Growth Curve Results: Interaction of Site and Time for Early Literacy Skill Regressions

Fixed effects	*b*	*Z*	*p*-value
Constant	4.63	7.49	<.0001
Time	2.09	5.04	<.0001
Time*time	-.56	-2.97	.003
Self-Regulation	.25	6.05	<.0001
Site A	.78	1.09	.274
Site C	1.70	2.53	.011
Random effects	Variance estimate	Standard error	*p*-value
Constant	13.14	2.80	<.0001
Time	.89	.34	<.01
Covariance	-1.87	.83	.024
Residual	2.86	.38	

Table 23 summarizes the coefficients used in models 6 and 7 for the cognitive self-regulation composite, as well as, the fit statistics for models 6 and 7. Model 7 utilized interactions of site by time, which was not statistically significant.

Although Model 5 is the best fitting model, fixed and random effects for model 6 are reported in Table 24 for informational purposes. See Appendix E for results of the growth curve analysis for model 7.

Table 23

Models and Fit Statistics Used to Examine Research Question 3: Cognitive Self-Regulation Composite

Effects and model fit	Model 6	Model 7
Constant	X	X
Time	X	X
Time*time	X	X
Early literacy	X	X
Early literacy*time	X	X
Site	X	X
Site*time		X
-2 log likelihood	1903.94	1899.46
Change in -2 log likelihood	1.98	4.48
Change in df	2	2
p-value	.372	.107

Note: The model that included the interaction of site and time (Model 7) did not provide a significantly better fit than the model without this interaction (Model 6); and Model 6 did not provide a significantly better fit than Model 5.

Overall, results of analyses completed for *Research Question 3*, indicate minimal variability across sites. The strong impact of time and self-regulation on early literacy skills remains significant. The lack of significant fixed effects for site in the analysis of self-regulation was expected since Model 6 did not provide a better fit to the data. In the analysis of early literacy, although Model 6 provided only a marginally better fit than Model 5, the fixed effect for site C (relative to site B) was statistically significant.

Table 24

Model 6 Growth Curve Results: Interaction of Site and Time for Cognitive Self-Regulation Skill Regressions

Fixed effects	*b*	*z*	*p*-value
Constant	5.16	8.32	<.0001
Time	2.32	3.75	<.0001
Time*time	-.21	-.80	.424
Early literacy	.57	9.18	<.0001
Early literacy*time	-.10	-2.38	.017
Site A	-.46	-.77	.440
Site C	.41	.72	.470
Random effects	Variance estimate	Standard error	*p*-value
Constant	8.74	3.15	<.01
Time	.98	.57	.086
Covariance	-1.80	1.22	.140
Residual	5.28	.68	

Conclusions

Results of *Research Question 1, 2,* and *3* are reported above, which indicate that students made growth in both early literacy and cognitive self-regulation skills across the preschool year, and growth in these skill sets looked very similar to one another. For example, both early literacy and cognitive self-regulation skills demonstrated a curvilinear relationship so that gains in these skills were more rapid at the beginning of the school year than at the end of the year. The findings from the present study also indicate a strong relationship between early literacy and cognitive self-regulation skills.

Therefore, students with higher cognitive self-regulation skills also had higher early literacy skills at all three time points measured. However, the impact of early literacy skills on cognitive self-regulation skills was stronger from the fall to winter than it was from the winter to spring. Overall there was not a significant difference across sites, however, Site B had significantly different initial scores from the other sites, but eventually narrowed this gap in scores by the middle and end of the school year.

CHAPTER V

DISCUSSION

The present work examined the effects of preschool progress in cognitive self-regulation and early literacy skills on school readiness. The results of this study add to a growing body of literature demonstrating the importance of behavioral aspects of self-regulation for positive academic and social outcomes, as well as the strong relationship between early literacy and cognitive self-regulation skills. This chapter includes a summary of the main findings of this study and a discussion pertaining to interpretation of these findings. Limitations of the study are discussed and implications for future research are provided.

Main Findings and Interpretation of Findings

The present study examined three research questions that targeted two critical school readiness skills: early literacy and cognitive self-regulation skills. Specifically, the present study examined the effects of preschool progress in cognitive self-regulation and early literacy skills on kindergarten readiness using multilevel growth modeling over time. Three assessment instruments were used to measure cognitive self-regulation and early literacy skills of the preschool students: the Peg Tapping Task (Diamond & Taylor, 1996), the Dimensional Change Card Sort Task (DCCS; Zelazo, 2006), and individual growth development indicators (IGDIs; McConnell, et al., 2002).

IGDIs are a set of brief, repeatable measures used to assess early academic skills. Three IGDIs were used in the present study, which comprised the composite score of overall early literacy skills. These included *Picture Naming*, which provides a measure of oral language and vocabulary, *Rhyming*, which provides a measure of phonological

awareness, and *"Which One Doesn't Belong,"* which provides a measure of comprehension skills. The Peg Tapping Task and Dimensional Change Card Sorting task are measures of inhibitory control, attention shifting, and working memory, which were used to generate the overall composite score of cognitive self-regulation.

The three research questions examined in the present study were aimed to address the growth in early literacy skills and cognitive self-regulation skills across the preschool year, as well as the relationship between early literacy skills and cognitive self-regulation in preschool students. Differences across communities were also examined. A discussion of the results is presented in order of research question examined.

Research Question 1. The first research question examined the growth in early literacy and cognitive self-regulation skills across the preschool year. Data were analyzed using descriptive statistics, Pearson correlations, and linear growth modeling. Students were found to make growth in both early literacy skills and cognitive self-regulation skills across the preschool year. Growth across the year also demonstrated a curvilinear relationship, and scores in the beginning of the preschool year, were significantly correlated with scores at the end of the preschool year. This general trend was consistent across both early literacy and cognitive self-regulation skills.

It is possible that a curvilinear relationship is due to a ceiling effect in the measures as the Peg Tapping task had a maximum score of 16 that many of the students reached by the end of the preschool year. However, a curvilinear relationship might more appropriately be explained by significant growth in the beginning of the school year and tapered growth towards the end of the preschool year as students are learning behavioral expectations rapidly within the first few months of school, which may impact both their

self-regulation and early literacy skills. To further support this hypothesis, the other self-regulation measure used, DCCS, had a maximum score that very few students reached by the end of the year.

Results also indicated that the students' scores differed from one student to another and at each time period, and the students had different rates of growth in early literacy and cognitive self-regulation skills across the preschool year. This finding is further explored through community level differences in the final research question.

Results of *research question 1* also lend support to previous research identifying the malleability of cognitive self-regulation skills (e.g. Connor et al., 2010; Raver et al., 2011; Tominey & McClelland, 2011), as children across all sites in the present study made gains in these skills. The source of the improvement cannot explicitly be explained as this growth can be due to a number of variables described in the discussion. Very few research studies have examined growth in self-regulation skills at this time, and instead have examined the predictive power of early cognitive self-regulation skills with academic trajectories in later elementary school grades.

Research Question 2. The second research question examined the relationship between early literacy and cognitive self-regulation skills in preschool students by examining correlations across measures as well as linear growth models where early literacy skills were regressed on time and cognitive self-regulation skills and cognitive self-regulation skills were regressed on early literacy skills and time. Results of *research question 2* indicated a strong relationship between early literacy skills and cognitive self-regulation skills across the preschool year, and measures were highly correlated at all three time points.

Based on the strong relationship between early literacy and cognitive self-regulation skills across the preschool year, the present research is consistent with other findings that have identified cognitive self-regulation at the preschool level as an early marker for later academic achievement (Mischel et al., 2011). Previous research indicated that underlying cognitive skills are involved in behavioral regulation, which involves processing and manipulating stimuli, or working memory; maintaining attention on relevant stimuli and shifting tasks when needed, or attention shifting; and inhibiting automatic reactions to stimuli, or inhibitory control. These components of cognitive self-regulation have been linked to academic achievement prior to the entrance to formal schooling (Blair, 2002; Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007).

A significant interaction effect between time and early literacy was found when examining influences on growth in cognitive self-regulation skills. Specifically, while the fixed coefficient associated with early literacy was positive, the interaction term of early literacy skills and time was statistically significant and negative. This finding indicated that, while students with higher cognitive self-regulation skills also had higher early literacy skills at all three time points measured, the impact of early literacy skills on cognitive self-regulation skills was stronger from fall to winter than it was from the winter to spring.

Research Question 3. The final research question examined the effects of early literacy and cognitive self-regulation skills across preschool sites. *Research question 3* was assessed using correlations, descriptive statistics, analysis of variance, intra-class correlation coefficients, and linear growth modeling. To aid in interpretation of

differences across sites, demographic and curricular differences are first discussed, followed by a summary of results and interpretation of those results.

Site Descriptions. Site A is located in a suburban area of the Pacific Northwest and has a range of Head Start and ECEAP (state-funded) preschool classrooms, as well as a classroom for students with an early childhood educational classification of developmental delay. To qualify for Head Start, families must meet or fall below the 100% of poverty income guidelines, and to qualify for ECEAP, families must meet 110% of poverty level. Therefore, about 98% of Site A students receive free and reduced lunch. Site A also represents the most ethnically diverse group of students among the three groups. Regarding curricular support, Site A uses a social-emotional curricula (PATHS), but does not have a prescribed literacy curriculum at this time. Story Champs, a language curriculum was implemented for the first time during this school year in some of the classrooms.

Site B is located in a charter elementary school within an inner-city school district in the mid-Atlantic region of the United States, and contains three preschool classrooms. About 99% of the students identify as black, and almost 100% of the students qualify for free and reduced lunch. This site has been receiving outside implementation support for several years for its implementation of two Direct Instruction programs; *Reading Mastery Signature Edition* Kindergarten Level as well as *Language for Learning*. Site B also uses CHAMPS, a class-wide positive behavior support framework.

Site C, located in the rural South, includes three preschool classrooms, and almost all students identify as white/Caucasian. Site C began implementing *Reading Mastery Signature Edition Language* Kindergarten level at the beginning of the school year in

which data were gathered and at the same time received outside consultation support to assist in implementation. Site C does not use a social-emotional curriculum.

Interpretation of Results. Results obtained from *research question 3* indicated that correlations in Site A were large across the preschool year and across measures, and correlations for Sites B and C reflected medium to large effects, but not all correlations were significant across the preschool year. Intraclass correlation coefficients were small and decreased across the preschool year for both early literacy and cognitive self-regulation skills. Further, results indicated that the differences in average scores across the sites were large in the fall, reflecting significant differences in initial skills, but were no longer statistically significant in the spring. Results indicate that scores in Site B, which had a lower average initial skill level, increased at a more rapid rate than scores in Site A and C.

Average early literacy and cognitive self-regulation scores in Site B ultimately caught up to scores in the other sites by the end of the year. There are a variety of reasons as to why this occurred, and one could argue it was due to regression to the mean. Another explanation is the strong implementation of an early literacy and language skills program. Site B had implemented Direct Instruction for several years prior to the study and was considered to have a "strong" implementation. As previously discussed, Siegfried Engelmann's Direct Instruction programs provide constant feedback to the students on their performance, which may have an indirect impact on cognitive self-regulation skills. These results are encouraging in that young children who enter preschool at a disadvantage in terms of having lower initial skills in the areas of self-regulation and early literacy skills can make more rapid gains, which decreases the gap

between these students and their peers. Although teacher-level variables were not collected in the present study, previous research (e.g. Fuhs et al., 2014) has indicated that these variables can also have great impact on the academic and cognitive self-regulation skills obtained in preschool, which may play a role in the results of the present research study.

Site C, which was also using DI reading and language programs, did not make similar strong drastic gains in scores across the preschool year. However, this was the first year of implementation. Again there are multiple plausible explanations as to why students in Site C did not experience as much growth as Site B. One explanation lends itself to the strong literature base indicating the importance of obtaining and maintaining fidelity of implementation of a specific program and the fact that it can take several years for teachers to develop the skills and schools to develop the structure to support a well implemented curriculum.

Limitations

There are some potential limitations to the present study. The discussion below describes these limitations as well as any threats to the study's internal validity including limitations to the overall study design, maturation, and testing effects.

Design. Due to a limitation of resources, the study design did not allow for any fidelity data to be collected. This includes both fidelity of implementation of the literacy and behavior management programs, as well as fidelity of data collection procedures. Despite this limitation, efforts were made to ensure that all data collectors were trained in the same manner by use of the same training videos and modules across sites. The principal investigator was also available and utilized to answer questions across sites

related to data collection procedures. When necessary, the principal investigator reached out to IGDIs development personnel for clarification on scoring. Although a lack of fidelity data is a flaw in the study design, it may also be considered a strength for the external validity of the study as it is possibly more reflective of typical practice within school districts. Many school districts do not necessarily have the resources available to collect implementation fidelity data, so data collection methods may reflect more realistic practice.

Maturation. Due to the inherent assumption that preschool students are rapidly making growth at the age of 4 and 5 years old, it is possible that the changes observed in scores from beginning, middle and end of the year were the result of maturation as students aged across the school year rather than a result of individual practices at each school site. However, one could argue that if the increase in scores is due to maturation effects, the changes should be very comparable across all sites. This was not found in the present study as students participating in the present study grew at different rates across sites, and therefore the results are likely not the result of maturation effects. Additionally, determining whether an increase in scores is due to maturation or intervention effects or simply the child's background such as home environment is difficult to assess, however, future research may explore this limitation further through longitudinal study designs. Future research may also compare student progress to normative data.

Data on student's history of schooling practices, such as whether they were in their first or second year of preschool at the time of the study, was not collected. A student's year in preschool could explain some differences in initial skills across sites, as well as across students.

Sample. This study used a small sample of students. Due to uncontrollable events, such as mobility of students, the sample size was affected. Future work using multilevel modeling should attempt to target a larger range of preschool students, such as students from a variety of communities across a broader range of socioeconomic groups. Future research may also use imputation as a solution for addressing missing data as growth modeling is fairly robust in handling missing data.

Testing Effects. Although efforts were made to reduce testing effects (e.g. altering the visual stimulus at each time point), repeated measurement may have led to testing effects as participants were already exposed to testing materials. This limitation is more specific to the cognitive self-regulation measures as there are not various forms provided for the measures, as are included for the early literacy measures. Ceiling effects could also be present in the data as there was a maximum score on each measure. Several students reached the maximum score on one cognitive self-regulation measure, the Peg Tapping task. However, very few reached the maximum score on the second cognitive self-regulation measure; DCCS.

Implications for Future Research

The current study provides several directions for future research on early intervention or preschool programs targeting students transitioning into kindergarten including longitudinal measurement of the effects of preschool alone as an intervention, further examination of variability in the sample such as differences in early literacy and cognitive self-regulation scores across gender and SES. Additionally, further research is needed to identify environmental factors related to the interaction of early literacy skills and cognitive self-regulation that facilitate student growth over time. Some various

environmental factors could include active participation in class activities, time allocated to instruction, and formative evaluation of student performance and could be associated with inter-individual differences in growth rates. Fuhs et al. (2014) found that teacher-level variables impacted cognitive self-regulation skills. Based on results obtained in the present study, the relationship between cognitive self-regulation and early literacy skills could also be impacted and future research is needed to further guide these findings.

The present work can also be expanded by examining sub-groups of the students, such as those with the lowest initial skills. Future research examining this dataset should also examine individual patterns of growth in students. From the present analyses, it is unclear whether all students actually made growth. Students with the lowest initial skills made significant growth as a group, but this could further be examined by looking at patterns of growth on an individual level.

To expand growth patterns further, possible mediators should also be examined in future analyses. For example, previous research has argued that IQ plays a large role in positive student outcomes, especially for students considered to be at-risk due to low SES (Easterbrooks, Davidson, & Chazan, 1993; Garmezy et al., 1984). It is unclear whether IQ is playing a role in the present analyses. Another possible mediator is the home environment or quality of parent-child interactions prior to preschool entry. For example, since the present data indicated significant differences across sites in initial skills, this could possibly suggest that the home environment, or the environment prior to preschool entry, is critical to explore as a mediating variable.

Another third variable that could possibly play a role in the data obtained from the present study is the comprehension of oral directions given for the self-regulation

measures. It is possible that scores were lower in the Fall due to difficulties with comprehension, and the growth that was seen was due to improving comprehension skills across the preschool year. This is difficult to tease apart, but should be considered in future research examining these critical school readiness components.

Future research may also use structural equation modeling (SEM) to explore this dataset further. SEM allows for imputation of relationships between latent variables from observable variables.

Additionally, the present study generated a composite score for overall early literacy skills and overall cognitive self-regulation skills, as school readiness in general was the outcome of interest. Future work in this area might examine the relationship between individual early literacy skills such as, phonemic awareness and comprehension with individual cognitive self-regulation skills, such as inhibitory control and attention shifting, as well as to assess growth in these individual skills across the preschool year.

Although a large number of children attend preschool the year before kindergarten, not all children are able to do so. Therefore, future research is warranted on other appropriate settings for both teaching these key school readiness skills and informing caregivers of these key skills. Another possible outlet for providing this information to caregivers is in integrated pediatric primary care settings. Weisleder and colleagues (2015) found significant effects when a video modeling intervention targeting parent-child interactions and strategies for reading with children was implemented into well-child visits in the early childhood years. This research supports another possible outlet of targeting school readiness skills within pediatric primary care settings.

Implications for Policy and Practice

These findings are important, as early intervention targeting the modification of behavioral skills is key to making broad gains both socially and academically. Children who display high rates of disruptive behavior or are considered at risk for behavior disorders are often found to have overall poor self-regulation skills (Barkley, 2010). Intervening early, prior to the start of kindergarten, can prevent the escalation of behavioral difficulties during the transition to school. Two-thirds of preschoolers with high rates of behavioral difficulties go on to receive a diagnosis of Attention Deficit/Hyperactivity Disorder (ADHD) or another disruptive behavior disorder by the age of nine, and later receive special education services (Campbell and Ewing, 1990; Redden et al., 2003).

Additionally, researchers have demonstrated specific interest in teaching self-regulatory skills during early childhood due to the malleability and plasticity aligned with this period of development in young children. The development of prefrontal cortical regions are linked to the specific skills outlined in this study (i.e working memory, inhibitory control, and attention shifting), which undergo rapid development during the childhood years (Diamond, 2002). The present research is aligned with previous research in suggesting that cognitive self-regulation is a fundamental component of school success. Previous research suggests that these skills can predict academic performance above and beyond general levels of intelligence (Blair & Razza, 2007). This again identifies that early childhood is an ideal period of development for teaching such skills.

Economists have also identified the benefit to focusing on early childhood development by suggesting that making investments in the early childhood years pay for

themselves (Heckman, 2011). Making an investment in early skill development has the potential to reduce risky behaviors over the course of the lifespan, resulting in reduced societal costs.

Conclusions

The present investigation of two key school readiness skills, early literacy and cognitive self-regulation skills, resulted in meaningful information on preparing students for the kindergarten transition. Specifically, results obtained from the first research question highlighted the growth in early literacy and cognitive self-regulation skills across the preschool year. Results of the second research question supported previous work, which outlined the strong relationship between cognitive self-regulation and academic skills, as well as extended this previous literature base by indicating that these skills are in fact highly linked even earlier than kindergarten, at the age of 4 years old and across the preschool year. Finally the third research question sought to examine community-level differences, and identified differences in growth rates across sites, which possibly reflects effectiveness of instructional programming at each site. This work contributes to the rapidly growing literature base targeting school readiness, however, additional research is needed on the best means for teaching these key school readiness skills as well as the most appropriate and accessible outlet to conduct this teaching.

APPENDIX A

PARENT/GUARDIAN PERMISSION FORM

University of Oregon
Department of Special Education & Clinical Sciences
PARENT / GUARDIAN PERMISSION FORM
UO IRB Protocol Number: 08182014.018

Introduction

Your child is invited to participate in a research study conducted by Caitlin Rasplica, from the University of Oregon, Department of Special Education and Clinical Sciences. I hope to learn about the role of early literacy skills and self-regulation, or monitoring one's own behavior, in preschool students and how they impact kindergarten readiness. I am a doctoral student in School Psychology and these results will contribute to my dissertation. Your child was selected as a possible participant in this study because he/she is four years of age and attends the Head Start/ECEAP program at the Franklin Pierce School District.

Description of Study Procedures

If your child participates, they will be given a brief assessment of their early literacy and self-regulation skills (monitoring one's own behavior) at three different time points during the school year. This includes an assessment in the Fall, Winter, and Spring. The early literacy assessment is already given to all students as part of the school district's usual procedures and takes 5 to 10 minutes to administer. It will provide information on the key early literacy skills they are developing, including phonemic awareness, vocabulary and oral language, comprehension and alphabet knowledge. Since the early literacy assessment is already administered by the district regardless of whether this study is taking place, the assessment will either be administered to your child by school staff or by a trained graduate student from the University of Oregon. The self-regulation assessment takes between 5 and 7 minutes and involves tapping a pattern in response to a pattern tapped by the assessor and sorting cards based upon a rule, such as sorting by color or shape. This assessment will be administered by a trained graduate student from the University of Oregon. All assessments will be administered within the preschool classroom during the typical school day, at times that are approved by the school staff.

Risks/ Discomforts

Although researchers will make every effort to protect your child's confidentiality, there is a minimal risk of loss of confidentiality. No other risks or discomforts are anticipated. There are no anticipated risks associated with participating.

Costs

There are no costs to participate.

Benefits

Teachers and participants may benefit from this study as key early literacy outcomes will be identified for each individual student, which provides information on where your child is performing in comparison to other students of their same age. These data will be provided to teachers, which will provide guidance on teaching instruction. This study may also benefit the general education community as it will provide a greater understanding of the role of early literacy skills and self-regulation in preschool students, both of which are key skills and indicators of a successful transition to school. However, I cannot guarantee that you or your child will personally receive any benefits from this research.

Confidentiality

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission. Your child's identity will be kept confidential by removing all identifying information from the data. Participants will be given a unique identifier, so that their name will not be connected with the data. Data will be stored on password-protected computers. The early literacy data will only be provided to your child's teacher to provide information on where your child is performing, with the hope of better preparing your child for Kindergarten. The data on self-regulation will not be shared. At the conclusion of the study, the results will be shared with the school district. At this time all data that is shared will be in aggregate form, so that it is both de-identified and represents a summary of all of the students who participated in the study as a whole, rather than individual student data.

Voluntary Participation/Withdrawal

Your child's participation is voluntary. Your decision whether or not to let your child participate will not affect your relationship with the Franklin Pierce School District Head Start/ECEAP. If you do decide to allow your child to participate, you are free to withdraw your consent and discontinue your child's participation at any time without penalty.

Contact Information and Questions

If you have any questions or concerns about the study, please feel free to contact Caitlin Rasplica by phone at 253-312-6709 or by email at rasplica@uoregon.edu. You may also contact the academic advisor, Roland Good, for this study at rhgood@uoregon.edu or at 541-954-9222. If you have questions regarding your child's rights as a research subject, contact Research Compliance Services, University of Oregon at (541) 346-2510 or researchcompliance@uoregon.edu.

Signatures/ Dates

Your signature indicates that you have read and understand the information provided above, that you willingly agree to your child's participation, that you may withdraw your consent at any time and discontinue participation without penalty, that you have received a copy of this form, and that you are not waiving any legal claims, rights or remedies.

Print Parent/Guardian Name_____

Parent/Guardian Signature_____

Date_____

Child Name _____

APPENDIX B

CORRELATIONS FOR GENERATION OF COMPOSITE SCORES

Table 1.

Early Literacy Skills Across Time: Correlations (N = 125)

Measures	1	2	3	4	5	6	7	8
1. Picture Name Fall	–							
2. Rhyming Fall	.63	–						
3. WODB Fall	.58	.60	–					
4. Picture Name Winter	.78	.59	.60	–				
5. Rhyming Winter	.49	.65	.52	.55	–			
6. WODB Winter	.50	.53	.54	.55	.45	–		
7. Picture Name Spring	.67	.54	.55	.80	.50	.48	–	
8. Rhyming Spring	.47	.60	.42	.50	.73	.36	.58	–
9. WODB Spring	.56	.58	.53	.61	.57	.69	.54	.60

Table 2.

Cognitive Self-Regulation Skills Across Time: Correlations (N = 125)

Measures	1	2	3	4	5
1. Peg Tapping Fall	–				
2. DCCS Fall	.45	–			
3. Peg Tapping Winter	.54	.37	–		
4. DCCS Winter	.39	.59	.46	–	
5. Peg Tapping Spring	.48	.40	.73	.43	–
6. DCCS Spring	.40	.53	.42	.64	.45

APPENDIX C

FIXED AND RANDOM EFFECTS OF LINEAR GROWTH MODELS 1, 2, AND 3

Table 1

Growth Curve Model Results – Early Literacy: Base Model, Linear and

Quadratic Effect of Time

	Model 1			Model 2			Model 3		
Fixed Effects									
	b	z	*p*-value	b	z	*p*- value	b	z	*p*-value
Constant	9.92	28.59	<.0001	8.12	20.97	<.0001	7.88	20.11	<.0001
Time	--	--	--	1.40	10.42	<.0001	2.86	7.59	<.0001
Time*time	--	--	--	--	--	--	-.73	-4.16	<.0001
Random Effects	Est	se	*p*-value	Est	se	*p*-value	Est	se	*p*-value
Constant	19.52	3.28	<.0001	16.30	2.39	<.0001	16.59	2.39	<.0001
Time	2.71	.56	<.0001	.77	.34	.024	.94	.33	.004
Covariance	-3.92	1.20	.001	-1.41	.66	.033	-1.59	.66	.016
Residual	2.95	.37		2.95	.37		2.59	.33	

Table 2

Growth Curve Model Results – Self-Regulation: Base Model, Linear and Quadratic Effect of Time

	Model 1			Model 2			Model 3		
Fixed Effects									
	b	z	*p*-value	b	z	*p*- value	b	z	*p*-value
Constant	12.05	36.37	<.0001	9.92	25.04	<.0001	9.69	23.97	<.0001
Time	--	--	--	1.65	9.77	<.0001	3.04	5.98	<.0001
Time*time	--	--	--	--	--	--	-.69	-2.90	.004
Random Effects	Est	se	*p*-value	Est	se	*p*-value	Est	se	*p*-value
Constant	19.90	3.62	<.0001	15.38	2.54	<.0001	15.65	2.54	<.0001
Time	3.75	.86	<.0001	1.02	.56	.068	1.18	.54	.029
Covariance	-5.56	1.54	<.001	-2.04	.91	.025	-2.20	.91	.016
Residual	5.12	.65		5.12	.65		4.79	.61	

APPENDIX D

FIXED AND RANDOM EFFECTS OF LINEAR GROWTH MODELS 4 AND 5

Table 12

Growth Curve Model Results: Models 4 and 5, Literacy Regressed on Time and Self-Regulation

	Model 4			Model 5		
Fixed Effects						
	b	z	*p*-value	b	z	*p*- value
Constant	5.41	10.28	<.0001	5.79	9.74	<.0001
Time	2.09	5.04	<.0001	1.76	3.51	<.0001
Time*time	-.56	-2.97	.003	-.62	-3.22	.001
Self-Reg.	.25	6.04	<.0001	.22	4.29	<.0001
Self-Reg*Time	--	--	--	.04	1.24	.215
Random Effect	Est	se	*p*-value	Est	se	*p*-value
Constant	11.01	1.95	<.0001	11.68	2.16	<.0001
Time	.89	.34	.008	.90	.35	.010
Covariance	-1.09	.58	.060	-1.39	.68	.041
Residual	2.86	.38		2.84	.38	

Table 13

Growth Curve Model Results: Models 4 and 5, Self-Regulation Regressed on Time and Literacy

	Model 4			Model 5		
Fixed Effects						
	b	z	*p*-value	b	z	*p*- value
Constant	5.79	11.51	<.0001	5.12	8.89	<.0001
Time	1.62	2.92	<.0001	2.29	3.71	<.0001
Time*time	-.33	-1.29	.197	-.20	-.78	.435
Literacy	.50	9.91	<.0001	.58	9.35	<.0001
Literacy*Time	--	--	--	-0.10	-2.37	.018
Random Effect	Est	se	*p*-value	Est	se	*p*-value
Constant	6.87	1.63	<.0001	6.29	1.52	<.0001
Time	1.15	.59	.051	.98	.57	.085
Covariance	-1.34	.77	.082	-.89	.74	.229
Residual	5.35	.69		5.30	.68	

APPENDIX E

FIXED AND RANDOM EFFECTS OF LINEAR GROWTH MODELS 6 AND 7

Table 20

Growth Curve Model Results: Interaction of Site and Time for Literacy Skill Regressions

	Model 6			Model 7		
Fixed Effects						
	b	z	*p*-value	b	z	*p*- value
Constant	4.63	7.49	<.0001	4.61	7.28	<.0001
Time	2.09	5.04	<.0001	2.26	4.98	<.0001
Time*time	-.56	-2.97	.003	-.57	-3.03	.002
Self-Reg	.25	6.05	<.0001	.24	5.68	<.0001
Site A	.78	1.09	.274	.85	1.06	.288
Site C	1.70	2.53	.011	2.08	2.72	.006
Site A*time				-.07	-.21	.836
Site C*time				-.34	-1.07	.286
Random						
Effect	Est	se	*p*-value	Est	se	*p*-value
Constant	13.14	2.80	<.0001	13.27	2.80	<.0001
Time	.89	.34	<.01	.86	.34	.011
Covariance	-1.87	.83	.024	-1.84	.82	.025
Residual	2.86	.38		2.83	.38	

Table 22

Growth Curve Model Results: Interaction of Site and Time for Self-Regulation Regressions

	Model 6			Model 7		
Fixed Effects						
	b	z	*p*-value	b	z	*p*- value
Constant	5.16	8.32	<.0001	5.00	7.86	<.0001
Time	2.32	3.75	<.0001	2.64	4.13	<.0001
Time*time	-.21	-.80	.424	-.24	-.94	.348
Literacy	.57	9.18	<.0001	.54	8.55	<.0001
Literacy*time	-.10	-2.38	<.0001	-.08	-1.90	.057
Site A	-.46	-.77	.440	-.03	-.04	.966
Site C	.41	.72	.470	1.28	1.81	.070
Site A*time				-.44	-1.05	.293
Site C*time				-.86	-2.14	.032
Random						
Effect	Est	se	*p*-value	Est	se	*p*-value
Constant	8.74	3.15	<.01	8.53	3.10	<.01
Time	.98	.57	.086	.85	.55	.122
Covariance	-1.80	1.22	.140	-1.60	1.20	.183
Residual	5.28	.68		5.26	.68	

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